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## Analysis of Two Typical EV Business Models Based on EV Taxi Demonstrations in China

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### Abstract

Shenzhen and Hangzhou are two demonstration cities for electric taxis applications in China. In this article, the EV taxi business models were introduced and profitability was analysed for battery quick charging in Shenzhen and for battery quick swapping in Hangzhou. The organization patterns of two business models are revealed. The net present value (NPV), the internal rate of return (IRR) and payback period (PP) of the two patterns were calculated by using the value chain analysis method and the cash flow calculation method. The result shows that the NPV and IRR of the two patterns for business models are both negative, payback period are much longer than reference investment, indicating a low profitability even with government subsidies. Sensitivity analysis is carried out to study the impacts of relevant factors on profitability, which indicates that Shenzhen quick charging model are faced with a profit gap while Hangzhou quick charging model are have strong potential of improving profitability through swapping frequency increase. Therefore, they need to be improved by developing profitable business and by enlarging local EV market scale respectively.

*Keywords: electric vehicle, business model, taxi, organization pattern, profitability*

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### 1 Introduction

The development of electric vehicle (EV) has become an ideal opportunity for China to reduce oil consumption and improve air quality nationwide. EV industry has been highly valued as “future strategic industry”, and over billions of dollars had been invested to boom this promising industry in the last decade. However, because of the high cost of battery, immature technology, lack of charging facilities and many other reasons, EV industry develops much slower than expected. Business model focus on the relationships between market and product has the potential of making up for the immature aspects of a certain kind of new technology and promote its marketization.

Since 2009, demonstrations of EV taxis have been carried out in selected cities of China. In which, Shenzhen and Hangzhou are two typical demonstration cities for EV taxi applications, through which we can have a glance of typical future EV business models. Though there have been research on EV business model, most of them are frame work study and do not include quantitative analysis<sup>[1-2]</sup>. In our article, in the way of case study, the EV taxi business organization pattern and profitability was analyzed, methodologies of value chain and cash flow calculation as well as sensitivity analysis are applied respectively<sup>[3-4]</sup>. In addition, measures that could possibly improve profitability are further discussed.

## 2 Methodology

### 2.1 Investigation

Investigations are carried out to obtain certain information required. In particular, the driving range of EV taxis are 200km and 80km respectively, the subsidy are both 20000 US dollars in total (including 10000 national subsidy and 10000 local subsidy). The basic information of business models in two cities by March 2013 are as follows (table 1).

### 2.2 Value Chain Analysis

Based on the theory of value chain, the EV business structure is divided as five parts: OEMs, energy suppliers, third party operators (TPO), channel and user, with all their value activities (fig1). By revealing value chain, their organization pattern, product flow and cash flow can be analyzed and the position and effect of each part can be evaluated.

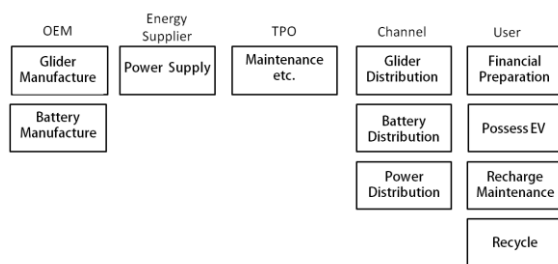


Figure 1: Value activities of EV business model

The taxi companies are EV users, their

value activities are: Financial preparation, possess EV, energy supply and recycle. Meanwhile, the value activities of OEMs are glider manufacture and battery manufacture; the activity of energy suppliers is power supply; activities of channel are sales of glider, battery and power; TPOs are in charge of finance service, maintenance, insurance and other value-added services.

### 2.3 Cash Flow Analysis

Profitability determines the sustainability of a certain business model. In our article, we assume the benefit of users are fully considered by the operators otherwise they will certainly not be EV users. Also, OEMs and power suppliers sell their product at a price that could bring in profit. In this case, the profitability of TPOs will be our only concern. Because of the similarity of the facilities in the same city, the profitability of each business unit, namely one standard charging station or a swapping station is calculated.

The net present value (NPV), the internal rate of return (IRR), and payback period (PP) of the two patterns were calculated by using cash flow calculation method., by referencing to the time of technology replacement, the average profitability of infrastructures, the calculation period is 5 years, the discounting rate is 8%. In this case, NPV shall be above zero, IRR shall be above 8% and PP shall be less than 5 years to meet the demand of profitability.

