
Current Situation and Shortcomings of Research on China's New Energy Automobile Infrastructure

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Abstract

This paper mainly studies the development status and shortcomings of China's new energy automobile infrastructure. After research, it has been found that the main reason for China's new energy automobile infrastructure inadequacy are inconclusive charge modes and operation mode of charge equipment to be explored and other reasons. The main solutions are with the continuous construction of the charge infrastructure, as well as the continuous promotion of platform construction of local alliance, collaborative innovation among members of the alliance will become an accelerator to promote the charge infrastructure construction.

Keywords

New energy automobile, supply chain, infrastructure.

1. Overview of Infrastructure Construction of New Energy Automobile

New energy automobile infrastructure is the engineering facility that provides electricity supply, maintenance and other necessary services for new energy automobile, it is the public service system that guarantees the normal driving of new energy automobile, the infrastructure in general sense is mainly the charging infrastructure, which are classified in accordance with the construction mode, mainly includes slow charging station (pile), fast charging station (pile) and battery charging station three kinds. Up to December 2016, the number of construction and operation for China's public class charging pile is close to 150,000, they are more than 2 times compared to 49,000 in the end of 2015, and China has become the fastest-growing country for charging infrastructure. The power project "purchase more than 3800 sets of charging equipment to meet the needs of electric automobile charging in 2017" launched by State Grid and can predict, 800,000 new charging pile will be increased in 2017 (including special pile 700,000 , public pile 100,000). From here we see that China will continue to maintain rapid growth in the charging infrastructure in the future.

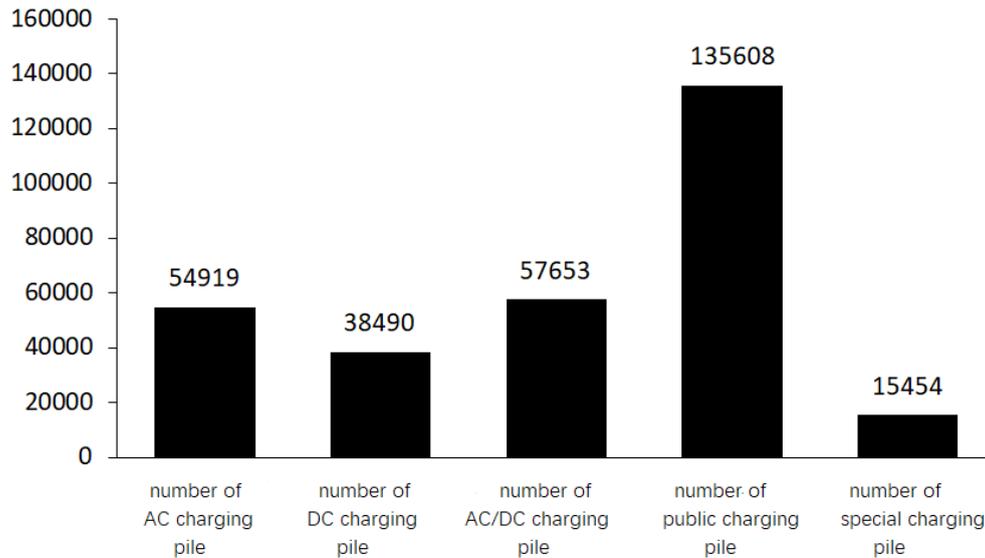


Figure.1 China's various types of charging pile number (up to February 2017)

Data source: First Auto Industry Network

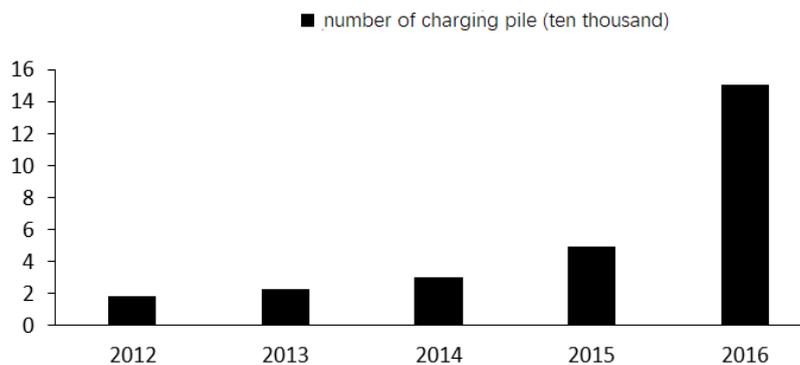


Figure.2 the construction number of China's pile in recent years

Data source: China Economic News Network, "China's New Energy Automobile Industry Development Report (2016)"

