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慶應義塾大学大学院経営管理研究科修士課程

学位論文（ 2020 年度）

論文題名

**Research on electric vehicle charging strategy
of automakers in China**

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論文要旨

所属ゼミ	浅 川 和 宏 研究会	氏名	岳 嵐嵐
Research on electric vehicle charging strategy of automakers in China			
<p>Abstract</p> <p>This research is about the different electric vehicle charging strategies offered by automakers in China. As we all know that the trend of electrification of automobiles has swept the world due to the energy saving and emission reduction. Unlike traditional automobile industry in which there's no worry about refueling, the distance anxiety, high battery price and the inconvenience of charging, all of these are the obstacles that would prevent customers from purchasing electric vehicles. Therefore, this paper will firstly discuss the shortcomings of the charging infrastructure in China and then study the performance of different charging strategies adopted by old players and new players in automobile industry through case analysis.</p> <p>Through the analysis of the charging pile industry and the strategies adopted by 3 auto companies in this industry, findings are summarized as follows:</p> <p>The improvement of charging infrastructure is very necessary to promote the electric vehicles in China.</p> <p>Car companies with new game strategy can solve the existed problems and do great contributions to the development of charging industry while old players with old game strategy cannot.</p> <p>NIO and BMW, new players in this industry, are free to adopt new game strategies to change the rule of the game and better suit the transformation of automobile industry. Moreover, BMW's strategy is more sustainable in the long term and easier to spread among other potential players in automobile industry.</p>			

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1.Introduction

This research is about the different electric vehicle charging strategies offered by automakers in China. As we all know that the trend of electrification of automobiles has swept the world due to the energy saving and emission reduction. Many countries around the world including China have gradually introduced various preferential policies to promote the development and consumption of new energy vehicles. Unlike traditional automobile industry in which there's no worries about refueling, the distance anxiety, high battery price and the inconvenience of charging, all of these are the obstacles that would prevent customers from purchasing electric vehicles. However, the automakers in China, especially for many local automakers, pay more attention to the R&D in battery technologies while have done little to construct charging facilities or offer charging services to users compared with the situation that charging facilities are almost built by automakers in Europe and America. Therefore, this paper will firstly discuss the problems of the charging infrastructure in China and then study the performance of different charging strategies adopted by old players and new players in automobile industry through case analysis in order to find out the way to improve electric vehicle users' charging experience.

The research questions of this paper are: What are the problems of charging infrastructure in China and How does automobile company improve user's charging experience?

Although China is currently the largest country in sales of electric vehicles, the purchase of electric vehicles is more rely on the subsidies on the demand side. With the reduction of car purchase subsidies from Chinese government, consumers will be more rational when buying electric cars and pay more attention to the quality and convenience of utility of the car. Since the battery capacity seems hard to be improved greatly in a short time, how to enhance the charging infrastructure and make charging more convenient become more important to promote electric vehicles in the present.

When mentioned to auto companies that build charging piles, the first one that comes to mind probably is Tesla. Unlike traditional car companies who only need to build a good car, electric car manufacturers also need to consider charging issues, especially the first mover in new energy vehicle industry. As early as when Model S went on the market, Tesla had already started the layout of super charging stations. As in the middle of 2020, Tesla had established 1,533 super charging stations in China and nearly 14,000 super charging stations around the world. The reason for Tesla to build its own charging network was largely because all the charging piles in the market at that

time were with low charging capacity and could not meet its needs. Taking the United States as an example, there are only 2 main charging pile companies, ChargePoint and Greenlots, and the whole charging pile industry are characterized by a small number of companies with a slower distribution speed. If automobile companies want to promote the sales of electric vehicles there, they must find ways to solve the slow construction of related infrastructure by themselves.

However, different from the U.S., the top three charging pile builders (in terms of the number of charging piles) in China are Telt, Star Charging and the State Grid Corporation and none of them have an auto manufacturing background. Although the business areas of above three operators are different (Telt and the Star Charging focus on charging pile constructions in cities while the State Grid monopolizes the highway charging constructions), the same is that for a long period of time, charging pile companies have been in a state of loss. This may be the reason why Chinese auto companies were reluctant to enter this field too much in the early days.

Since the proportion of new energy vehicles was only about 4% in total vehicles reported in 2019, it is more urgent to find out what are the unsatisfied charging experience for Chinese electric vehicle users and can automakers solve these problems and improve users' charging experience.

To fill this gap, the current status and problems of charging facilities in China will be studied. Then through the case study, the innovative charging services offered by two auto companies will be analyzed through AVAC analysis in order to learn the advantages and disadvantages of both approaches compared with old charging strategy from old player, and give suggestions for other automakers that is selling or prepare to sell electric vehicles in China. Therefore, the rest of the thesis is organized according to the following schedule:

Chapter 2: Briefly explain the background of this topic and the theory applied to the study of this topic.

Chapter 3: Introduce the research method of this study, the data collection of primary and secondary data and the most important case study method in this paper.

Chapter 4: Give an overview of electric vehicle market and charging pile industry in China based on which summarize the problems of the charging infrastructure in China that lower the users' charging experience.

Chapter 5: Study the charging strategies adopted by three auto companies respectively and analyze the features of each strategy.

Chapter 6: Discussed the advantages and disadvantages of these strategies through comparisons and concluded a best one that suits most automakers and can optimize users' charging experience from the long-term perspective.

2. Background

2.1 Phenomenon

Both Chinese and foreign automobile brands have launched electrification strategies in recent years. While accelerating product line matrix and increasing vehicle sales, the construction of charging infrastructure is essential. As the policy subsidies for new energy vehicles from Chinese government are gradually receding from 2020, the changes from ‘policy-oriented’ to ‘market-oriented’ in the current Chinese electric vehicle market will result in a more open market environment. Although the charging infrastructure in China has developed swiftly these years, there are still many problems complained by users and concerned by other potential customers that is negative for the diffuse of electric vehicles in China. But Chinese automakers always put more resources in developing battery capacities overlooking the importance of charging experience and charging infrastructure. Since 2020, the national government has begun to tilt subsidies from new energy vehicle purchasing to construction and operation of charging infrastructure. Therefore, it’s obviously a signal that automakers should put more effort on charging infrastructure.

In fact, Chinese auto companies also have relatively early players in the field of charging piles. As early as 2015, SAIC Group founded a charging pile company called ANYO Charging. At that time, SAIC Group stated that its main purpose of the construction of public charging piles was to promote and sell new energy vehicles to meet the needs of the ‘new energy vehicle strategy’. Up to now, the number of ANYO Charging piles in the market has reached more than 15,000 units. In addition, BYD also launched the charging pile business in the same year but gave up this business in 2019. In the fifth chapter, ANYO Charging’s strategy will be discussed and compared with new game strategies played by new player NIO Motor and BMW.

2.2 Theory

With the Chinese government’s subsidies and positive policies for promoting new energy vehicles in early years and further expansion of the new energy vehicle market these years, the entry of a large number of new car companies, not only high-end level composed of joint ventures between Chinese state-owned auto companies and multinational brands like BMW, Volkswagen, etc., middle and lower tiers including private or local state owned automobile companies, but also a

number of smaller automakers of private ownership are competing together in this booming electric vehicle industry. However, as an emerging mode of transportation, electrified vehicle customers are often anxious about the state of their vehicle, including the battery state of charge, available electric miles, vehicle energy consumption etc., among other pieces of information (N. Khalid Ahmed and J. Kapadia, 2017). Electric vehicles lack the energy supplement network similar with the gas refueling stations would seriously block the diffuse and development of new energy vehicles. Thus, the charging services can be a kind of aftersales for new energy vehicles that is very different from traditional gasoline cars since car companies don't consider refueling as a service for their customers in gasoline vehicle era. On the other hand, this also gives the possibilities for auto companies to differentiate themselves from other competitors from the charging services (like Tesla) and take competitive advantages from it. The innovative charging service could be an innovative strategy for one company. But since it's a new game and has no reference before, we need to apply a framework to analyze these new charging strategies and see if these companies are applying the right new game strategies and offer values that appreciated by customers.

According to Alan Afuah (2007) in his book 'Strategic Innovation', strategic innovation is a game-changing innovation in products/services, business models, business processes, and/or positioning vis-à-vis coopetitors to improve performance. A new game strategy is a set of activities that creates and/or appropriates value in new ways. A new game strategy not only entails some type of commitment but also involves tradeoffs. In his theory, the new game strategy is a function of the four components: Activities, Value, Appropriability, and Change (AVAC). Thus, one can estimate the extent to which a new game strategy stands to give a firm a competitive advantage by answering the following four questions:

- 1 Activities: is the firm performing the right activities? Does it have what it takes to perform them?
- 2 Value: do customers perceive the value created by the strategy as unique?
- 3 Appropriability: does the firm make money from the value created?
- 4 Change: does the strategy take advantage of change (present or future) to create unique value and/or position itself to appropriate the value?

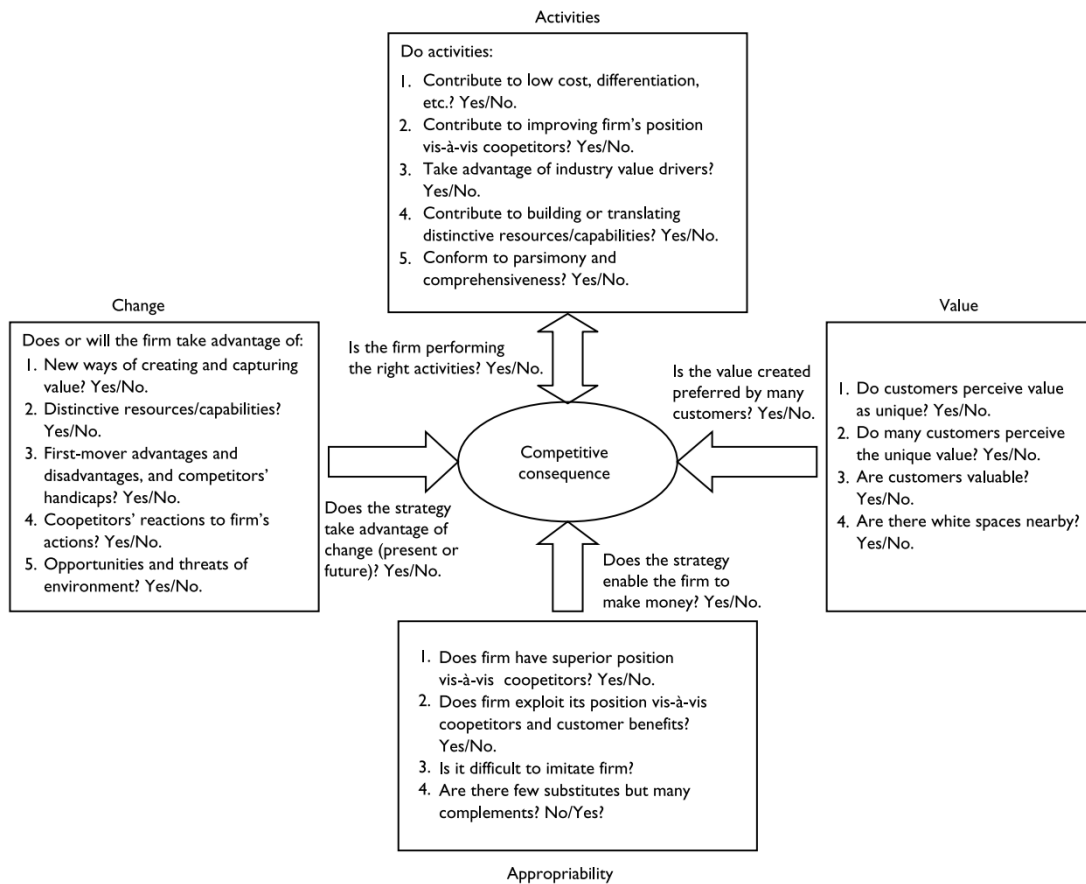


Figure 2-1: Drivers of the Components of an AVAC Analysis

(Graph from: Allan Afua, Strategic innovation, 2007)

The AVAC analysis can be used to estimate the profitability potential of a strategy or the extent to which a strategy is likely to give a firm a competitive advantage.

