Application Research on PPP Mode of Charging Infrastructure

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Abstract

At present, China is facing the dual pressure of fossil energy shortage and controlled carbon emission, as well as the rapid development of emerging technologies such as cloud computing, Internet of things, big data, artificial intelligence and 5g. The full popularization of new energy vehicles will become an inevitable trend. Then, charging infrastructure, as an important energy supplement channel for new energy vehicles, is a crucial guarantee factor. However, the overall layout of new energy vehicle charging infrastructure has high construction cost and wide range. If it is driven by the government's financial resources alone, it will not only greatly increase the financial pressure of the government, but also lead to problems in construction and operation, such as low professionalism and low efficiency. Therefore, China encourages the government to adopt PPP mode to build charging infrastructure. On the one hand, the investment of social capital can effectively reduce the financial pressure of the government and improve the work efficiency of the project. On the other hand, social capital is better at resource integration of emerging technologies and can better optimize the layout of charging infrastructure. Therefore, PPP mode is the best choice for the construction of charging infrastructure in China. Based on the current development status of charging infrastructure of new energy vehicles in China, this paper finds out the problems through the analysis of data of new energy vehicles and charging piles in recent 6 years, and uses the charging Infrastructure PPP project to join the social capital side, Aiming at solving the problems of charging infrastructure construction and the financial pressure of the government, this paper finally puts forward the application strategy of charging infrastructure.

Keywords-*PPP; new energy vehicles; charging infrastructure*

1. INTRODUCTION

In order to achieve the goal of carbon peak and carbon neutralization as soon as possible, the demand for the development of new energy vehicle industry and its supporting infrastructure is becoming more and more urgent and timely. Since 2013, the national development and Reform Commission, the Ministry of industry and information technology, the Ministry of science and technology and the Ministry of finance have issued a series of policies to promote the development of new energy vehicle industry. However, with the rapid development of new energy vehicle industry, the supporting infrastructure construction is insufficient, and it has fallen into a bottleneck period [1] . Among them, the construction of charging infrastructure can not keep up is a great obstacle, so it is urgent to speed up the construction of charging infrastructure. However, the overall layout of new energy vehicle charging infrastructure has high construction cost and wide range. If only relying on the government's financial support, it will not only greatly increase the financial pressure of the government, but also cause problems in the construction and operation, such as low professionalism and low efficiency.

Therefore, in 2015, the general office of the State Council issued the guidance on accelerating the construction of electric vehicle charging infrastructure, which proposed the main strategic orientation of China to develop new energy vehicles with pure electric drive as the main strategic orientation, and to build a new energy vehicle charging infrastructure system to meet the

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charging requirements of more than 5million electric vehicles; We should broaden the channels of multi financing, create conditions for social capital to participate in the construction and operation of charging infrastructure, and encourage the government to adopt PPP mode to build charging infrastructure. PPP, a project that is a project of cooperation between public sector and social capital, has the advantage that the investment of social capital can effectively reduce the financial pressure of the government and improve the efficiency of the project, and is the best choice for the construction of charging infrastructure in China. Therefore, this paper will introduce PPP mode on the basis of the current situation and problems in the field of charging infrastructure in China, and give full play to the role of market mechanism, and then put forward the strategy of promoting PPP mode in the application of new energy vehicle charging infrastructure.

2. Analysis of Charging Infrastructure of New Energy Vehicles in China

2.1. Analysis of Charging Infrastructure Construction in China

The early construction of domestic charging facilities in China is mainly led by the government, and the State Grid and China Southern Power Grid occupy the main market of the city. However, due to the low penetration rate and many technical problems in the early development of new energy vehicles, most of the projects are at a loss; Therefore, from 2014, the Chinese government issued relevant documents to encourage social capital to enter the field of charging facilities construction. Since then, the whole charging facilities construction market has been fully opened, and the participants have become rich and diverse.