In order to meet the growing user demand for charging, countries continue to introduce relevant policies to encourage the construction of charging infrastructure. The subsidy policy continue to be implemented by the local, under this impetus, the charging pile construction begin to accelerate. From the national level, the number of public piles achieves a breakthrough; they increased from less than 50,000 at the beginning of 2016 to 150,000 at the end of the year. The installation proportion of the special piles achieve promotion, according to the data provided by the car sales manufacturers, installation ratio of charging pile of private passenger car has increased to more than 80%. Intercity quick charge station has achieved enlarged dimension in the construction, the intercity quick charge station has served 14,000 km highway, four horizontal, four vertical and double ring have formed, the average distance between the stations is 48.6 km, it laid a good foundation for the drive to the world. In urban construction, Beijing has built public charging network whose average service radius is 5 km in sixth ring range, the public charging network in Shanghai, Shenzhen, Guangzhou, Nanjing and other cities has begun to form embryo. The private charging pile in Beijing, Shanghai and other places are more than 50,000; crowd funding construction pile mode is used, Taiyuan quickly built more than 8,000 service network of electric taxi. The charging service station of civil aviation, public transport, sanitation and other special areas is developing; the service model by using change battery for the taxi and other special car is also constantly exploring and innovating.

Table 1 "13th Five" charging infrastructure central finance subsidy standard

Unit: ten thousand Yuan/automobile

year	air pollution control key areas			central region and Fujian province			other areas		
	subsidy threshold	subsidy standard	highest cap	subsidy threshold	subsidy standard	highest cap	subsidy threshold	subsidy standard	highest cap
2016	30000	9000	12000	18000	5400	12000	10000	3000	12000
2017	35000	9500	14000	22000	5950	14000	12000	3250	14000
2018	43000	10400	16000	28000	6700	16000	15000	3600	16000
2019	55000	11500	18000	38000	8000	18000	20000	4200	18000
2020	70000	12600	200000	50000	9000	200000	30000	5400	200000

2. Research Statuses of the Reasons for the insufficient Construction of New Energy Automobile Charging Infrastructure

The charging infrastructure is the guarantee of the free driving of electric automobile, which is the basis for the rapid development of electric automobile industry. However, because currently China's new energy automobiles in the related supporting services and equipment construction such as charging pile, after-sales service points has deficiencies, which seriously affects the promotion and popularization of new energy automobiles. From the existing research references on the construction of charging infrastructure, the reasons for the slow construction of charging equipment are as follows:

(1) Charging method is inconclusive. New energy automobiles have change and charge two ways, charging equipment include charging pile and charging station two kinds. Charging station use centralized charge; which is generally used for sanitation, public transport class new energy automobiles. Charging pile is used for private new energy automobile charging, which is mainly arranged in the residential area or the parking lot near the working palace (Fang Ling, 2013). Because the constructed charging equipment in China's pilot cities are less, equipment distribution are more concentrated, which cause a lot of inconvenience to consumers charging. What charging way should be taken to supply power, the views of State Grid and Southern Power Grid two companies and most auto manufacturers are inconsistent. Power supply companies advocate "changing power dominate, plug charging supplement, centralized charging, unified distribution", while the car manufacturers are optimistic about the "charge dominate, changing power supplement." But in essence, no matter what adopt kind of energy supply way, the final starting point is also more convenient for consumers to use and maximize the benefits of corporate. Therefore, when analyzing what kind of charging method, domestic and foreign scholars have expressed their views based on the calculation of enterprise cost and benefit, and consumer demand viewpoint.

Accenture (2011) based on the changing power station, charging station and charging pile three charging infrastructure, calculate the life cycle and maintenance cost of electric automobiles are calculated by setting two different scenarios. The conclusion show that the distributed slow charging mode will exist for a long time, and the distributed slow charging mode is the least investment and the lowest risk mode when the development trend of the charging technology is uncertain and the number of electric automobiles is small. Liu (2012) thought that quick charging infrastructure construction costs are high and should be mainly deployed on highways to ensure long distance travel, and fast charging stations and household charging can meet 45% and 36% of the charging market demand, respectively, the two are important parts of charging infrastructure network the electric automobile.