3.Methodology

3.1 Method

This paper takes an inductive approach to do the research. Researcher starts to collect data and make conclusions from the data which build up theories. This research tended to gain new knowledge about the stated phenomenon and the innovation of charging services in the cases. In the study, author have to gain empirical data before summarizing a general pattern. The final decisions are built up from the conclusions that accepted from the empirical investigation.

In this paper, both primary and secondary data were collected and analyzed to support the research. To look deep into SAIC Group's ANYO Charging company's charging pile business and future plan, I interviewed the operation director, Mrs. WU of ANYO Charging and asked some questions as follows:

What's your current charging strategy? Why took this strategy?

How is ANYO Charging's financial situation these years? Profit or loss?

How many fast and slow charging piles have been constructed by ANYO Charging until now?

How about the utility rate of both kinds of charging piles?

Is ANYO trying to do cooperation with other charging companies to interconnect charging pile information? If no, why and what are the difficulties?

Will SAIC Group keep on investing in ANYO Charging to expand charging pile business? What's your next five-year plan?

This interview has greatly helped me understand the competitive relationship in the charging pile industry and the difficulties in cooperation between existing charging pile companies. The primary data about the number of charging piles ANYO owns and the utility rate will be showed by graph and the main content will be expressed in the SAIC Group case of the case study chapter.

The secondary data are collected form several related industry reports, professional auto-service website and auto companies' official websites. Detail sources will be listed in the reference part.

3.2 Case study research

An initial definition of the research question is important in building theory from case studies because it permitted these investigators to specify the kind of organization to be approached, and

the kind of data to be gathered (Eisenhardt 1989). In this paper, the research questions are defined as following:

What are the problems of charging infrastructures in China?

How does automobile company improve users' charging experience?

Unlike hypothesis-testing studies that rely on statistical sampling, the goal of theoretical sampling is to choose cases which are likely to replicate or extend the emergent theory (Eisenhardt 1989). In this paper, the sample author has chosen is not random, but reflects the selection of specific cases to extend the pattern to a broad range of organizations. Three companies, famous multinational automobile company BMW who is new comer in Chinese electric vehicle market, new set-up internet electric vehicle company NIO Motor and traditional Chinese state-owned automobile company SAIC Group are chosen. Both BMW and NIO Motor are playing new game strategies of charging services while SAIC is still playing the old game. SAIC is the first automobile company to participate in the charging pile industry and offer charging service for all electric vehicle drivers unlike Tesla. Now ANYO Charging by SAIC Group has the most public charging piles among all automobile companies. BMW, a multinational company that is planning to release 5 to 10 electric models into Chinese market, has adopted a new game strategy to build a platform to integrate existing public charging piles on its platform and cooperate with the State Grid electricity company so that BMW will be able to offer more than 270,000 public charging piles to their customers in 2020 and develop super-charger with 350kW capacity. NIO motor is the only car company that build its own holistic power system in China to serve its users with several charging services including battery swap. Based on its power system, they further developed a new business model called BaaS model to separate the purchase of vehicle and battery.

Qualitative research is more useful understanding different behaviors and is more process orientated than quantitative research. In this paper, how different new game strategies to affect these drivers of AVAC analysis such as low cost, differentiation, value, change, etc. and thus what kind of competitive advantages the company will get will be discussed. By comparing the advantages and disadvantages of three different approaches, author will summarize a proper application for auto company to offer charging services. This is more behavior and process oriented so that a qualitative research is more suitable.

4. Overview of charging pile industry in China

4.1 The new energy vehicle market in China

Since 2014, under the encouragement of national policies, China's new energy vehicle sales have increased year after year, and the penetration rate has also increased rapidly. From 2018, government subsidies have gradually decreased, and sales of new energy vehicles began to slowdown. By 2019, new energy vehicles accounted for 4.59% of overall vehicle.

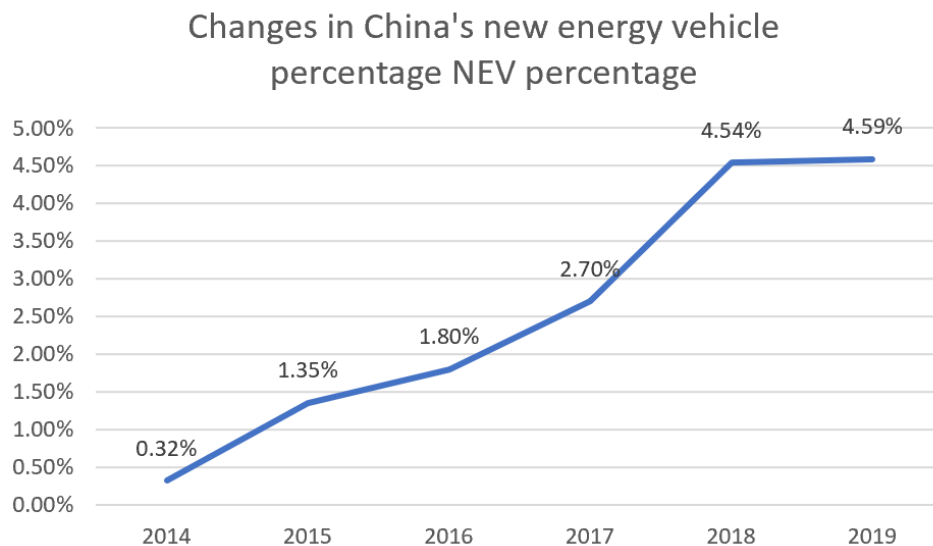


Figure 4-1: Changes in China's new energy vehicle percentage

(Data from: Annual report on new energy vehicle industry in China (2019), 2020, graph by author)

4.2 The charging pile market in China

4.2.1 Types of charging piles in China

There are mainly 2 kinds of charging piles in China, Alternating Current (AC) slow charging pile and Direct Current (DC) fast charging pile. AC slow charging pile is with mature technology, low barriers, low construction cost, but low charging efficiency, so it's suitable for long-time charging application scenarios, for example, charging at home or at work place. Currently the public AC pile charging power is mainly 7 kW, for an electric car with 70 kWh capacity, it takes about 10

hours to fully charge the battery.

DC fast charging pile is with higher power, but the technology is complex and costly, suitable for professional centralized operation and maintenance scenarios. The average power of public DC charging piles in China is about 60 kW. The power of latest DC charging piles reached 120 kW in 2020. It takes about 1 hour to fully charge a battery with 70 kWh capacity.

	AC charging pile	DC charging pile
Input	AC grid 220V	AC 380V
Output	volt 220V, current 16~32A	Continuously adjustable DC, max.volt 750V, max.current 250A
Application scenario	Parking lot, home charging interface	Fast charging pile
Charge time	5~10 hours	0.3~0.5 hours
Charge power	<10kW	50~120kW
Impact on battery life	Good	Harmful
Infrastructure investment	Simple structure, low cost	Transformers and harmonic devices are expensive
Station characteristics	Low impact on the power grid, low requirements for	High requirements for power distribution,
	power distribution expansion, small footprint, flexible layout	large area for the construction of fast charging stations
Average price of equipment	6000 RMB (\$925)	80000~120000 RMB (\$12330~\$18495)

Table 4-1: Comparison of performance indexes of DC pile and AC pile

(Data from: In-depth report on the electrical equipment industry, Shengang Securities, 2019,

Table edited by author)

4.2.2 The development of public charging pile industry in China

In China, different from the high construction rate of private piles in U.S, about one third electric vehicles users cannot install private piles due to the constraints of the objective environment. And the need for long distance driving across provinces and cities also require power supply on the way. Therefore, the public charging pile construction in China is critical to diffuse electric vehicles.

After introduction of ‘New National Standard’ for unified physical interface of charging piles, in 2016, the construction of charging piles increased quickly. While since the long payback period and the commercial centers and other places with higher utilization rates have basically been divided up by charging pile operators, the entire industry quickly calmed down and the increase rate of public charging piles are decreasing year by year.

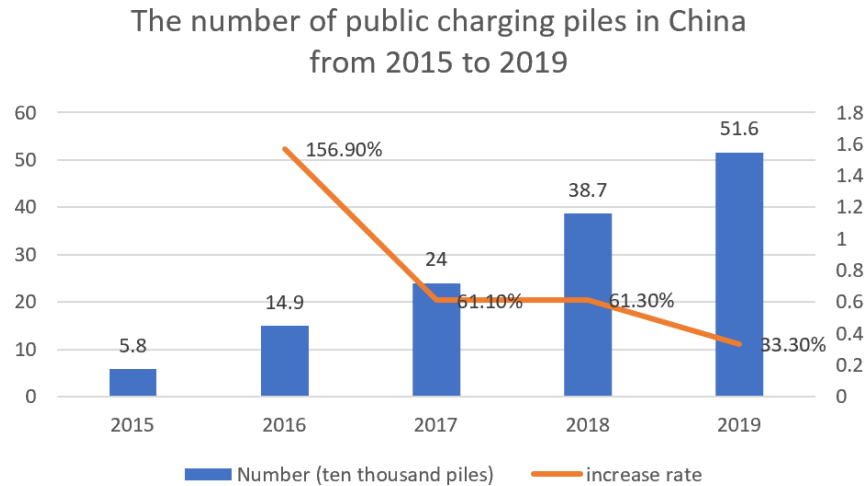


Figure 4-2: The number of public charging piles in China from 2015 to 2019

(Data from: Annual report on new energy vehicle industry in China (2019), 2020, graph by author)

The graph above shows that although the total number of charging piles are growing every year, the increase rate is continuously decreasing.

In the early stage of the development of the charging pile industry, charging pile operators largely built cheaper AC piles to grab popular areas. In 2019, the proportion of AC piles accounted for more than 60% of public charging piles, but the utilization rate is significantly lower than that of DC piles.

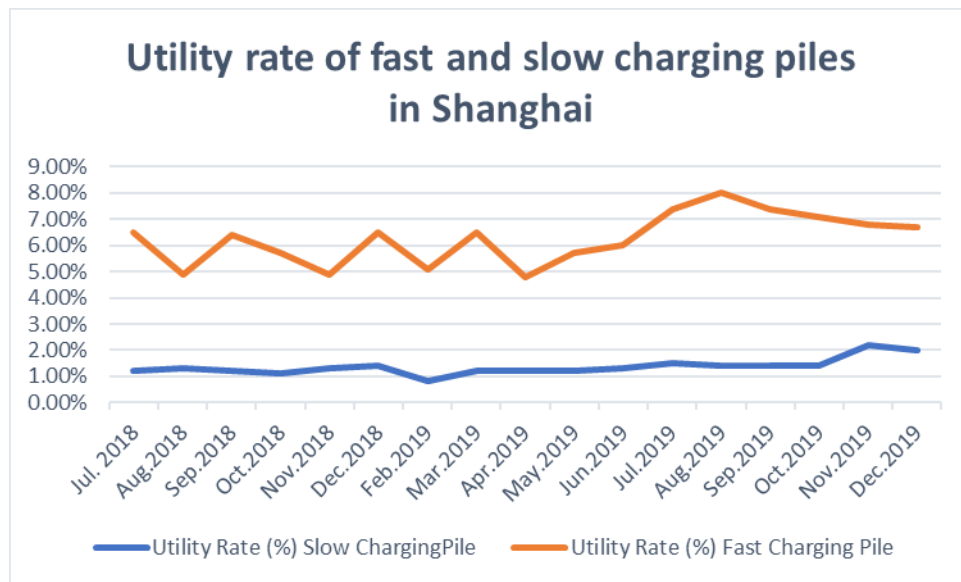


Figure 4-3: Utility rate of fast and slow charging piles in Shanghai

(Data from: Annual report on new energy vehicle industry in China (2019), 2020, graph by author)

According to the graph, it is understood that fast charging piles are with higher utility which means the need for fast charging pile is much bigger than that for slow ones. But currently, the proportion of slow charging pile is more than 60% of total public piles. This raises the first problem of charging infrastructure in China that the largely built slow piles cannot meet user's needs for shorter charging time.