According to the statistical data of China charging Union, the data of new energy vehicles and charging piles in China in recent 6 years are summarized as shown in Table 1. By the first half of 2021,the cumulative number of charging piles in china was 1.866 million,including 88000 public charging infrastructure and 986000 charging facilities for vehicle accessories The number of new energy vehicles in China reached 6.03 million, including 4.93 million pure electric vehicles, accounting for 81.68% of the total number of new energy vehicles. According to the relevant plans of the State Council, it is expected that by 2020, the production and sales of new energy vehicles in China will reach 5 million, which has exceeded the task. As the leading direction of the future automobile industry, the development of new energy vehicles is unstoppable. However, the guideline for the development of electric vehicle charging infrastructure (2015-2020) announced that by 2020, it will be built to meet the charging demand of 5 million electric vehicles in China, and the pile vehicle ratio needs to reach 1:1. From the analysis data, it is still far from enough, which also reflects the huge lag in the construction of charging infrastructure. Draw a box diagram of the data in the table, as shown in Figure 1. It can be clearly seen from the figure that pure electric vehicles have increased rapidly in recent 6 years and have become the leader in the development of new energy vehicle industry. However, as an important energy channel for new energy vehicles, the growth of charging piles in recent years is not obvious, and the charging piles equipped with vehicles account for more than half of the total number of charging piles. At present, there are many enterprises involved in the construction and operation of charging infrastructure, among which special calls, star charging and the State Grid occupy most of the market. At the same time, China has gradually advocated sharing private piles, but it is in the pilot stage, and the operators are mainly star charging.

TABLE 1. Statistics on the ownership of new energy vehicles and charging piles in China from 2016 to 2021

Year	Public charging pile (10000 sets)	Private charging pile (10000 sets)	Pure electric vehicle (10000 vehicles)	Other new energy vehicles (10000 vehicles)	Vehicle pile ratio
2016	15	6.3	72.56	18.72	4.3:1
2017	24	23.2	125.47	27.93	3.3:1
2018	39	47.7	211.37	49.41	3:1
2019	52	70.3	309.25	71.53	3.1:1
2020	81	87.4	400.13	91.89	3:1
2021	88	98.6	493	110	3.2:1

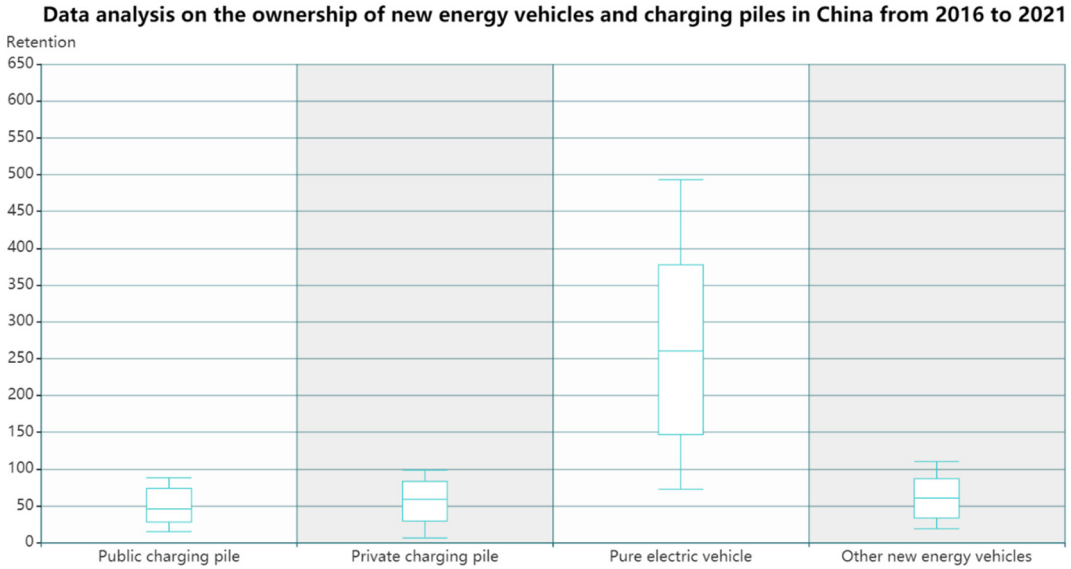

Figure 1. Data analysis on the ownership of new energy vehicles and charging piles in China from 2016 to 2021

