

# Business Model Analysis of the Third-Party Platform of Electric Vehicle Charging Pile

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**Abstract.** Game theory is used to analyze the business model of electric vehicle third-party platform, analyze the strategic choices of the three parties under the cooperation mode of three business models, and put forward Suggestions for the results.

## Introduction

Compared with traditional fuel vehicles, electric vehicles have the advantages of clean and environmental protection, zero emissions, low cost of use, high energy efficiency, and the strong support of the policy has made the electric vehicle industry develop rapidly, vehicle charging pile industry has also entered a stage of rapid development. With the strong support of the government and social funds, and the increasing number of business model innovations in social operations, the third-party operating platform of charging piles has ushered in new opportunities.

## Literature Review

Liu Yingqi used the morphology matrix to divide the business model elements of the charging pile industry into three elements: value proposition, value chain and profit model[1].Magretta introduced the concept of industrial chain and summarized a business model innovation approach based on the adjustment of industry industry chain process. It is proposed that the business model and industrial chain of the enterprise are inseparable. It runs through the production chain of the whole industry chain[2].Gao Wei and Guan Xin based on the basic value chain of enterprises, using their different changes in the entire industry value chain and the innovation of their own basic value activities to explain how enterprises achieve business model innovation[3].Platform economy has become a research hotspot in academia, and Internet platform enterprises have brought subversive innovation paths for traditional business model innovation[4].The third-party operation platform of the charging pile integrates the marketing activities in the industrial value chain into the basic activities of its own value chain by integrating the charging pile manufacturers, operators and users, and jointly distributes the value of the enterprises in its value chain.

## Business Model Game Analysis

Assume that there are third-party platforms, operators and users in the market, and the set is  $N=[1.2.3]$ . Among them, the player 1 represents the third-party platform, the player 2 represents the operator, and the player 3 represents the user. All three parties in the game are rational economic people, and they pursue the maximization of their own interests.

The action set of the player 1 is  $A_1=\{a_{11}, a_{12}\}$ .  $a_{11}$  indicates that the third-party platform only provides an open platform to provide services to users and operators.  $a_{12}$  indicates that the third-party platform not only opens the platform to attract operators, but also participates in the construction of charging piles, and provides operators with charging piles and self-operated charging piles.Assume that the platform revenue is  $I_p$ . when the third-party platform does not participate in the construction, and the part of the cooperation revenue of the platform is  $I_{pj}$ , the platform operation cost is  $C_p$ , and the input cost of the self-operated charging pile is  $F$ . Assuming

that the revenue of the third-party platform independent operation pile is directly proportional to its input, the total revenue of the platform when participating in construction is  $I_{p1}=I_{pj}+aF$ .

The action set of the player 2 is  $A_2= \{a_{21},a_{22}\}$ , and  $a_{21}$  indicates that the operator does not newly establish a charging platform after the operator chooses to cooperate with the third-party platform, or the operator in the market gives up the original independence Platform,  $a_{22}$  indicates that the operator does not access the third-party platform and chooses an independent operation platform. Assume that when the third-party platform does not participate in the construction, the revenue of the operator when cooperating with the platform is  $I_y$ , the revenue when the independent operation is  $I_{yd}$ , and the independent operation investment is  $C_d$ ; when a third-party platform participates in the construction, the revenue of the operator participating in the cooperation is  $I_{y1}$ . Since the operator's revenue is not related to the third-party platform action when the user chooses to use the operator independent platform, the revenue is still  $I_{yd}$  when operating independently.

The action set of the player 3 is  $A_3= \{a_{31}, a_{32}\}$ .  $a_{31}$  indicates that the user only uses the third-party charging platform as the charging interface, and  $a_{32}$  indicates that the user only uses the independent platform of the operator as the charging interface. In this paper, the user's revenue is equal to the difference between the utility and the cost of the consumer behavior. When the third-party platform does not participate in the construction, the revenue of the user using the third-party platform is  $R_s$ , and the revenue of using the operator platform is  $R_d$ . Since the third-party platform has the convenience of resource integration,  $R_s>R_d>0$ . The participation of third-party platforms can provide users with more convenient services. At this time, the revenue of users using third-party platforms is  $R_{sj}$ . Assume that the revenue obtained by users from independent operations of third-party platforms is  $bF$ , then  $R_{sj}=R_s+bF$ . When a third-party platform participates in the construction of a charging pile, if the operator does not participate in the cooperation, the user's revenue is  $bF$ .