4.2.3 The players and market share of charging pile operators

In 2019, there are three operators with more than 80,000 charging piles each and 356,000 units in total, accounting for 69% of the public charging piles in China. The industry concentration is relatively high, and the leading companies have significant advantages. At the same time, the number of charging piles for local small enterprises is also increasing steadily. At present, the players in charging pile industry is in a situation where leading enterprises are the mainstay and small enterprises are the supplementary. However, the current charging pile industry is in the transition from the initial stage to the mid-term, and the number of charging piles has not yet reached the national target, so the industry structure has not been fully concluded.

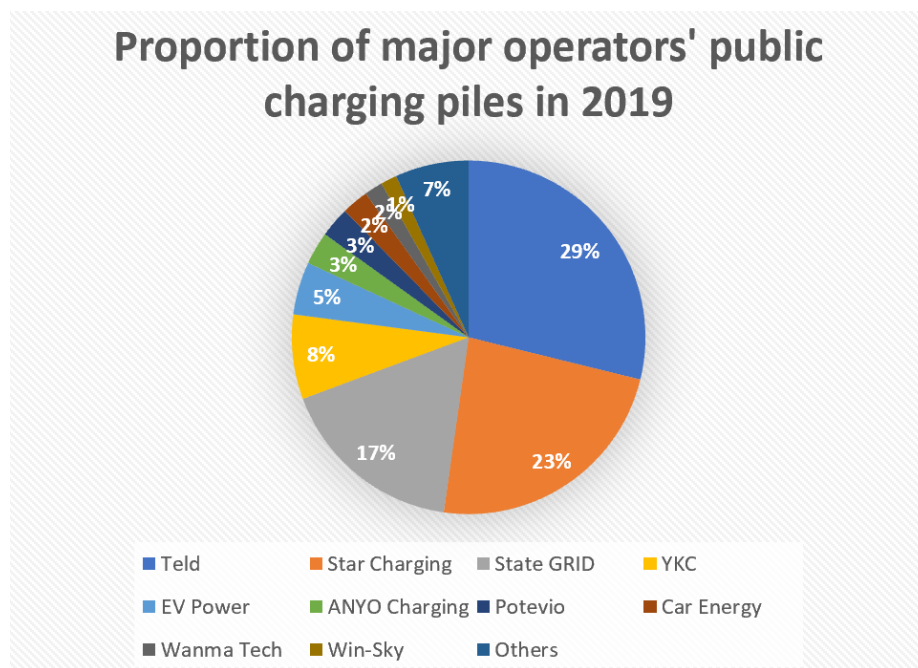


Figure 4-4: Proportion of major operator's public charging piles in 2019

(Data from: China's public charging pile industry research report, 2020, graph by author)

From the graph, we can see that there are 10 major players in charging pile industry. Most of them are with electric equipment manufacturing and power supply background. Only one is founded by auto mobile company.

Now it is understood that there are few auto companies are doing contributions to charging infrastructure in China.

4.2.4 Problems of current charging infrastructure in China

Since Each charging pile company has its own charging APP, the various players in charging pile industry result in complicate searching and payment process. Users need to download more than one APP, register several accounts and search simultaneously to satisfy charging demand. And another problem mentioned before is the slow charging speed result from the largely built slow AC charging piles.

In a word, the slow charging speed and complicate searching and payment method are the 2 main problems that make charging experience worse than refueling in China.

5. Case analysis

To study how automakers can solve the problems in charging infrastructure in China and improve charging experience effectively, 3 auto companies will be explained in this chapter. Among them, one is old player and other two are new players in charging industry. The first one is the old player SAIC Group who is the biggest state-owned auto group in China and is the first auto company to participate in charging pile industry. The second player is NIO Motor, a new set-up trying to offer new power services through new game strategy. Now it's the most popular new electric vehicle brand in China for its power service. The third player is BMW, who is a new comer in Chinese pure electric vehicle market hoping to build charging network quickly through new game strategy.

5.1 State-Owned SAIC Group: Old game strategy

5.1.1 Company introduction

Shanghai Automotive Group Co., Ltd., as a leading domestic automotive listed company, strives to grasp the industry development trend and accelerate the innovation and transformation. It is moving from a traditional manufacturing enterprise to providing consumers with mobile integrated supplier development of travel services and products. At present, the main business of SAIC Group includes the research and development, production and sales of complete vehicles (including passenger vehicles and commercial vehicles). It is actively promoting the commercialization of new energy vehicles and internet connected vehicles, and conducting research and industrialization exploration of intelligent driving technologies; R&D, production, and sales of parts (including power train systems, chassis systems, interior and exterior trim systems, core components and smart product systems for new energy vehicles such as batteries, electric drives, power electronics, etc.); logistics, automotive e-commerce, mobile travel services such as energy saving and charging services; automobile-related finance, insurance and investment businesses, overseas operations and international commerce businesses, and actively deploy in the fields of industrial big data and artificial intelligence technologies.

The main vehicle companies affiliated to SAIC include SAIC Passenger Vehicle Branch (popular independent brand ROEWE), SAIC Maxus, SAIC Volkswagen, SAIC GM, SAIC GM Wuling, Nanjing Iveco, SAIC Iveco Hongyan, Shanghai Shenwo, etc.

In 2019, SAIC Motor sold 6.238 million complete vehicles throughout the year, with a domestic market share of 22.7%. While continuing to maintain its leading advantage in the domestic automotive market, it achieved sales of 185,000 new energy vehicles (most of them are plug-in hybrid electric vehicles), a year-on-year increase of 30.4%, continuing to maintain a relatively fast pace in sales growth. It also realized the export of complete vehicles and overseas sales of 350,000 units, a year-on-year increase of 26.5%, ranking first among domestic auto groups. In August 2020, SAIC Motor's consolidated sales revenue of US\$122,071.4 billion for the previous year ranked 52nd in the Fortune 500 list. It has been included in the top 100 list for 7 consecutive years and is ranked 7th among the global auto companies on the list.

SAIC's new energy vehicle strategy for next five years:

Looking into the future, SAIC will firmly grasp the general direction of scientific and technological progress, the general pattern of market evolution, the general trend of industry changes, and continue to deepen the "New Four Modernizations" strategy of "electricity, intelligent network connection, sharing and internationalization". While striving to improve performance, in-depth deployment and promotion of innovation chain construction in the process of restructuring the global automotive industry value chain, SAIC Motor is striding forward to the goal of seizing advantageous positions and commanding heights, accelerating business transformation and upgrading, and becoming a world-class auto company with global competitiveness and influence. It was informed that at the plenary session of the '2020 World New Energy Vehicle Conference', SAIC's President Wang Xiaoqiu revealed that SAIC will continue to invest in the three technical routes of 'pure electric, plug-in hybrid, and fuel cell'. SAIC plans to launch nearly 100 new energy products by 2025, doubling the current number of SAIC new energy vehicle models. Among them, there are no less than 20 plug-in hybrid products and 10 hydrogen fuel cell products.

It was also reported that SAIC will continue to increase the launch of Chinese brand-new energy products, from passenger cars to commercial vehicles, aiming at different usage scenarios, launching nearly 60 independent new energy models, and will also accelerate the release of new energy models in joint ventures with foreign partners. In the near future, SAIC Volkswagen's first MEB electric car ID.4 will be put into production and listed. In the future, SAIC Volkswagen's Volkswagen and Skoda brands will launch new energy products, covering the mainstream market segments of luxury large and medium-sized cars to economical small cars. New energy products will account for more than 40% of the new models launched by SAIC General Motor (joint venture) in China in the next five years, covering the three major brands of Cadillac, Buick, and Chevrolet, and 100% of these new energy models will be domestically produced.

In fact, SAIC Group released their first pure electric passenger car in 2012 and first PHEV in 2013. At that time, according to SAIC Group, they decided to participate in the construction of charging facilities in order to promote their new energy vehicles. But unlike Tesla who only build fast and super charging piles for their own customers, SAIC Group set up a company, ANYO Charging, to operate charging piles to all users not only for its own customers.

5.1.2 Old game strategy: set up charging pile company ‘ANYO Charging’

Shanghai SAIC ANYO Charging Technology Co., Ltd. is a one-stop integrated service provider under SAIC Group engaged in the investment, construction and operation of new energy vehicle charging facilities. ANYO Charging was established on October 28, 2015, with a registered capital of 300 million yuan, funded by SAIC Motor. The company's main business scope includes: charging system and terminal network investment and construction, charging and leasing system management, parking lot resource integration, electronic payment and new energy vehicle-related industrial chain business. At present, ANYO's charging pile network have covered 17 districts in Shanghai. The charging piles in Hangzhou, Wuxi, Liuzhou, Nantong, Dalian, Tianjin and other places are also under development and construction. More than 10,000 charging piles have been put into operation, of which, 80% are located in Shanghai. In addition, ANYO Charging has also deployed charging station facilities in Hangzhou, Beijing, Huzhou, Taiyuan, Xi'an, Guangzhou, Wuhu, Qinhuangdao, Shaoxing and other places.

In 2015, the entire charging pile market was in its infancy period, lacking a unified industry standard, and the profit model was not clear, which left companies who want to enter the market in a state of confusion. At that time, SAIC started to investigate and study the charging pile market. In order to promote and sell new energy vehicles, in line with its ‘new energy vehicle strategy’, in the second half of 2015, SAIC Group established ANYO Charging to enter the charging pile industry. In terms of specific location selection, ANYO Charging is mainly deployed in places with a lot of traffic such as commercial centers.

Due to the formal implementation of the ‘new national standard’, the entire industry has a unified standard in physical interface of charging piles. In 2016, more and more players entered the game, and the charging market was in a crazy state. ‘Especially when going out for discussing cooperation, you usually face fierce competition among peers.’ Recalled by Wu Bo, general manager of the marketing department of ANYO.

However, this crazy situation did not last long. On the one hand, the profit problem of public stakes

bothered the players who entered the market. On the other hand, the commercial centers and other places with higher utilization rates have basically been divided up by charging pile operators and the entire industry quickly calmed down.

Therefore, the pace of ANYO's charging network layout is also slowing down. ANYO did not go to construct charging piles even for some communities with a lot of charging requirements. In terms of specific strategies, ANYO Charging adopted "more points and less piles" strategy, which meant that the outlets of charging piles are dense while each outlet would not build too many charging piles.

During the interview, Zhao Xinhong repeatedly emphasized that the further development of the charging pile industry is inseparable from the increase in the number of new energy vehicles. Among them, the increase in the number of pure electric vehicles is crucial to the development of the charging pile industry.

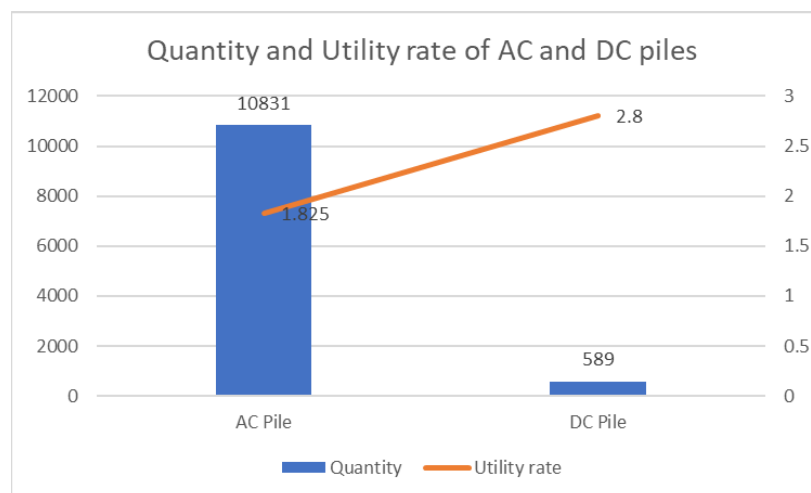


Figure 5-1: Quantity and utility rate of AC and DC piles of ANYO Charging

(Data source: primary data collected by author through interview)

From the graph, it is understood that 95% of the charging piles of ANYO Charging in public places are AC piles, and only 5% are DC piles. And the utility rate of AC piles is much less than that of DC piles. This is mainly related to Shanghai's new energy vehicle policy. In order to encourage the development of new energy vehicles, Shanghai's government will issue free special licenses to individual consumers who purchase new energy vehicles (both pure electric vehicles and plug-in hybrid vehicles).