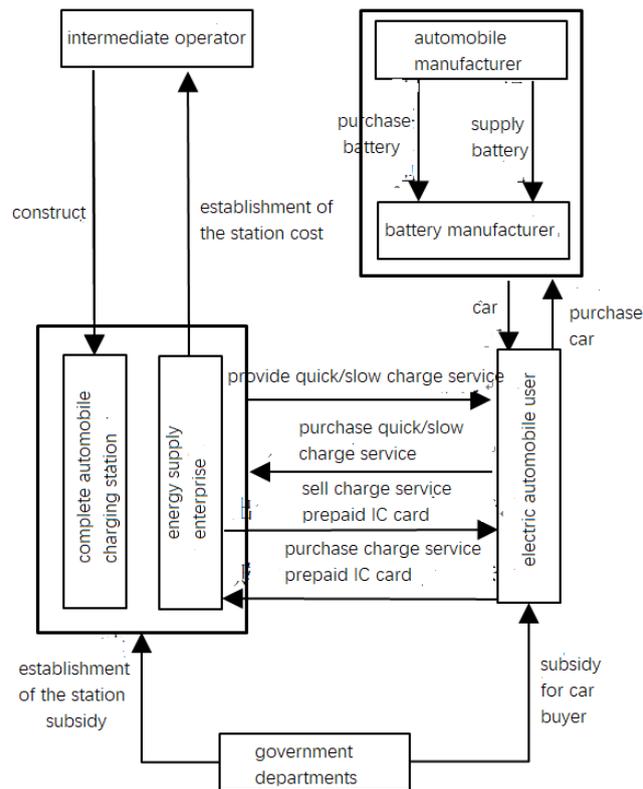
Table 2 Comparison of the advantages and disadvantages of energy supply model

energy supply model		advantage	disadvantage
charging mode	slow charging	Equipment requirements and installation costs are less, suitable for housing estate	time-consuming is long, it takes 5-10 hours to complete the charging
	quick charging	time-consuming is short, it takes just 20min-2h to complete the charging	1. Charging current is generally more than 150A, equipment requirements is high, installation costs is large 2. The battery has a greater loss, shorten the battery life
change mode		1. It takes the shortest time, only a few minutes 2. The demand of the charging station for picking space is not high	1. The replacement needs to be completed by professional equipment and personnel 2. The battery shape and installation position of each automobile model are different, and the operation is inconvenient 3. The charging stations need to prepare the batteries of various models

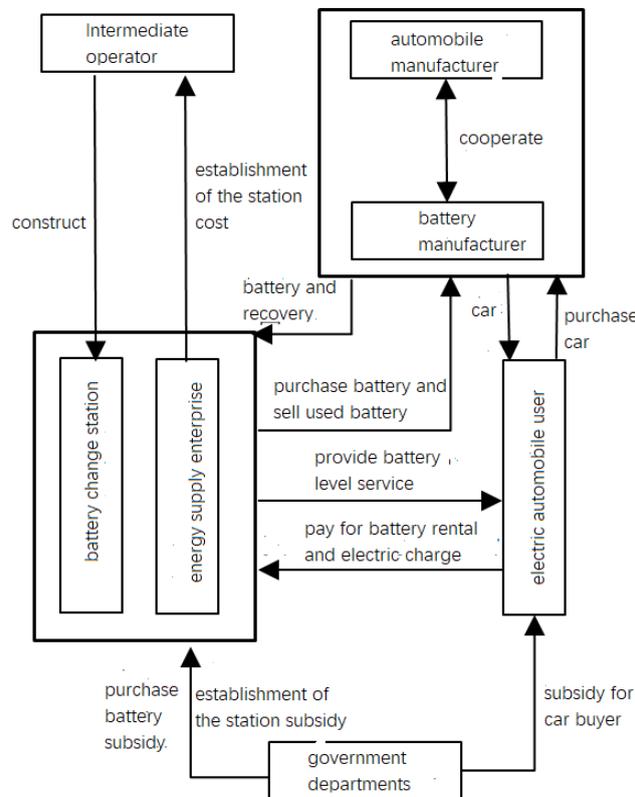
Data source: Ministry of Science and Technology, Donghai Securities Research Institute