For the smaller players and new entrants in the operator industry, due to the high risk, high cost and large  $C_d$  of the independent operation platform, At this point the operator's action is  $a_{21}$ .

Table 1. Set of parties' strategies

A <sub>1</sub>	A <sub>3</sub>	
	a <sub>31</sub>	a <sub>32</sub>
a <sub>11</sub>	(I <sub>p</sub> -C <sub>p</sub> , R <sub>s</sub> )	(-C <sub>p</sub> , 0)
a <sub>12</sub>	(I <sub>p1</sub> -C <sub>p</sub> -F, R <sub>s1</sub> )	(-C <sub>p</sub> -F, 0)

As can be seen from the table,  $a_{32}$  strategy is strictly inferior to  $a_{31}$ . When  $aF-F>0$ , it can be known from the scribing method that when the self-operated part of the third-party platform can achieve profitability,  $(a_{12}, a_{31})$  is a pure strategy Nash equilibrium. This shows that when there are many small charging pile operators and new charging entrants in the market, if the third-party platform self-operating part can achieve profitability, the third-party platform participates in the charging pile construction, the third-party platform and users can get more revenue. When  $aF-F<0$ , it can be known from the scribing method that the independent operation part of the third-party platform cannot realize profit, and  $(a_{11}, a_{31})$  is a pure strategy Nash equilibrium. At this time, the third-party platform does not participate in the construction of charging piles, and third-party platforms and users can achieve more revenue.

Although the third-party platform in the market is developing, it does not occupy a dominant position when it cooperates with the industry's head operators. Let the operator's cooperative revenue share ratio be  $t$ , then  $I_y=tI_p=tI_{yd}$ . When the third-party platform in the market does not participate in the construction of charging piles, the third-party action set is only  $a_{11}$ . In this paper,  $P_{ij}$  represents the probability of man  $i$  choosing strategy  $j$ .

Table 2. Set of parties' strategies

A <sub>2</sub>	A <sub>3</sub>	
	a <sub>31</sub>	a <sub>32</sub>
a <sub>21</sub>	(I <sub>y</sub> -C <sub>y</sub> , R <sub>s</sub> )	(-C <sub>y</sub> , 0)
a <sub>22</sub>	(-C <sub>y</sub> -C <sub>d</sub> , 0)	(I <sub>yd</sub> -C <sub>y</sub> -C <sub>d</sub> , R <sub>d</sub> )

When  $I_{yd}-C_d < 0$ , it can be known from the scribing method ( $a_{21}$ ,  $a_{31}$ ) that the Nash equilibrium solution, when the operator's independent operating revenue is less than the operating cost, the operator will choose to cooperate with the third-party platform. When  $I_{yd}-C_d > 0$ , this paper uses the hybrid strategy method, and the expected revenue of both parties is as follows;

$$U_2 = p_{21}p_{31}(I_y - C_y) + a_{21}a_{32}(-C_y) + a_{22}a_{31}(-C_y - C_d) + a_{22}a_{32}(I_{yd} - C_y - C_d); U_3 = p_{21}p_{31}R_s + p_{22}p_{32}R_d$$

Set up equations:  $\frac{\partial U_2}{\partial p_{21}} = 0$ ,  $\frac{\partial U_3}{\partial p_{31}} = 0$ . Result is;  $p_{21} = R_d / (R_d + R_s)$ ,  $p_{31} = I_{yd} - C_d / I_{yd} + I_y$ . Under the condition

of equalization,  $p_{21}$  is used to find the first derivative of  $R_s$ :  $\frac{\partial p_{21}}{\partial R_s} = \frac{-R_d}{(R_s + R_d)^2}$ . It can be seen that  $p_{31}$  is the decreasing function of  $R_s$ . When the third-party platform adopts the  $a_{11}$ , the probability that the operator participates in the platform cooperation will not increase as the user gains from the platform. Under the condition of equalization,  $p_{21}$  is used to find the first derivative of  $R_d$ :  $\frac{\partial p_{21}}{\partial R_d} =$