In the current stage, consumers are naturally more willing to choose plug-in hybrid vehicles. However, Zhao Xinhong believes that plug-in hybrid electric vehicles are just a transition. ‘Car companies are all doing research on pure electric vehicles, and this situation will eventually change.’

Disadvantage of the conservative approach

Because of the low utility of slow piles (an average of 1.825%) and the high investment in facilities and charging sites, ANYO has been in a loss until now and makes SAIC unwilling to invest in reconstruction of AC piles and build fast charging piles anymore. This further results in the loss and no invest in this business. The vicious cycle put SAIC in a dilemma.

Moreover, ANYO’s charging pile operator identity also prevents SAIC from connecting charging piles from other charging pile companies into ANYO’s charging platform, which leads to the situation that only ANYO’s charging piles are available on SAIC’s APP.

Therefore, the old player SAIC and its old game strategy makes no improvement in charging experience for users.

5.2 New set-up NIO Motor: New game strategy

5.2.1 Company introduction

NIO Inc, a pioneer in China’s premium electric vehicle market, was co- founded by Li Bin and Li Xiang, who have a deep understanding of users and invested by top Internet companies and capitals such as Tencent, Lenovo and so on. NIO design, jointly manufacture, and sell smart and connected premium electric vehicles, driving innovations in technologies in connectivity, autonomous driving and artificial intelligence. At the end of 2017, NIO's first production car, ES8, was officially launched. Until now, NIO has released 3 car models including two SUVs and one coupe.

NIO’s holistic power service ecosystem (NIO Power service)

Unlike other automobile companies, the company is taking one of the more comprehensive approaches to the entire EV user experience with what it calls its comprehensive NIO Power strategy aiming to offer users an experience beyond refueling. NIO Power is a mobile internet-based charging solution with extensive energy supplement for battery power. They not only provide users with home charging solutions (Power Home service), but public charging and power swap facility network (Power Charger service). Besides, Power Mobile service is a brand-new power service developed by NIO whose Power Mobile vehicles serve as mobile power banks,

which can come to our users to supply their vehicle with power. Enhanced by Power Cloud, NIO Power offers users exclusive power service experience beyond expectations.

Battery-as-a-Service business model (BaaS model)

Based on their unique NIO Power strategy, NIO further designed BaaS business model and made it possible. The BaaS model offer users an alternative to purchase its EVs and subscribe to the usage of battery packs separately. If a user purchases one of the company's ES8, ES6, or EC6 models and subscribes to a 70-kW·h battery pack under the BaaS model, they will get a vehicle purchase price deduction of RMB70,000 (about \$10,300) in exchange for paying a monthly battery-pack subscription fee of RMB980 (\$150) while still be able to enjoy existing favorable policies such as purchase tax exemption and other government subsidies for EVs. On NIO's battery day in October this year, NIO has released an upgraded battery pack with 100-kW·h capacity so that the BaaS model, NIO's 'chargeable, swappable, upgradable' battery plan, has finally been activated. According to NIO's intention, users are able to choose on-demand battery subscription for flexible battery capacity through Baas model and achieve a longer range in one swap. Thus, continuous battery upgrades enabled by technological advancement can be enjoyed even by early users.

5.2.2 AVAC analysis of NIO Motor's new game strategy

Activity

1. Established charging and fully-automatic power swap facility network.
2. Developed Power Mobile vehicles as mobile power banks which can come to users to supply their vehicle with power.
3. Provided one-click-for-power mobile charger, and path planning function of the charging map to all NIO App users including users who are non-NIO owners.
4. Co-founded a Battery Assets Company with Chinese top battery supplier CATL, Guotai Junan securities and Hubei Science and Technology company.
5. Separated EVs and battery packs: sell EV while lend battery pack to user.
6. Offered 2 battery upgrade plans: rent 70 kWh and 100 kWh battery flexibly by month or by year.
7. Establish a user-oriented corporate culture and brand image.

Do the Activities Contribute to Low Cost, Differentiation, etc.?

High cost, but high differentiation.

Although offering comprehensive power solutions such as public fast-charging piles, power swap

stations and power mobile vehicles cost a lot in initial stage, the unique power swap method and other energy supplement service according to different charging scenes provided by NIO make great differentiation compared with other car companies. For example, NIO is the first and only car company to offer battery swap service to private users in China until now.

Based on their battery swap mode, NIO further developed a ‘vehicle-battery separation’ mode called ‘Battery-as-a-Service’ model. Actually, the vehicle-battery separation mode has been discussed in the EV industry for years but NIO took the lead in perfecting and commercializing it. To boost the innovation and development of this battery concept, battery assets need to be managed and circulated by a specialized company. Thus, NIO and other 3 partners jointly set up a battery assets company and launch a broader BaaS industry initiative that includes vehicle-battery separation, battery rental and other rechargeable services. The battery asset company will purchase battery packs and commission NIO to provide battery subscription and operation services to users. In the battery swap industry, this company, known as ‘battery bank’, is regarded as an innovation in the business model of ‘separation of car and battery’.

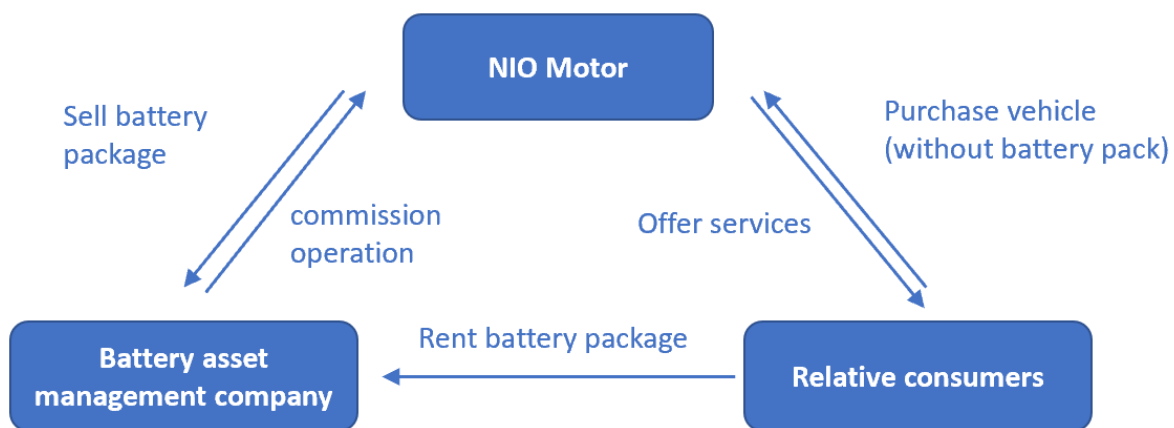


Figure 5-2: Operating model of battery asset management company

(Data: NIO official website <https://www.nio.com/>, graph by author)

For NIO, the battery assets company also plays an important role to release NIO’s huge financial pressure for undertaking battery assets. Before the introduction of BaaS mode, NIO offered users a sales plan that allow users to purchase the entire vehicle without batteries at one time and purchase the batteries by installments without interest so that NIO not only hadn’t the ownership of the battery but need to afford about \$13800 per car for lending.

For users who choose the 'BaaS mode' to purchase electric vehicles, they can enjoy one more service, battery upgrade service. Until now, NIO has developed 2 kinds of battery capacity, 70-kW·h and 100-kW·h and proposed 2 flexible battery upgrade plans that allow users to upgrade batteries flexibly on a monthly and yearly basis. This is also an innovative measure of NIO which aims to the greatest extent to meet the travel needs of users in different scenarios.

Except for these energy supplement solutions, NIO also offer users excellent charging path planning function of the charging map on its NIO APP to all users. NIO, the only car company that provide this function in its APP, updated this function earlier this year making it support personalized route settings. Now users with different brand of EVs can input key information such as available electric miles, planned remaining capacity, planned charging capacity, and vehicle energy consumption per 100 kilometers according to the actual situation of their electric vehicles and their own requirements, so as to obtain more accurate and personalized charging route recommendation. At the same time, in the recommended route, the road conditions and service area information along the route are added to facilitate user's decision-making on schedule and his/her estimation of the travel time. A compact modular design enables the smallest power swap station in the world, taking up only three parking spaces. This also reduced the place rent compared with that of charging station.

Do Activities Contribute to Improving Its Position vis-à-vis its Coopetitors?

Yes. Since much more batteries are required for each car in the mode of battery swap compared with the situation of one battery per car in ordinary charging mode, NIO increased its bargain power over battery supplier even though it hasn't formed large scaled production in NIO's early days.

Do Activities Take Advantage of Industry Value Drivers?

No. In power supply industry, the utility rate and cost are 2 factors that affect the profitability directly. NIO's various charging and swap stations, 'one-click-for-power' services and so on require huge investment in facility construction and human operations. This heavy asset mode will take NIO a long time to cover the cost and make profit.

But this may be improved when NIO's sales of electric vehicles increase. In automobile industry, size matters. The scale effect is very important for lowering the cost per car since the heavy asset such as plants held by OEM and huge investment for R&D. And the economics effect of scale makes automakers easier to earn profits from offering an ample range of products and gain strong bargaining power with suppliers. In order to prevent and respond to range anxiety in both short-

distance and long-distance and encourage more people to purchase electric cars, activities taken by NIO are providing a wide range of power services with NIO Power.

Do Activities Build or Translate Distinctive Resources/Capabilities into Unique Positions?

Yes. A key distinctive resource for NIO is its distinct power supplement network NIO Power. Up to October 2020, NIO has deployed 158 power swap stations in China, and has provided users with more than 1.18 million power swap services. The new released 100kWh battery combined with NIO's power swap stations covering more than 60 cities nationwide. The Power Swap network concentrated in the Beijing-Tianjin-Hebei region, the Yangtze River Delta and the Pearl River Delta allows NIO users to enjoy a worry-free user experience in these three major economic zones, as with the G2 Beijing–Shanghai Expressway and the G4 Beijing–Hong Kong–Macau Expressway.

Another resource built by NIO is the 'Battery Bank', the battery assets company. This company requires the participation of the government, OEMs, battery manufacturers, power grids, towers or energy storage, social capital and other parties to create a closed loop of battery R&D, design, operation and tiered utilization, as well as power exchange operations and energy networks.

Now this company has already covered four major parts of the government, OEMs, battery manufacturers and social capital. The business revenue in the future will not only be battery rental fees, but also has many other value-added points. It will restructure the battery industry and become a very large battery purchaser, asset owner, and decommissioned battery supplier. NIO is planning to make the company serve as an open platform to attract more car manufacturers and provide asset services for more different brands of electric vehicles based on the BaaS model.

Value

Through the surveys did by various institutions such as vehicle service platform and auto makers, most of NIO's users appreciate the power service NIO offers and with high brand loyalty.

In comparison with fuel cars, the shortcomings of electric cars that most complaint by users are the high cost of the battery, available electric miles, long charging time, low battery anxiety due to the insufficient charging infrastructures, battery switch cost, battery degradation, used car value preservation rate and so on. To consumers, the fastest power supply solution offered by NIO can realize fully-automatic battery swap in 3 minutes, even faster than refueling. In May 2020, NIO users had a total of 500,000 battery swaps, and the cumulative number of battery swaps surged by

more than 1 million in October. It took two years for NIO users to swap the battery from 0 to 500,000 times, but it only took less than 5 months to swap from 500,000 to 1 million times. This shows the development of NIO's battery swap business and the car owners' support and affirmation of the battery swap mode.