Zhou Fengquan and so on (2010), based on the analysis of profitable way of the complete automobile charging and change-battery two power supply modes, and has carried on the comparative analysis on their own competitiveness, profit mode, the influence of grid operation, thought China's electric automobile charging stations should take changing power as major, complete automobile charging as complementary this approach to make energy supply in the future. Chen Chuyue (2015) analyzed the influence factors of charging and changing power demand, respectively. The factors influencing charging demand mainly include the travel distance of electric automobiles, the access time of the electric automobile, the remaining power of electric automobiles, the stop time of the electric automobile and the configuration of charging equipment. The factors influencing the demand for changing power include the number of stored batteries, the remaining power of electric automobiles, and the capacity of the battery and the size of electric automobiles. Tian Shihui (2017) from indirect network effects between the electric car and charging pile market, analyses the formation process of feedback mechanism between the two, construct the decision model of the consumers and charging pile enterprise, respectively, values of equilibrium condition and critical equilibrium are obtained through simultaneity. The analysis shows that when considering indirect network effect, the initial investment of the operator is greater, but the profit will increase as the market of electric automobile develops.

(2) The operation mode of charging equipment is to be explored. At present, there are three kinds of charging pile operation modes internationally; there are the government-oriented charging pile operation mode, the power grid enterprise-oriented charging pile operation mode and the automobile manufacturer-oriented charging pile operation mode. Government-oriented charging pile operation mode is suitable for the early stages of the development of electric automobiles, the stage of commercial operation with smaller scale, it needs the government to encourage and support enterprises engaged in the construction of charging pile. The government funds and construct the charging pile, and the resulting loss can be financed by the financial burden and can promote implementation and development of commercialization operation of electric automobiles. However, with the increase of the number of charging piles, investment demand increases, the governmental finance will be difficult to support, and this model due to lack of market competition, it will cause inefficiency of charging pile project.



Profit mode of complete automobile charging mode



Profit mode of replacing the battery

Figure.3 profit way of complete automobile charging and battery replacement mode

Data source: Zhou Fanquan (2010)

Grid enterprise-oriented charging pile operation mode is applicable to the commercialization of electric automobiles with a larger scale, charging user size and service demand are relatively stable,

investment channels is smooth. At present, the State Grid, China Southern Power Grid bear the construction of electric automobile charging pile. Power grid enterprises build a charging pile, which is optimistic about the prospects of the charging pile; the power grid enterprises build the charging pile with power resources advantages, network transmission advantages and technical standards advantages, but lack terminal sales network and operation experience of charging pile.

The charging pile operation mode dominated by automobile manufacturer is suitable for commercialization of electric automobiles with large operating scale, charging service infrastructure is good, commercial conditions are ripe, development stage of smooth development channels. Automobile manufacturers invest in charging pile, which takes the construction of the charging pile as the service content of the electric car market service, the product and service value chain are integrated, but also commercialized operation is carried out in accordance with the marketization principles. However, when the charging pile increases with large scale, the supplied power and technology may not be able to meet the actual demand, profit of charging pile is affected by price fluctuations. Although China's charging pile construction is relatively slow, it still cannot meet the growing demand for charging, but the construction of the charging pile cannot only choose the government-led operation model, it is necessary to combine China's specific national conditions and implement proper operation model, but adopt what kind of operation model, scholars have also put forward their own ideas.

Liu Juanjuan, Cao Shenglan (2015) thought that the charging pile construction is still in its infancy in China, the most ideal choice should be "automobile manufacturers+ power grid enterprises" alliance mode, namely the automobile manufacturers and power grid enterprise jointly construct and operate charging pile. This paper find that optimal electric automobile number of charging pile service is associated with the cost coefficient of power generation through analysis and calculation, with the decrease of the cost coefficient of power generation, the number of operated electric automobiles increases, profits of alliance-operation charging pile mode show a tendency to decrease first and then increase. When the scale of electric automobiles is smaller, the number of charging piles should be built up as the number of electric automobiles increases, when the number of operated electric automobiles reaches a certain scale, the electric automobile market is stable, the charging piles can be shared, and the speed of building charging piles can be slowed down appropriately.

Tang Min (2011) and others compare and study the advantages and disadvantages of government-led, enterprise-led and user-led three charging infrastructure business model, and think China's charging infrastructure construction should use hybrid business model that is dominated and driven by enterprise, government involvement and support at current stage. Liu Xiaoxiao and Lian Guohai (2011) summed up foreign experience and point out that commercial operation of electric automobile charging equipment will through the demonstration operation, mature promotion and leading promotion three stages, in the operation process of charging equipment commercialization, we need to strengthen the government leadership to solve the initial input, implement the pure electric bus plans to boost operating efficiency of charging stations gains improvement, improve policy support and implement matching funds, also strengthen management and improve after-sales service guarantee.