Thereafter, the sensitivity analysis is proceeded to show in what extent the four key

Table 1 basic information of EV taxi operation

Item	ShenZhen	HangZhou
Business Model	Battery Quick Charging	Battery Quick Swapping
Additional Subsidy	50% discount of maintenance fee and annual inspection charge	0.02 dollar/km per vehicle, for 6 years or 60000km( The first to reach)
Operator	Pengcheng EV Taxi Company	New Energy EV Taxi company
EV Model	BYD E6	ZOTYE M300 EV
Charging or Swapping Facility	57	17
Number of EV Taxi	300	184
Duration of single shift/ h	12	15
Time for one Charge/ h	1.5 h	—
Frequency of Swapping	—	3~4 times/day

factors (initial investment, marginal cost, charging or swapping fee, charging or swapping frequency) affect the profitability.

### 3 Organization Pattern

#### 3.1 Shenzhen Quick Charging Business Model

The organization pattern of Shenzhen quick charging business model can be concluded as: quick-charging, vehicle-purchasing, and third-party-operating (Fig.2). The EV Taxi Company purchases complete EV from the OEM. The EV charging service is provided by a third-party operator, Potevio, which build battery quick charging stations and acquire electricity from the grid. Through vertical integration, the OEM, namely BYD, has a strong ability in vehicle production, so it produces both glider and battery, which improves the consistency of the product and lowers the cost. With capital advantage, the operator Potevio possesses 57 charging stations through construction and merging, covering 95% of the charging facilities in the city, and provides users with charging and other value-added service. Based on OEMs and Operator, the EV business model of Shenzhen is established.

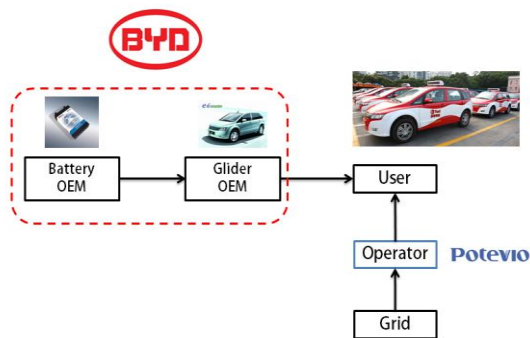


Figure 2: Organization Pattern for the Quick Charging Business Model

The value chain of Shenzhen quick charging business model is abstracted by concluding the participants and their value activities based on value chain theory (Fig.3).

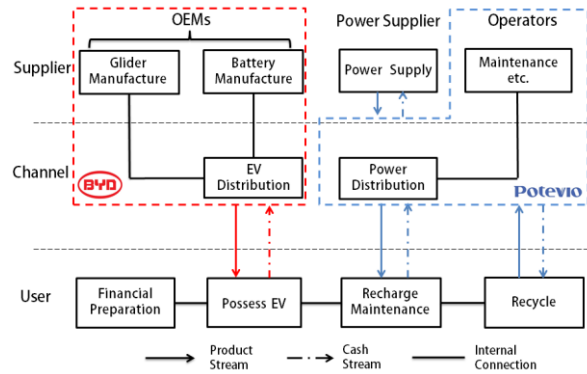


Figure 3: Value Chain for the Quick Charging Business Model

#### 3.2 Hangzhou Quick Swapping Business Model

The pattern of Hangzhou quick charging business model can be concluded as: battery-swapping, vehicle-purchasing without batteries, and battery-leasing (Fig.4). The User only purchase glider and lease battery from the operator. The operator purchase battery from OEM and it provides user with bind service including battery leasing, swapping and maintenance service. Users pay the rent by mileage.

There is no mighty auto company in Hangzhou, so the vehicle OEM only produce glider. With the capital and grid infrastructure advantage, the State Grid dominates the business model by horizontally integrates battery swapping facility operation, power supply, power distribution as well as battery distribution.

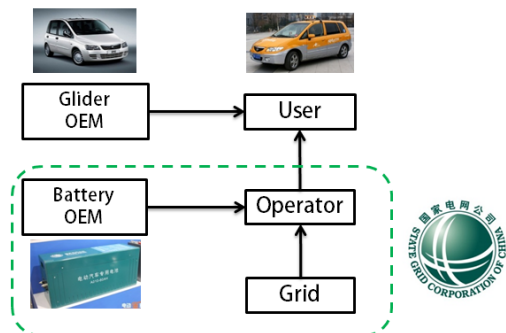


Figure 4: Organization Pattern for the Quick Swapping Business Model

The value chain of Shenzhen quick charging business model is abstracted by concluding the participants and their value activities based on value chain theory (Fig.5).