Besides battery swap, NIO has other range of solutions to make range anxiety a non-issue like NIO Power van, a service vehicle with two 70-kWh battery packs in the rear that can come to where you are and recharge your car for you in an emergency. This service is powered by the popular NIO app and its 'One Click for Power' option, which LI stated the serviced had been used over 28,000 times while he was on stage during NIO Day 2018.

Worry-Free Power Plan

Convenient charging experience is just one click away.

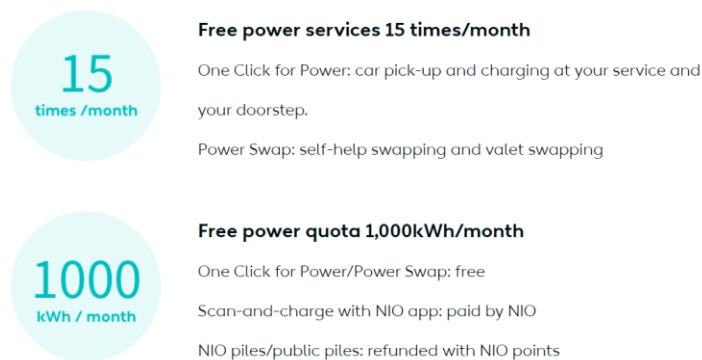


Figure 5-3: Subscription of NIO's Worry-Free Power Plan

(Data: NIO official website <https://www.nio.com/>)

In 2018, the average times that 'One Click for Power' service is used per month was about 4660 while in 2019, this number roared to more than 16000 times per month.

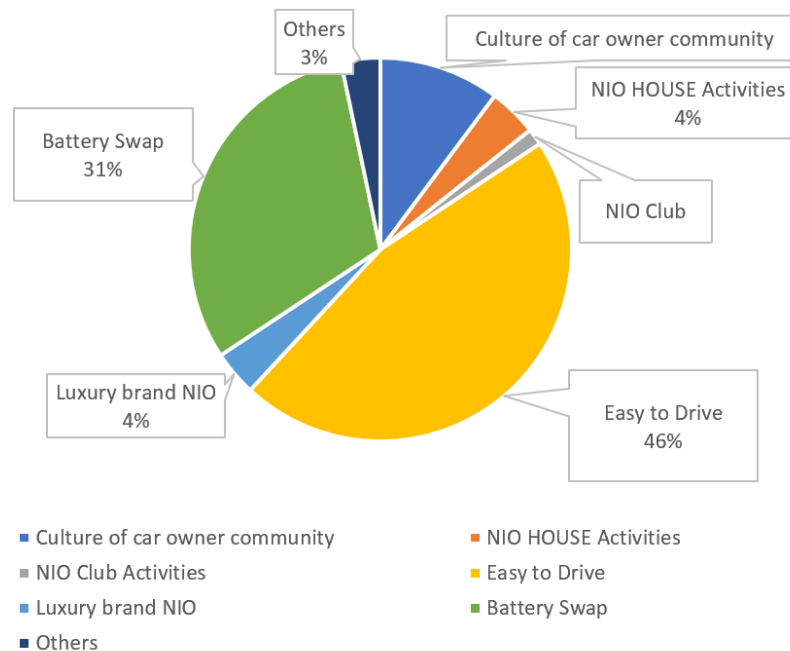


Figure 5-4: Reasons for NIO owners to purchase NIO's electric vehicles

(Data source: electric vehicle commune)

Statistics based on the survey of 1,100 real car owners of NIO launched by professional public platform 'Electric Vehicle Commune' shows that more than 30% customers purchased NIO electric vehicles due to their battery swap service, just following the top reason 'easy to drive'. This means that NIO's vehicle not only has good quality, their power services is favorable by their customers and is becoming a feature of NIO.

The unique business model, NIO BaaS, makes the purchase decision much easier and represents a better balance between the purchasing cost and the using cost. With BaaS, both costs are lower than those of ICE cars in the same segment (purchase price reduction of about \$10,300 and a monthly battery-pack subscription fee of \$150 for a 70kWh battery). At the same time, BaaS also represents a systematic solution to the long-existing challenges for EV penetration, including battery degradation, battery upgradability, and lower resale value. Customers can upgrade the battery pack capacity according to their flexible demands without worrying about the absence of advanced battery technology in the future. NIO released 2 battery packs with capacity of 70kWh and 100kWh, and they promised to develop battery packs with higher capacity continuously and provide users more choices to charge, swap, and upgrade their batteries to solve their distance anxiety in different scenarios.

NIO integrates all the power service on its' NIO APP charging map and opened the 'charging route'

planning function to all APP users. This is one of the outstanding functions of NIO's charging map. The long-distance charging route planning function allows EV users to plan long travel routes according to their car conditions. Another excellent characteristic of NIO's charging map is its high user activity. There are real user reviews under most charging facilities that tell other users the actual status of the facility, which is not available in other charging APPs.

The customers of NIO are valuable not only for the sales of NIO's EVs, but for the information communication, advertisement of NIO products, comments on public charging facilities and the construction of NIO online society on NIO APP. According to the data on NIO's day, thanks to the loyal user community and excellent user reputation, the proportion of recommendations from old users recently reached 69% in 2nd quarter in 2020, higher than the annual average of 45% in 2019, ranking the first among all automakers.

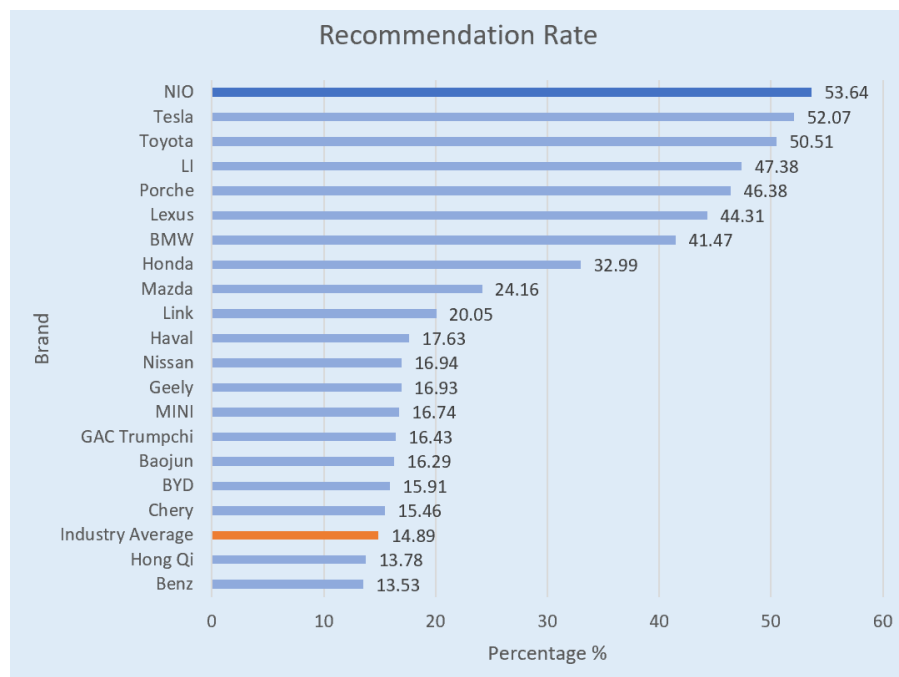


Figure 5-5: Top 20 net recommendation rates of passenger car brands in the first eight months of 2020 in China

(Data: Yiche Platform: <https://www.yiche.com/>)

According to the research from the professional electric vehicle service platform, NIO leads the TOP 20 net recommendation rate of mainstream passenger car brands (brand's annual sales beyond 10,000) in China in the first eight months of 2020 with a score of 53.64%, surpassing Tesla, Toyota, Ideal and Porsche, showing the degree of recognition of NIO brand and the customer satisfaction

for their cars and services.

Currently, NIO mainly deploy their power supplement equipment in first-tier cities in which the sales of EVs are good. Since NIO has released a new coupe of lower price comparing their existing SUV models, NIO could expand their constructions of battery swap stations into second-tier cities to promote their EVs under BaaS models.

Appropriability

Did NIO make money from the value that it created?

Not yet. The service fee from the battery swap and charging. But intended to attract more customers to buy their EVs to make profit without worrying about the electric miles and charging problems.

The logical cognition is that the profit brought by the service with high brand effect is expected. In addition, an excellent service system can bring customer stickiness. The stickiness of customers brings about the extension of the service cycle. Service cycles can bring longer profit cycles, so logically speaking, NIO's service system is profitable. The subscription model of service payment, NIO's current worry-free service package charges 10,800 RMB a year. In 2018, the average times that 'One Click for Power' service is used per month was about 4660 while in 2019, this number roared to more than 16000 times per month.

Does NIO Have a Superior Position vis-à-vis Coopetitors?

Yes. Battery suppliers can sell more batteries to ensure an increase in market share. Automakers reduce battery procurement costs and provide battery usage platforms to ensure positive battery subsystem profits. Consumers adopt battery leasing models to reduce battery usage concerns while reducing the cost of buying a car to a certain extent.

If the user chooses the BAAS plan, NIO has the right to price the battery rental fee. (Pricing power) Sales ranked 1st in B-class Electric SUV segment which is currently a niche market in China for electric vehicles.

Give customers unique charging experience and power service, increase customers' willing to pay, build brand reputation and use customers to propagandize its products. All these services can naturally become their marketing methods.

As of August 20, NIO has already obtained more than 1,200 patents related to battery swapping, built 143 Power Swap stations nationwide.

The superior service is one of the key factors that makes NIO a luxury independent Chinese brand that very different from other brands for people.

Did NIO Exploit its Position vis-à-vis Coopetitors and customer benefits?

Yes. NIO offered 'One click for Power' for all EV users to earn service fees from other brands' users and propagandize its own brand simultaneously.

The BaaS program can encourage car owners to switch old cars to new cars faster since the purchase cost is much lower. Then the sales of NIO will also increase result from the faster switch.

Did NIO Have the Right Resources/Capabilities, Including Complementary Assets?

Yes. NIO had the resource including its' power supplement network, customer-oriented company culture to realize the BaaS program. In the very beginning, CEO LI BIN was planning to realize BaaS program so that he chose the techniques of charging together with battery swapping which successfully made BaaS the last step to close NIO's battery ecosystem, 'chargeable, swappable, upgradable'. And it can continuously profit from the battery rental fee since the car is sold and the subscription fee of their power service that are all new game activities not offered by other brands before. And CEO Li Bin's connections in internet industry and NIO's innovated idea helped NIO attracting huge amount of invests that can support their constructions of charging facilities and R&D in battery technology update and AI inventions.

Internet thinking of the top managers. Continuous improve their service and battery techs to upgrade their battery capacity. Customers in NIO's online society offer their sources and information to improve their service and charging map.

Imitability

Hard to imitate.

Although it was easy for other auto companies to imitate some of the activities that NIO did, it's difficult to imitate the whole system of its NIO Power and BaaS program that it performed. Other companies could easily separate the sales of vehicle and battery, but the added value for this separation cannot be offered if there's no battery swap and upgrade service and the separation of the sales will only be reduced to a financial plan as same as a purchase loan of the battery. Even if

a company tries to imitate all the activities that NIO did, it not only needs to modify the car structures and unify the battery sizes of different car models, but starts doing swap tests, constructing the battery swap stations and so on. Any of these actions costs a lot of money. Or they could use NIO's battery swap stations and battery standards, but this requires these companies adapting their battery pack size and parameters to NIO's standards and share part of the information of the battery conditions to NIO. Generally, the battery conditions and parameters are high confidential information for the automakers and no one would like to share them to other competitors.

In addition, NIO's customer-oriented company culture and the high leveled customer activity on NIO APP cannot be easily imitated. For example, when a staff sends a car to a user, he will wipe the car for the user when he waits for the user, and sometimes he will put a box of snacks when returning the car to the user. As long as one staff sees questions asked by users on the app, even if it has nothing to do with his job, he will try their best to answer the questions and do interactions with users in the online society. And the established brand image and trusts from the customers in NIO's attitude to users dampen the customers' concerns about NIO's pricing power over battery rental price in the future.