2.2. Analysis of Charging Infrastructure in China

At present, the central and local governments attach great importance to the promotion and application of new energy vehicles. From the data growth over the years, China's new energy vehicle market has ranked first in the world. As an important guarantee for the development of new energy vehicles, charging infrastructure is not optimistic, and its development is in trouble.

2.2.1. Large gap in Charging Infrastructure

According to the document "electric vehicle charging infrastructure development guide (2015-2020)", by 2020, more than 12000 new charging and replacement power stations and more than 4.8 million distributed charging piles will be added to meet the charging demand of 5 million electric vehicles nationwide, and the ratio of pile to vehicle should reach 1:1. However, according to the statistics of China charging alliance, the number of pure electric vehicles in China has reached 4.93 million, and the total charging infrastructure is 1.866 million. The pile car ratio is far from the planned number, which is difficult to meet the growing number of new energy vehicles.

2.2.2. High Investment Cost of Charging Infrastructure

According to the construction scale of charging infrastructure, it can be divided into two types: charging pile and charging station. According to the estimation of Ping An Securities, the construction of a charging station needs land acquisition cost, infrastructure cost and operation cost. If the land acquisition cost is ignored, the construction of a charging station costs 3 million yuan, and the average price of charging pile is 20000 yuan / piece. If we consider the cost of land, in addition to the price factor, another problem hindering the promotion of charging infrastructure is the shortage of land resources [2].

2.2.3. Difficulty in Construction

In the early stage of construction, many preconditions such as planning, land use and power are needed. In the process of project implementation, many competent departments and enterprises are involved, which makes it difficult to coordinate. In the field of private charging pile construction, users without fixed parking spaces or old residential areas cannot install piles because they do not have proper installation conditions; For users with installation conditions, there is also a phenomenon that the owner committee does not support and does not cooperate with the property service enterprises. China charging Union statistics analyzes the reasons for 379000 charging facilities not built with the vehicle, including no fixed parking space, no real estate cooperation, no fixed parking space in the workplace, difficult to report and install, 51.2% of which are charged by users using special stations and other reasons, which has exceeded half of the total, It also reflects the problem that our country still faces difficulties in pile construction.

3. Related Research on PPP Model

3.1. Classification of PPP Modes

In China, the specific operation of PPP mode is mainly carried out by purchasing services, franchising and equity cooperation. This paper mainly summarizes the classification methods of Wang Hao in the definition and classification of PPP [3] .

3.1.1. Outsourcing PPP Projects

Generally, it is invested by the government and contracted by the private sector for one or more of the whole project. For example, it is only responsible for engineering construction, or entrusted by the government to manage and maintain facilities or provide part of public services, and the revenue is realized through government payment. In outsourcing PPP projects, the private sector takes relatively small risks.

3.1.2. Concession PPP Projects

Private investors should participate in part or all of the investment, and share the project risks and benefits with the public sector through a certain cooperation mechanism. According to the actual income of the project, the public sector may charge a certain franchise fee or give a certain compensation to the franchise company, which requires the public sector to coordinate the balance between the profit of the private sector and the public welfare of the project. Therefore, the success of the franchise project largely depends on the management level of the relevant government departments. Through the establishment of an effective regulatory mechanism, franchise projects can give full play to their respective advantages, save the construction and operation costs of the whole project, and improve the quality of public services. The assets of the project are ultimately reserved by the public sector, so there is generally a transfer process of the right to use and ownership of the project, that is, after the end of the contract, the private sector is required to transfer the right to use or ownership of the project to the public sector.