$\frac{R_s}{(R_s + R_d)^2}$ . It can be seen that  $p_{21}$  is an increasing function of  $R_d$ . When a third-party platform adopts the  $a_{11}$ , the probability of the operator participating in the platform cooperation will not decrease as the operator's independent operating revenue increases. It can be seen from the above formula that  $p_{31}$  is a decreasing function of  $C_d$ , and as the independent operating cost of the operator decreases, the probability of the user selecting to use the third-party platform increases.  $P_{31}$  is the decreasing function of  $t$ , and the higher the proportion of third-party platform cooperation, the higher the probability that the user chooses to use the third-party platform. Under the condition of equalization,  $p_{31}$  is used to find the first derivative of  $I_{yd}$ :  $\frac{\partial p_{31}}{\partial I_{yd}} = \frac{C_d}{(1+t)I_{yd}}$ . It can be seen that  $p_{31}$  is an increasing function of  $I_{yd}$ , and as the total revenue of the market increases, the user tends to use a third-party platform as a charging interface.

Combined with the market development, when the operator and the third-party platform are in the same market position, the benefits of both parties are as follows.

Table 3. Set of parties' strategies

A <sub>2</sub>	A <sub>1</sub>	
	a <sub>11</sub>	a <sub>12</sub>
a <sub>21</sub>	(I <sub>y</sub> -C <sub>y</sub> , I <sub>p</sub> -C <sub>p</sub> )	(I <sub>y1</sub> -C <sub>y</sub> , I <sub>p1</sub> -C <sub>p</sub> -F)
a <sub>22</sub>	(I <sub>yd</sub> -C <sub>y</sub> -C <sub>d</sub> , -C <sub>p</sub> )	(I <sub>yd</sub> -C <sub>y</sub> -C <sub>d</sub> , aF-C <sub>p</sub> -F)

In the case that the probability that the third-party platform does not participate in the construction is  $P_1$ , the operator's expected return is:

$$U_1 = p_1(I_y - C_y) + (1-p_1)(I_{y1} - C_y); U_2 = p_1(I_{yd} - C_y - C_d) + (1-p_1)(I_{yd} - C_y - C_d)$$

When  $U_1 = U_2$ ,  $P_1 = \frac{I_y + C_d}{I_{yd} + I_{y1} - I_y - I_{yd}}$ .  $P_1$  is positively correlated with  $C_d$ , indicating that the higher the independent operating cost of the operator, the more inclined the platform does not build the charging pile.

According to the hypothesis, the total charge on the market in a certain period of time does not change, set to  $I$ . From the above analysis,  $I_y$ ,  $I_{yd}$ ,  $I_{y1}$ ,  $I_{yd1}$  are all related to  $I$ , and have a positive correlation. Dividing the numerator and denominator of the above formula by  $I$ , we can see that  $P_1$

has a negative correlation with  $I$ , that is, with the increase of total charging revenue in the market, third-party platforms tend to participate in the construction of charging piles.

Seeking the same principle:  $P2 = \frac{aF - F}{I_p - I_{pj}}$ . At this time, when the revenue and investment of the independent operation part of the third-party platform is higher, the operator tends to cooperate with the third-party platform. However, when the market for the independent operation of the third-party platform is divided, that is, the larger the  $I_{pj} - I_p$  is, the lower the probability that the operator cooperate with the platform.

## Summary

According to the calculation results, with the continuous development of the industry, the third-party platform of charging piles participates in the construction of charging piles, which can bring more benefits to the platform and users. The relationship between the operator and the third-party platform is non-homogeneous and non-heterogeneous. When the third-party platform develops better and better, the operator's cooperation motive can be increased, but when the third-party platform encroaches on the operator's market share When it is worthwhile, it will reduce its motivation for cooperation. Generally speaking, the participation of the third-party platform in the construction of charging piles is conducive to the development of the industry, but the scope of construction should avoid overlapping with the scope of operators. It should be built in areas where the service of existing operators is weak, avoid upstream and downstream competition, and further improve charging services.

## References

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