Substitutability and Complementarity

Gasoline cars and other transports are substitutes for electric cars. But if the charging experience is more and more close to that of refueling, more people will choose electric cars since it's more economic in utility and more comfortable.

Change: The New Game Factors

Take Advantage of the New Ways of Creating and Capturing New Value Generated by Change?

The advantage of policy: Yes.

The 2020 policy of national NEV subsidies has explicitly recognized the vehicle-battery separation based on battery swapping technology. Electric vehicles priced at over RMB 300,000 are eligible for subsidies only if they have the capability of battery swapping. This means that only NIO's products can enjoy this policy among all the luxury electric cars. Besides, in this year's government work report, power swap station was mentioned and regarded as part of the construction of new types of infrastructure for the first time. Thus, more confidence from stakeholders and more invests from capitals will be expected and more attention from public will be attracted.

The advantage of the development of the battery technology: No.

Since NIO adopt the battery swap as one of the power supplement methods, NIO has to update its battery capacity with one physical size and some other technical parameters. This is a double-edged sword because the standardize of battery can decrease the cost of manufacturing, increase the production efficiency and enable customers to enjoy the advanced battery technology without switching their cars but prevent NIO from developing smaller batteries, battery-vehicle integrated structure or other technical possibilities.

Take Advantage of Opportunities Generated by Change to Build New Resources or Translate Existing Ones in New Ways? Yes.

Noticing users' recognition of Power Swap, the authority decides to give full support to the battery swapping technology roadmap. NIO took the advantage of the support and build new strategic alliance with the biggest State-Owned electricity company, State Grid, to further develop power swap technology and construct battery swap stations. More money and technical support can be adopted.

Does the Firm Take Advantage of First-mover's Advantages and Disadvantages, and Competitors' Handicaps? Yes.

Firstly, the National Energy Administration issued the power exchange industry standards researched and formulated by NIO, in which NIO took the lead in the preparation of three standards 10435, 10436 and 33025, and deeply participated in the preparation of two standards 10434 and 33004 this year. This means that other companies that intend to build swap stations are required to obey the safety regulations the same as NIO's. This obviously increase the entry barrier for other companies that want to enter the power swap industry.

Secondly, NIO build relationship with powerful battery supplier, the battery asset company. By first to build a complementary power supplement network including charging and swapping, NIO has quickly built reputation and luxury brand image for its unique power service and customer-oriented culture.

Thirdly, supported by the relevant authority of the industry, NIO has already accomplished the homologation for vehicles to be sold without the battery, the first company registered to sell electric vehicles without battery.

Does the Firm Anticipate and Respond to Coopetitors' Reactions to its Actions? Yes.

CEO said that NIO always welcomes other companies to participate in the battery swap area since

the more users the higher utilities leading to more benefit. NIO is willing to share their patents of power swap to other companies in order to diffuse electric cars.

Identify and Take Advantage of Opportunities and Threats of Environment? Yes.

Are There no Better Alternatives? Yes. Still need to develop more models.

They targeted the niche market, B-class electric SUV segment and build a luxury Chinese independent brand image through their extraordinary service. This is some kind the same as Tesla's strategy, starting from high end markets and build brand image but with different technical routes. The lower private charging pile installation rate in China made its battery swap service favorable to Chinese customers.

Other alternatives: developing coupe for other market segment. But the battery swap service is a life-time contract that NIO has to perform battery swap service (producing battery with one size and other parameters) as long as there's one user. In long term, the battery swap may be NIO's disadvantage in battery development.

5.3 Multinational new player BMW with new game strategy

5.3.1 Company introduction

BMW is a German multinational company which produces luxury vehicles and motorcycles. It is headquartered in Munich and produces motor vehicles in Germany, Brazil, China, India, South Africa, the United Kingdom, the United States and Mexico. To catch up the trend of electrification of automobile industry, the rapid expansion of electromobility is an important aspect of the BMW group strategy. In 2020, about 8% of BMW's models sold all over the world are with electric engines. According to BMW's next iNext strategy, they have planned that by 2023, this proportion will reach 20%, 25 models of pure electric or plug-in hybrid vehicles worldwide. And in 2025, the number will continuously increase to 50%.

To prepare for the entry in Chinses electric vehicle market, BMW has adopted two new game strategies to improve customer's charging experience and promote their electric vehicles. One is the platform strategy and another is the super-charger strategy.

In the platform strategy, BMW has built a platform on which realizes data interconnection with local charging pile companies for quickly building charging network in China. Through this method, BMW not only expanded its public charging network to 270,000 charging piles (about 80% of public chargers in China) in one year, but unify payment of piles from different operators. This platform acts like a retailer between charging pile companies and users. In a word, through this strategy, BMW users can search, unlock and pay for 270,000 piles by one APP.

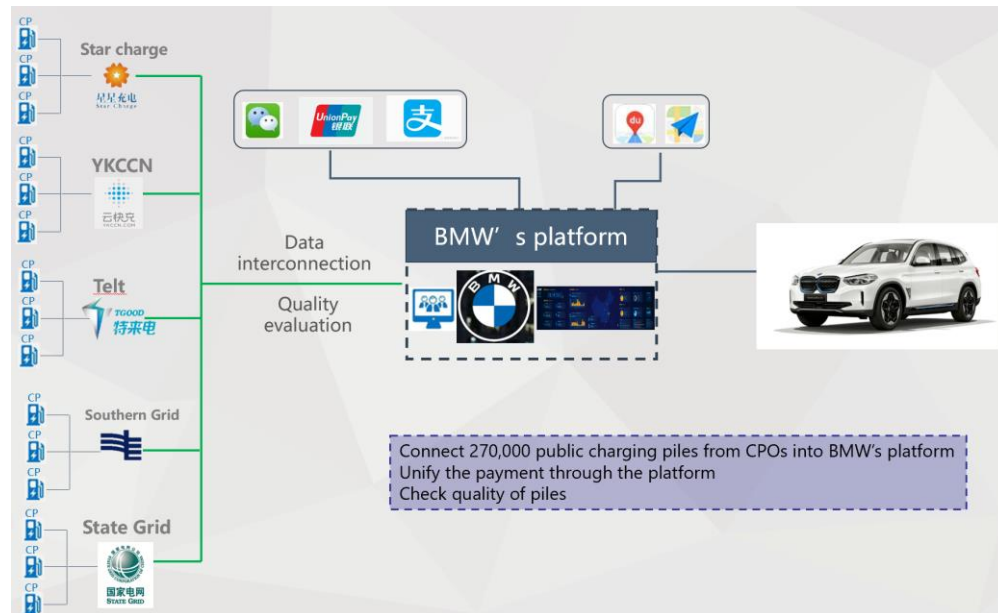


Figure 5-6: Mechanism of BMW's platform

(Graph by author)

In super-charger strategy, BMW cooperated with the State Grid Electric Vehicle Company to develop and construct super-chargers in China. Moreover, the cooperative business is not limited to charging piles, but also covers charging technology, photovoltaics, energy storage, and echelon utilization. The cooperation between the two parties involves three major aspects: research and innovation of charging technology, cooperation and promotion of charging service products, and promotion of new energy power for new energy vehicles.

5.3.2 AVAC analysis of BMW's new game strategy

Activities

1. Built a platform to connect existing public charging piles from charging pile operators.
2. Cooperate with the State Grid to reconstruct the slow charging pile of charging pile company into super chargers and set high power charging standards together.

Contribute to low cost, differentiation, etc.?

Yes. Compared with self-build charging piles, the costs of building a platform and buying data from charging pile operators are much lower. Through the cooperation with the State Grid, BMW has planned to expand public charging network to 270,000 charging piles among which there will be 80,000 fast charging piles by the end of the year. According to the cost evaluation formula (including material cost, place rent, electric construction fee, etc.) used by charging pile operator, the cost of an AC charging pile is about 1.2 RMB/W and a DC charging pile is about 2 RMB/W. If BMW builds charging piles itself, the initial investment would be 4.56 billion RMB (about 700 million dollars) $[190,000 \times 20,000 \text{ (assume average 20KW per pile)} \times 1.2 = 456,000,000]$ for AC charging piles and about 9.6 billion RMB (about 1.467 billion dollars) $[80,000 \times 60,000 \text{ (assume average 60KW per pile)} \times 2]$ for DC charging piles. But through purchasing data of existing charging piles from charging pile operators, the data utility fee is about 56.25 RMB for each pile per year. This allows BMW to save huge amount of upfront investment of charging piles construction, to eliminate the formalities needed of dealing with the relevant local government agencies to build a charging station, and to utilize many public charging piles in a short time since only opi connections are required. And the platform BMW built only costs around 800,000 RMB and this platform enabled BMW to define its own pay method for all charging piles even of different charging pile operators. This makes BMW different from most automakers that just buy data utility without a self-built platform because other automakers' charging APP will skip to each charging pile operator's APP when pay the bill and the payment method is not unified.

Contribute to improving firm's position vis-à-vis Coopetitors?

Yes. Compared with those companies that just buy the access of the charging piles from charging pile operators, BMW has more bargain power over charging pile operators. Unlike other car companies that can only passively participate in the activities of the operator's platform, BMW can carry out its own preferential activities and develop more functions such as scheduled charging functions and offering charging discounts on the self-developed platform, release BMW's specific charging card without being restricted by the operator. In addition, BMW can monitor the status of each charging piles through their platform so that they can easily make out the charging piles with low utility rate or 'zombie piles', and then negotiate with charging pile operators to eliminate it from contracts or have bargain power over them to ask for a rebate on good charging piles.

Taking advantage of industry value drivers?

Yes. In charging pile industry, the high cost of construction and low utility rate are the key factors that cause long term losses for charging pile operators. BMW's platform strategy makes them acquire most charging piles with low initial investment while its super-charger strategy will have

comparative high utility rate since they only build supercharging piles that are more welcomed by users with the State Grid and have customers themselves. Thus, BMW are taking advantage of charging pile industry's value drivers.

Contribute to building or translating distinctive resources/capabilities?

Yes. Although BMW just has the utility right of the public charging pile from other charging pile operators, its platform will enable them to learn the distribution of all the charging piles that connect on this platform and help them identify the white space of its charging network.

Thanks to the corporation of the State Grid, BMW will quickly cover more than 50,000 kilometers of highways across the country since the State Grid is almost monopolizing the charging facilities in highways. Due to the power of the State Grid (State-owned electricity corporation) in charging pile industry, a member of a joint demonstration working group to promote high-power charging technology verification, product development and standard formulation, BMW will have a great chance to set the super-charging standard together with the State Grid so that the parameters of BMW's supercharging piles could be the standards that other companies' supercharging piles must follow.

Value:

Do customers perceive value as unique?

On BMW's charging APP, users can not only unlock the charging piles of multiple operators in one APP, but also complete the payment in the same interface. This APP is more integrated and reduces the error probability during the interface jump process between APPs.

Besides public charging area, BMW charging facilities will also cover private charging, brand charging and digital charging services. Now BMW's new energy vehicles and the State Grid's charging piles are undergoing comprehensive interoperability testing of 350kW high-power charging technology that is even 100 kW higher than TESLA's V3 super-charger. In the future, a pure electric vehicle of BMW is expected to complete a charge within 10 minutes by its own super-charging pile and this charging experience is very close to the refueling experience of a gasoline vehicle. In China, the State Grid is the only company that invented the 'charge and plug' technology currently. After only one-time purchase, and then bundle your own car, you can directly complete the plug-and-charge.

Are there white spaces nearby?

Yes. Until now, BMW has just unified the payment of the public charging piles from different

charging pile operators through its platform. Actually, based on this platform, BMW is able to exploit more customized services such as scheduled charging. The unified payment enables users to pay the charging bill on BMW's APP without scanning the code on charging piles, so it is possible to schedule charging time on a certain charging pile so that users can manage the charging period if they don't want their car to be fully charged. Furthermore, users can make a charging appointment on a certain public pile to charging without waiting. Besides, BMW will also be able to offer service fee discounts to their customers through its platform instead of releasing several charging cards of different charging pile operators.