3.1.3. Divestiture PPP Projects

The private sector is required to be responsible for all the investment of the project. Under the supervision of the government, it can recover the investment and realize profits by charging users. Because the ownership of private PPP projects is permanently owned by the private sector and does not have the characteristics of limited recourse, the private sector bears the greatest risk in such PPP projects.

3.2. Related Research on PPP Model

The public private partnership (PPP) in China has gone through the exploration stage (1984-1992), the pilot stage (1993-2002), the promotion stage (2003-2007), the adjustment phase 1 (2008-2013) and the comprehensive development stage (2014-2017), and has stepped into the comprehensive standardization stage since 2018 [4] . From the perspective of time development, PPP mode has not been running for a long time in China, and the practical experience is not rich. Most of the projects are in the initial stage. However, with the support and operation of relevant institutions and departments, the application of PPP in various fields continues to heat up. Both the number of projects and the value of projects show a trend of rapid growth. The industries involved include energy, transportation, water conservancy construction, ecological construction and environmental protection, municipal engineering, district development, etc. These projects are related to the field of public service and closely related to public life.

In the context of the rapid development of new energy vehicles, the construction of charging infrastructure and transportation management is becoming an emerging industry, which stimulates the investment enthusiasm of all kinds of capital. According to the statistics of PPP demonstration projects related to charging infrastructure construction in the national PPP comprehensive information platform project library of the Ministry of finance, as of January 2018, there are 13 projects, which belong to the fields of energy, transportation or municipal construction. The projects are all initiated by the government, have passed the value for money evaluation, and have long cooperation time. Through the analysis, it is found that most of the current demonstration projects adopt BOT mode, but they are still in the early stage of identification and preparation. Most of the follow-up projects plan to obtain investment return through feasibility gap subsidy and user payment, or increase local government debt in disguised form, and the demonstration driving role needs to be further improved.

4. Application Strategy of Charging Infrastructure in PPP Mode

China's comprehensive promotion of new energy vehicles is irresistible, and it is inevitable to fully promote the construction and operation of charging infrastructure. At the same time, the current charging infrastructure belongs to the emerging energy industry, and there is no monopoly enterprise in the industry, so the development restriction is small. Moreover, enterprises are better at capital operation and can obtain greater value on this basis. From the practical development trend and policy orientation, it is inevitable to introduce PPP mode into the construction and operation of charging infrastructure. Therefore, combined with the previous analysis, this paper provides the direction for PPP mode in the application of new energy vehicle charging infrastructure.

4.1. Strengthen the Overall Arrangement at the Initial Stage of the Project

Considering the characteristics of charging infrastructure projects, many factors need to be considered. In order to realize the network effect of charging infrastructure, the government should comprehensively consider the economic development of the construction area, the number of new energy vehicles,

charging demand, land supply, etc; Furthermore, charging infrastructure is a part of the future infrastructure system, such as power grid, transportation planning, communication services and other infrastructure planning. Whether the capacity of the power grid has the installation conditions directly, such as the old community, the old city and so on. Now, we advocate the Internet of vehicles, hoping to improve the economy through the efficiency and reliability of the network. Charging pile networking is also the trend of future development. To establish a unified charging system platform and network integrated management, we need to cooperate with traffic planning and network service planning. Technology update iteration is also an important factor. Considering that the construction and operation of new energy vehicle battery technology and charging infrastructure are developing vigorously at the present stage, the planning here is a dynamic process. In the process of development, it is necessary to constantly refine the planning content and revision. Referring to the case of Anqing new energy electric vehicle charging infrastructure project, we should first focus on the short-term goals, Then we should look at the long-term goal and follow the principle of "car pile is suitable for the body, moderately advanced, and in stages and batches". Therefore, at the initial stage of PPP project of charging infrastructure, government departments should strengthen the overall arrangement to lay a solid foundation.