In addition to the above three operating modes, in recent years, because the PPP model gradually spread in the field of public infrastructure applications, scholars have begun to explore the application of PPP model in the new energy automobile charging equipment construction and operations. Bai Hua Tan Deqing(2017) think that the new energy automobile charging equipment is the basis and guarantee for the development and popularization of new energy automobiles, with the nature of quasi-public goods, but because the number of its construction projects is large, widely distributed, investment is large, and long-term use and maintenance also need huge amounts of money, and thus become a bottleneck promotion and use of new energy automobile. The PPP model has the internal driving force to lead the concept, technology and system innovation, the government and the social subject cooperate based on the spirit of contract, so as to realize the benefits sharing, the risk sharing and the

whole cooperation, it will effectively improve the operation efficiency of the charging equipment construction of new energy automobile.

In addition to the above two issues, China's new energy automobile infrastructure construction still have many problems. For example, in the construction of charging equipment, the main existing problems are the long power access cycle and high cost, the private construction, property matching, pile project reporting process is complex, with long cycle and other issues; in the charging operation services, there are pay interconnection and new and old standard switching problems of pile, charging safety issues, fuel truck occupancy, charging equipment layout is unreasonable, the user find the pile difficult, utilization of equipment is low, charging operations companies are difficult to profit and other issues, In aspects of charging safety, the standard is not complete, maintenance of equipment is and security is not in place, which lead to charging security risks, as well as the problem of charging service information security urgently need to be solved. In addition, the low industry threshold results in chaotic market; there is 'bad money drive out good money' phenomenon.

In order to solve the above problems of charging infrastructure construction, operation, service and safety, and effectively promote the healthy development of electric automobile charging infrastructure, the National Electric Automobile Charging Infrastructure Promotion Alliance was established in 2015, Shanghai established the first local platform that link country charging equipment information service platform in 2017. The alliance is composed of major domestic electric automobile manufacturers, energy suppliers, communication service providers, charging equipment manufacturers, charging operation providers, third party organizations and related organizations, it is important to promote research development and implementation of charging equipment standards, establish and improve the certification system of charging equipment, promote the standardization and scale development of charging operation service, promote the interconnection of charging equipment and establish the network intelligent management platform of charging equipment.

On the one hand, the establishment of the alliance of charging infrastructure is conducive to realize the interconnection of charging equipment in various regions. On the other hand, the key to solving the above problems is that the alliance members can cooperatively establish charging equipment standards and realize information sharing. The literature on how to achieve cooperation among alliance members, because the alliance is still in its infancy currently, the cooperation among the members is still in the preliminary exploration stage, therefore, how scholars can have a better idea on how to achieve deeper cooperation among alliance members is less. Liu juanjuan, a scholar who collected relevant issues in the literature (2015) thought that the key issue to be solved in charging pile alliance construction model is the automobile manufacturers, power grid enterprise and residential properties three cost-sharing issues. In this paper, the Shapley method in game theory is used to give the cost-sharing method among enterprises. The satisfaction of the cost-sharing results is verified, and the satisfaction of the three is similar. Finally, this paper pointed out that it is necessary to unilaterally abandon the prejudice and solve the problems, the new energy automobile charging pile alliance construction enterprises reach the maximum coordination in the case of information asymmetry.

3. Research Review

The relevant research on the new energy automobile charging infrastructure are integrated, it can be found that although there are many operation mode, security and other issues in the construction process of charging infrastructure, but the construction speed of charging station and charging pile is rapidly changing under the stimulus of the governmental subsidies. Because the charging infrastructure construction not only involves the interests of a single enterprise, which is related to the common interests of the new energy automobile manufacturers, power grid company as well as many consumers, thus the charging infrastructure construction needs to balance the interests of all parties, it is a process of cooperative game. How to realize the interests of all parties do not conflict, jointly promote the construction of China's new energy automobile charging infrastructure to gradually

improve, the establishment of electric automobile charging infrastructure promotion alliance has opened the interests of all sides work together. Alliance platform has been spread to the local, then we need to further study what kind of incentives to better promote the coordination among the alliance members. It can be found from above scholars' research that the current research is mainly based on the specific analysis of specific problems, jump out of specific problems and rise to co-innovation among the alliance enterprises still relatively lack research. Therefore, with the continuous construction of the charging infrastructure, as well as the continued promotion of construction of the local alliance platform, the co-innovation among alliance members will be accelerator to promote the charging infrastructure construction.

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