Appropriability

BMW charges pile and installation fee from customers if they want to install a private charging pile at their parking lot but free for the charging box that can be fixed on the wall. The private pile is 800 RMB and the installation fee depends on the conditions of installation scene such as the length of wires, the holes needed to be blasted. During utility of the public charging piles, the service fee will also be charged by BMW. They charged service fee from customers and then pay 90% to charging pile operators.

Although service fee charged by BMW is little compared with the construction cost of a public charging pile, the main purpose of the construction of charging piles is not to profit from the service fee but for the promotion of its new energy vehicles. Charging service, as an important part of after sale service for new energy vehicles, greatly affects the utility experience and purchase willingness of customers. As a luxury traditional automobile brand, BMW is hoping to complete the process of search, charging and payment to launch a 'one-stop' digital charging experience for users, and form a smart charging ecosystem that connects users, charging piles and services through the BMW cloud interconnection application. By accessing the digital ecology of charging piles, BMW can gain insight into customers' behavior and preferences which can be used to build a complete ecosystem involving design, manufacture, sale and aftersales in China.

Is it difficult to imitate firm?

Not that difficult to imitate this platform but it's still not easy for other companies to negotiate with top charging pile operators to join their self-built platform. Since all the top operators have their own platform and prefer auto companies to connect into their platform since the operation fee of the platform and the data security problem. If one operator connects their piles into a third party's platform, the third party will have the authority to see the utility rate of their charging piles that is confidential information for an operator. This may raise the risk that the third party will use these data to build their own charging piles where the utilization of charging piles is high and participate

in competition. But for BMW who is a famous automaker with a long history, operators would rather negotiate with them and treat them as a high-end customer than refuse them.

Change

Distinctive resources/capabilities?

Although BMW has just improved the charging experience that unified the payment of more public charging piles within one APP until now, the platform they built has the potential to exploit more functions and activities in the future and makes BMW differentiated from its competitors. Secondly, the light asset mode allows BMW to invest more money in super-charging piles without being dragged down by the outdated and obsolete charging equipment. This gives BMW more agility to adapt the environment of rapid development of battery and charging technologies. Thirdly, the cooperation with the State Grid not only gives BMW technology support for fast-charging piles and electric power, but also a distinctive resource for building relationship with local governments since it's a state-owned company and the biggest electricity supplier in China.

First-mover advantages and disadvantages, and competitors' handicaps?

BMW takes the first mover disadvantage through cooperating with local charging pile operators to build charging network quickly in China. Since the charging pile industry is developing fast in China these years, BMW doesn't need to build slow charging piles (below 20 kW) and fast charging piles (above 60 kW) itself like other Chinese auto companies five years ago when there's lack of charging infrastructure, but integrate existing charging piles into its charging APP. Therefore, BMW takes the follower advantage thanks to the development of the charging pile industry in China.

Since the State Grid is a member of a joint demonstration working group to promote high-power charging technology verification, product development and standard formulation, BMW is now cooperating with the State Grid to do the comprehensive interoperability testing of 350kW high-power charging technology to take the first mover advantage in super-charging area in both standard setting and construction. Once the State Grid's standards are adopted as the national super-charging standard, BMW will be the first auto company whose new energy vehicles can be charged by these super-charging piles.

Opportunities and threats of environment?

Opportunity:

BMW is taking advantage of the government's policy change. Now, the Chinese government is gradually shifting subsidies from the purchase of new energy vehicle to those for charging

infrastructure. It's an opportunity for BMW to cooperate with State Grid Electric Vehicle Company and develop superpower charging technology not only to share the subsidies but also to establish competitive advantages in the future.

Threat:

Although BMW is the first multinational auto company to have a strategic alliance with the State Grid to build super-charging piles, other competitors like Benz and Volkswagen also starts to cooperate with local charging pile operators or automobile companies to construct fast chargers together in China for their promotion of pure electric vehicles in the following years. BMW needs to compete with Tesla who has already built its fast-charging network in China and Chinese local luxury electric car brand NIO with its battery swap network while defending new comers such as Japanese and other German brands.

5.4 Comparison between old game strategy and new game strategy

5.4.1 Comparison of activities

Cost comparison

ANYO by SAIC Group: the cost of an AC charging pile is about 1.2 RMB/W and a DC charging pile is about 2 RMB/W so that a 7kW AC charging pile is 8400 RMB and a 60kW DC charging pile is about 120,000RMB. The total investment in charging piles (11453 AC charging piles and 698 DC charging piles) is about 1.8billion RMB in which the operation cost is not included. According to the engineer of ANYO, if the utility rate of a 60kW pile reaches 10%, it will recover the cost in about 5 years. But until now, the average utility rate of ANYO's charging piles is less than 5%, this means that it will take more than 10 years for them to be profit.

NIO Motor: The cost of construction of a battery swap station is more than 5,500,000 RMB while the operation cost is about 600,000 RMB. Thus, although the service fee charged is a bit higher than that of charging piles, under the same utilization rate, the initial investment of the swap station is greater and the profitability is inferior to that of the charging station, resulting in longer cost recovery time. As NIO offer 6 free battery swaps for their users every month, the cost recovery time will be much longer. Besides, since the different battery standards of different auto companies, only NIO's own battery swap stations can be used which means NIO has to build more stations to meet more customers' needs in the future.

BMW: Through connecting existing charging piles, now BMW can access about 270,000 charging piles in China. If BMW builds charging piles itself, the initial investment would be 4.56 billion RMB (about 700 million dollars) $[190,000 \times 7,000 (\text{assume average } 7\text{KW per pile}) \times 1.2 = 1.6 \text{ billion}]$ for AC charging piles and about 9.6 billion RMB (about 1.467 billion dollars) $[80,000 \times 60,000 (\text{assume average } 60\text{KW per pile}) \times 2]$ for DC charging piles, total 11.2 billion RMB. But through purchasing data of existing charging piles from charging pile operators, the data utility fee is about 16 million RMB per year including operation fee. Assuming the depreciation is 10 years, 10 years later, BMW only need to pay 160.8 million RMB totally for 270,000 charging piles plus platform cost.

Therefore, BMW's light asset mode is with the lowest cost among three methods. This gives BMW more agility to adapt the environment of rapid development of battery and charging technologies. And this also allows BMW to invest money on super-charging piles without being dragged down by the outdated and obsolete charging equipment like the dilemma where SAIC is in currently. In the future, a pure electric vehicle of BMW is expected to complete a charge within 10 minutes by its own super-charging pile and this charging experience will be very close to the refueling experience of a gasoline vehicle. Moreover, through reconstruct the slow charging pile of charging pile company into super chargers, BMW can save the site rent and eliminate a series of cumbersome procedures for applying and building charging stations in China.

Differentiation comparison

ANYO by SAIC Group: ANYO offers the same services to all EV users as other charging operators in the market. No customized service and other operators' charging piles for SAIC Group's own users.

NIO Motor: NIO offers a holistic power system ("One Click for Power" power van, battery swap, super-charger) and integrate them on NIO App to meet all possible scenarios for NIO users to supplement power. The most integrated charging system and charging APP in this industry.

BMW: Solve one of the most complained problems by EV users: unify the payment of charging pile from different charging pile operators. BMW app covers almost 80% of the public charging piles in China.

Compared with the old game strategy, BMW offers the most charging piles and unify the payment for their users while NIO focus on the different charging needs and charging scenarios for EV users. Both of new players offer different charging services to users from those offered by charging

operators.

5.4.2 Comparison of value created for customers

Consumers use cost comparison of refueling, charging and battery swap

I've chosen two vehicles, BMW X3 and NIO ES6 that are in the same price segment in the vehicle market and compare their use cost per month. In this comparison, I assume the driving distance per month is 2000 km since usually the average distance for a user who drives car for working in the city is about 2000 km according to the report in vehicle service website.

	Refueling	Charging	Battery Swap
Selected Model	BMW X3	NIO ES6	NIO ES6
Single refueling (charging) volume	65L	70kWh	70kWh
Distance per fueling (charging)	823km	415km	415km
Fuel (battery) consumption/100km	7.9L/100km	16.87kWh	16.87kWh
Price per refuel/charge	0.7RMB/km	0.25RMB	0.11RMB
Battery rental fee	/	/	980RMB
Driving distance/month	2000km	2000km	2000km
Total cost for power supplement/month	1400RMB(\$216)	500RMB(\$77)	1200RMB(\$185)
6 free battery swaps per month for the first owner of NIO EV			980RMB(\$151)

Table 5-1: Consumers use cost comparison of refueling, charging and battery swap

(Data: official website of BMW and NIO, vehicle service website: <https://www.autohome.com.cn>,
table edited by writer)

According to this table, both charging and swap offer more economic power supplement than a traditional gasoline car. Further comparing charging and battery swap mode by NIO's service fee, the utility cost of using charging piles are about 480 RMB cheaper than battery swap for users.

Charging time

According to a survey of 1034 EV users shows that the public DC charging pile costs an average charging time of 1 hour and 54 minutes to finish charging. The AC charging pile requires a longer charging time with an average charging time of 5 hours and 45 minutes. Therefore, about 75% users chose fast chargers as their first choice.

Compared with existing public charging piles, NIO's battery swap only costs 3 minutes to have a fully charged battery. For those who cannot install private charging piles, the battery swap within 3 minutes greatly improves their charging experience and solve their power supplement anxiety.

Now BMW is further cooperating with local charging pile company, the State Grid to develop and build super-charging piles with 350kw power that is even 100 kW higher than TESLA's V3 super-charger. It is expected that BMW's electric vehicle can finish one charge within 10 minutes in the near future.

Therefore, NIO's battery swap is the fastest charging solution among three strategies.

5.4.3 Comparison of appropriability

Profit

ANYO by SAIC Group: Initially, ANYO is aiming to make money from the charging pile business but five years past, it hasn't yet covered its initial investment and be profit. Through interviewing their platform response Mrs. Wu, she said that only DC chargers with higher charging capacity have higher utility. The AC chargers built in the early days have greatly held ANYO back and they don't want to invest more money in charging pile construction. In addition, limited by the space and electricity capacity, it's getting more and more difficult to build fast-charging piles in the places with more traffic like city center. It is believed that the loss of ANYO won't get better in the coming years.

BMW and NIO Motor: Both companies offer power services in order to promote their electric vehicles and improve their users' charging experience. NIO and BMW only earn some service fee for their charging service but expect to diffuse the electric vehicles in the future.

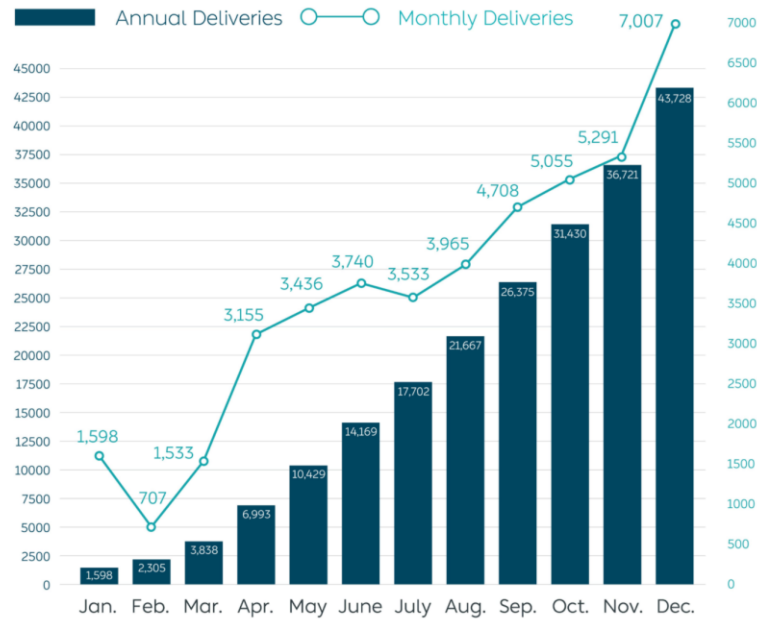


Figure 5-7: NIO monthly deliveries and cumulative deliveries in 2020

(Data from: the official website of NIO)

Based on the annual sales of NIO Motor's annual report shown in graph, the luxury electric vehicle brand and their excellent services are getting recognized by public. The continuously increasing sales of NIO are outstanding among other new vehicle brands in China.