4.2. Reasonable Allocation of Project Risks of Both Parties

The success of PPP project financing is closely related to the level of project risk sharing. As far as private enterprises are concerned, they will not choose charging Infrastructure PPP project if they are assessed to bear too high risk or the income and risk are seriously unbalanced before investing in the project. In other words, it is easy to fail even if they invest in the project. As a government department, it should establish the spirit of equality and mutual trust. When signing the charging Infrastructure PPP project agreement, it should adhere to the principle of "matching risk and benefit", and combine with the actual situation of the project, scientifically design the risk-taking scheme to attract the participation of social capital. In the actual PPP projects, the public sector pays more attention to the effect of social services and the long-term development of the industry, while the private sector tends to pay more attention to the project benefits and economic benefits. Therefore, the rights and responsibilities, risks and benefits in PPP projects need to be reasonably allocated in order to better balance the interests of all parties. If too much risk is concentrated in one side of PPP project, it will inevitably lead to the failure of the project because that side can not bear the risk. Therefore, in order to achieve mutual benefit and win-win situation, ensure the successful completion of the PPP project of new energy vehicle charging infrastructure, and reasonably allocate the investment risk, it can be corresponding to the project income and agreed by signing an agreement.

4.3. Moderately Broaden the Way of Project Income

Charging infrastructure has the characteristics of high investment cost, long return cycle and single return mode. It is also because of these unfavorable factors that many private sectors are deterred. Therefore, the PPP project of new energy vehicle charging infrastructure should be moderately innovated, the income channel should be widened, and the private sector should be helped to make profits in the PPP project, so as to attract more capital to join. Based on the above-mentioned intelligent sharing platform, while meeting the basic needs of users, the project company can further develop more functions, such as reservation charging function, charging payment function, query navigation function, etc., and then connect the idle private charging pile with the public charging pile, which can be rented out in the idle time of the charging pile. On the one hand, individuals can charge the rental fee, On the other hand, the government can better integrate resources and avoid waste of resources. Considering the vigorous development of financing projects, we can also moderately develop supporting PPP project financial products. Government departments and financial institutions can work together to launch financial products that match the project. On the one hand, it can disperse the risk of the project, on the other hand, it can raise more funds.

5. CONCLUSION

At present, China is facing the dual pressure of fossil energy shortage and carbon emission control. In order to achieve the goal of carbon peak and carbon neutralization as soon as possible, the demand for the development of new energy vehicle industry and its supporting infrastructure is increasingly urgent. At the right time, charging infrastructure as an important energy supplement channel for new energy vehicles is a crucial guarantee factor. The construction of charging infrastructure can not keep up with the pace of new energy vehicles, which has become a great obstacle. Therefore, PPP project of new energy vehicle charging infrastructure is an effective way to solve this problem.

This paper takes new energy vehicle charging locomotive facilities as the research object, analyzes the current situation of China's new energy vehicle charging infrastructure from the development and current situation of China's charging infrastructure, and concludes that China is facing a large gap in the number of new energy vehicle charging infrastructure, which is difficult to meet the growing consumer demand; the investment cost of

new energy vehicle charging infrastructure is high and the return period is long; As well as the difficulty of construction and coordination. Then combined with the relevant research of PPP mode, that is, China's PPP mode can be divided into outsourcing, franchising and privatization, and China's charging Infrastructure PPP projects are still in the initial stage of development, the number is small and most of them are in the preparation stage. Finally, the application strategies of new energy vehicle charging infrastructure under PPP mode are put forward, which are to strengthen the overall arrangement at the initial stage of the project, make short-term and long-term planning, and lay a solid foundation for the long-term development of charging infrastructure; Reasonable allocation of project risks between the two parties, to promote better cooperation between the public sector and social capital; We should appropriately broaden the way of project income and stimulate more social capital to participate.

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