Imitability

Due to the special battery pack and vehicle structure for battery swap, this mode is hard for other auto companies to imitate. If one company wants to do battery swap, this company needs to redesign vehicle structure and battery size to match the battery swap structure. It also needs to build the battery swap network from the beginning, this will cost huge time and money. Or it can join NIO Motor's network if it is willing to share the battery information and adapt its own battery size into NIO Motor's standard. Since the battery technology and information is one of the most confidential and critical technology for an electric vehicle, few companies are willing to share this information to competitors.

Therefore, NIO Motor's battery swap is the most difficult charging service for other companies to imitate.

5.4.4 Comparison of change factors

Development of Battery technologies

SAIC Group failed to take the advantage of first mover advantage while BMW takes the advantage of first mover disadvantage in charging pile industry. SAIC's heavy asset mode makes it hard to overcome the huge sunk cost and keep following the dynamic environment of this industry.

NIO Motor's method may be a disadvantage in the development of battery technology. The fixed size and structure of the battery pack of all car models may block the innovation of the battery vehicle structure. Now BYD has developed a battery called 'knife battery' that is very light and slim while with the same power capacity. Tesla, is also developing a structure to fix battery in vehicles so that hundreds of battery pack components can be eliminated and lower the manufacturing cost of the car. But for NIO Motor, they will not adopt these innovations, at least in a short time.

Therefore, BMW's light asset mode and super-charger strategy are the best charging strategy to adapt the dynamic environment of charging industry.

5.5 Summary

By comparing the old game strategy and 2 new game strategies played by new players, we can see that both new strategies improve users' charging experience:

NIO Motor's battery swap solves the slow charging problem and offers the fastest charging solution within 3 minutes, even faster than refueling.

BMW's platform strategy solves the problem of complicate searching and payment method for charging piles from different charging pile companies. Its super charging APP offers users 80% public charging piles in China with unified payment method greatly makes the charging experience closer to refueling experience.

By contrast, the old player SAIC Group is dragged down by obsolete charging facilities and struggling for survive in the charging pile business. Its old game strategy restricts it from making changes to improve the charging experience for users.

6. Discussion and Conclusion

Reviewing this paper, first of all, I explained the importance of the charging infrastructure and charging experience for the development and promotion of electric vehicles. Due to the difference between the energy supplement method of a traditional gasoline vehicle and an electric vehicle, the distance anxiety and the worse charging experience are the decisive factors that affect consumers to choose an electric vehicle while there's no concerns for them to refuel a gasoline car. Although many automakers attach great importance to the research and development of the battery capacity, it is difficult for them to make breakthroughs in view of the short-term. Therefore, this article focuses on how automobile companies can improve customer charging experience to stimulate the electric vehicle consumption, especially with the gradual reduction of electric vehicle purchase subsidies by Chinese government from 2020.

In the second place, through the analysis of the current status of China's public charging facilities and the research of the participants in the charging pile market, I have discovered the current shortcomings of China's charging infrastructure and their impacts on the charging experience of electric vehicle users. Based on the secondary data collected from relevant industry reports, although the number of China's public charging facilities are among the best in the world, almost two-thirds of them are slow charging piles by which it takes more than ten hours to fully charge an electric vehicle with 70kWh battery capacity. The extremely long charging time results in the huge inconvenience and impractical for electric vehicle users compared with about only 5 minutes per refuel, and the low utilization of slow charging piles leaves charging pile companies with long-term losses. In contrast, fast charging piles are in short supply and cannot meet users' charging needs. Besides the long charging time, another problem that lower the charging experience is the complicate searching and payment method caused by the various charging APPs operated by different charging companies in the market. Currently there are ten major players in charging pile industry and each has their own charging APP so that if one wants to search charging piles, he needs to download more than one APPs, register several accounts and search in multiple APPs simultaneously to meet his charging needs. This made charging process much more complicated than that of refueling and greatly damaged the charging experience. In order to find out solutions for the slow charging and complex charging processes, I selected three car companies involved in charging services to see if their charging strategies could solve these issues and improve user's charging experience.

During case study, I analyzed the SAIC Group who is an old player in charging pile industry with

old charging strategy and other 2 new comers, Chinese new setup NIO Motor and famous multinational company BMW, with their new charging strategies by applying Allen Afuah's AVAC analysis. As the first automaker to enter the charging pile industry, the state-owned SAIC Group founded a charging pile company, ANYO Charging, to largely construct the slow charging piles and offer charging services to all electric vehicle users. ANYO's charging pile company identity prevents other charging pile companies from cooperating with SAIC while the large initial investment of piles, high land lease and low profitability limits SAIC's continued investment in remodeling slow charging piles or adopt new charging strategies. Until now, SAIC's electric vehicle users can only use ANYO's charging piles 90% of which are slow charging piles so that they still need to register other accounts to meet their charging needs. This old charging strategy taken by SAIC hasn't contributed to the improvement of charging experience for electric vehicle users.

On the contrary, the new charging strategies adopted by NIO Motor and BMW have solved the problems mentioned before in different ways. The unique battery swap service offered by NIO Motor has reduced the energy supplement time into 3 minutes that is even faster than refueling a gasoline vehicle. Furthermore, NIO Motor has exploited the unique battery swap structure to further develop a new business model, Battery as a Service model, that separate the sales of vehicle and battery pack. With this model, NIO's users are not only able to enjoy the battery swap service, but easily upgrade the battery pack capacity for a longer charging distance by a monthly or yearly subscription. All NIO's battery packs with different capacities are designed in the uniform size and structure so that it enables their early users to enjoy the development of battery technology continuously.

Different from NIO Motor's battery swap method, BMW has adopted a light asset mode to integrate the resources of local charging companies into its self-built platform and simplify the charging process. Thanks to this platform, BMW's users can search, unlock more than 80% public charging piles of different charging pile companies and finish payment within BMW's APP without registering several accounts on different charging APPs. In addition to the simplification of charging process, BMW is also engaging in developing super-chargers for a shorter charging time. Currently it is cooperating with a famous local charging company to test super charging pile with more than 350 kWh by which it will only take about 10 minutes to fully charge an electric vehicle. Although the energy supplement logic is different from that of NIO Motor's, BMW's new charging strategy has still improved user's charging experience and will soon compress the charging time into ten minutes.

Conclusion

From the study of the different charging strategies taken by the auto companies, it can be concluded as follows:

The old charging strategy taken by old players in charging pile industry cannot improve charging experience for users. In the early stage of the charging pile industry, SAIC's ANYO Charging, like other charging pile companies in this industry, largely built slow charging piles with comparatively low cost to occupy busy areas without considering the inconvenience of long charging time for users. These obsolete charging facilities have dragged SAIC down and made it hard to keep first mover advantage in this industry. And since ANYO Charging is a competitor in charging pile industry, other charging pile companies have low motivations to share their charging pile data with ANYO Charging so that SAIC's users still have to search charging piles by more than one APP.

By contrast, new player NIO Motor's new charging strategy, battery swap service, has perfectly solved the long charging time issue. Although the battery swap station requires more investment than that of a charging station, the value it offers to users is also unique and hard to be imitated. To realize battery swap and further developed BaaS model, new setup NIO who is free to design vehicle structures and battery packs, unified the size and standards of battery packs with different capacity and adapt the structure of different car models to these battery conditions, which is totally different from electric vehicles designed by other brands. NIO's battery swap design not only improve the energy supplement time even shorter than refueling, but also allows NIO's users upgrade battery pack with higher capacity by battery swap to have a longer charging distance without buying a new vehicle.

Another new comer, BMW, has successfully built charging network quickly in China with a lower investment and simplified charging process by playing new game strategy as well. By interconnection of charging pile information with local charging pile companies through its own platform, BMW makes it possible for its users to finish charging process, search, unlock and pay, within one APP even the piles are from different charging pile companies. It takes the advantage of follower advantage in China's charging pile industry and its light asset mode makes BMW more agile to the changing environment of electric vehicle industry. Moreover, its efforts in developing super chargers with high charging speed and reconstructing slow charging piles with local charging pile company enable BMW continuously shorten the user's charging time and improve their charging experience in the future.

Furthermore, by comparing both new game strategies, the platform and supercharger strategy is

more practical for most automakers and better suit the transformation of automobile industry than battery swap strategy. Although battery swap offers unique values for customers currently, the huge cost of the construction of battery swap station and the fixed size of batteries and constructure of vehicles makes NIO less flexible to adapt the dynamics of electric automobile industry. The fixed structure of the battery pack of all car models for battery swap will prevent NIO from the innovation of smaller and lighter battery pack, or other novel vehicle structures such as battery and body integrated structure that is much lighter and economic. In addition, for automobile companies who have already entered the mass production of electric vehicles, the adoption of NIO's new game strategy will cause huge sunk costs due to the modifications of vehicle structures and battery packs. Hence, from my point of view, BMW's new charging strategy is more sustainable in the long term and easier to spread among other potential players in automobile industry.

Contribution and limitation

Through the analysis of old and new charging strategies, the contributions of this paper are summarized as follows:

Find out the deficiencies of current charging pile industry in China;

Give the most reasonable charging suggestions to automakers who are in transition or about to enter the electric vehicle industry;

Optimize the charging experience of electric vehicle users and help to promote the electric vehicles.

In recent years, in an effort to curb the greenhouse effect and air pollution caused by emissions from conventional fuel vehicles, governments have introduced increasingly stringent penalties to urge traditional car companies to transfer to the electric vehicle manufacturing. However, at a developing stage of electric vehicle industry in which battery technology and utility experience are not as mature as those of conventional vehicles, most of the electric vehicle consumptions are driven by government subsidies and various preferential policies. From a long-term perspective, to enhance users' charging experience and make it as convenient as refueling experience is a critical task for car companies to truly popularize electric vehicles and gradually realize the displacement of traditional fuel vehicles.

In China, where the construction of public charging piles is more rapid than in other countries, the conservative approach of car companies to build slow charging piles by themselves has proved that neither can they establish a first mover advantage for themselves, nor give users a good charging experience. As a third party with own users, car companies have the ability to integrate the public charging pile information of various charging pile companies through self-built

platforms, and realize the completion of the pile searching, unlocking and payment within one APP, which greatly simplifies the charging steps for electric vehicle users. Not only that, through this method, automaker is able to establish its own charging network with minimal investment in a short time while diverts its own users to charging pile companies' charging facilities, achieving a win-win situation for itself and charging pile companies. This method is suitable for all automakers, especially for new players like multinational car companies that are preparing to launch a large number of electric vehicles soon in China. In the future charging pile market, it is generally considered that public fast charging piles will gradually replace slow charging piles. Automobile companies only need to concentrate on jointly developing high-power charging piles with charging pile companies and rebuilding existing slow charging piles. Therefore, this paper suggests that cooperation with local charging pile companies in charging technology development and facility construction will be a trend for automakers in the future.

On the other hand, it seems that the battery swap strategy has a huge advantage for its short energy supplement time at present, but the high construction cost and the requirements for the battery and car body structure are still difficult to spread this strategy among other automakers. It is more suitable for business vehicles that are charged frequently, or automobile companies with ride-hailing business, or high-end brand cars with higher price premiums. Otherwise, the huge upfront investment and low frequency of power swap may easily cause the cashflow problem or the long-term loss. For car companies that have already entered the electric vehicle industry, unlike NIO who is a start-up company and can freely design the car body structure, joining the battery swap mode will also incur sunk costs. In my opinion, whether to adopt battery swap strategy should be considered carefully by car companies that have already set foot in the electric vehicle industry.

Finally, there certainly exist some shortcomings in this paper. The analysis in this paper is mainly focused on the charging strategies but mentioned little about the process of decision making of the management. Therefore, the future research on this topic will look deep into company's organization and explore their dynamic capabilities to adapt the transformation of automobile industry and the quickly developing battery technologies.

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