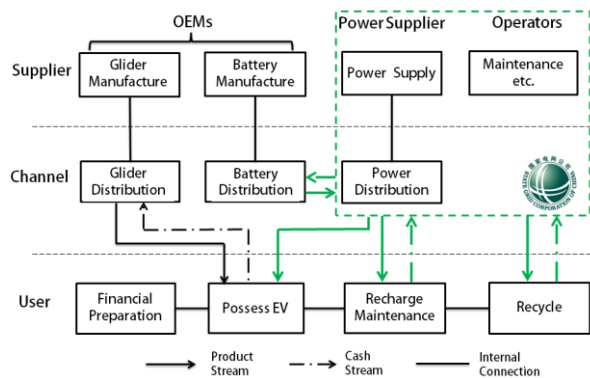


Figure 5: Value Chain for the Quick Swapping Business Model

## 4 Profitability

### 4.1 Shenzhen Quick Charging Business Model

#### 4.1.1 Profitability Analysis

The scenario is based on following facts or assumptions derived from investigation: There are 500 electric taxis in total. The average range of BYD E6 is 200km per charge, the battery capacity is 60kWh, the average electricity cost is \$5/100km and the average charging time is 1.5h. For every charging station, there are 8 chargers available; operating 24 hours and it can be calculated that the theoretical maximum service capacity is 128 charges per day. The total cost of a standard station is 800 thousand dollars including land rent, construction and charging equipment. Because some of the stations have to charge for EV buses in the city, the actual number of stations available for taxis is about 30, which means each stations has 50 charges per day. According to the EV development speed in Shenzhen, the amount of charging service will increase by 15% in the next a few years. The electricity cost and price is \$0.09/kWh and 0.2/kWh respectively and will remain constant, the income tax rate is 25%.

The result from table 2 shows that the current NPV and IRR are both negative, the PP is 14 years, indicating that the profitability of current quick charging business model is very weak. Even the theoretical maximum service number is reached, the business unit is still in deficit.

Table 2: Shenzhen quick charging model profitability analysis

Charging Frequency(charge/day)	NPV/Thousand\$	IRR / %	PP/year
50	-512.5	-34	14
128	-195.3	-8	10

#### 4.1.2 Sensitivity Analysis

The sensitivity of Initial Investment, marginal cost, charging fee, charging frequency is analysed.

From view of cost, as can be seen in figure 6, the initial investment has greater effect on profitability, for the reason of high cost land renting and high voltage charging equipment. The electricity cost account for 60% of marginal cost, but electricity cost is almost impossible to decline in city's current situation.

In terms of benefit, both charging frequency and charging fee have positive effect on profitability. However, the result of table 2 has proved that even with maximum frequency, there is still no chance of earning profit, this is because of the long charging time of EV. Higher charging fee might be beneficial, but when the IRR reach 8%, the charging fee per EV taxi will be \$12/100km per vehicle, that is the same price with current gasoline taxi, which means it's not affordable by market.

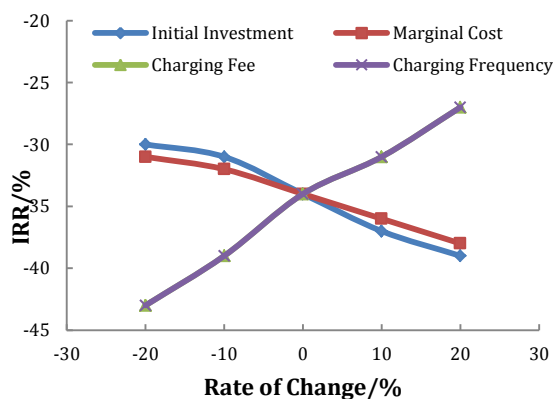


Figure 6: Profitability Sensitivity Analysis for the Quick Charging Business Model

### 4.2 Hangzhou Quick Swapping Business Model

#### 4.2.1 Profitability Analysis

The scenario is based on following facts or assumptions derived from investigation: There are

200 EV taxis. The range of ZOTYE M300 EV is 80km, the battery capacity is 12kWh, the taxi swaps 4 times per day, the battery service fee is 0.9\$/km, namely 6.5 dollars per swap. The swapping time is 10min per vehicle and the maximum swapping is 432times per day. There are 17 swapping stations in Hangzhou, each serves 46 swaps per day. The initial investment of a standard charging station is 600 thousand dollars, including land rent, construction and swapping equipment. The backup battery needed for each unit is 1.5 times the vehicle it serves. The initial purchase battery number is 18, and its amount increases by 10% per year to meet market demand. The cost of battery is 45 thousand dollars, and the government subsidy is 10 thousand dollars per battery. According to the subsidy policy, newly purchased battery in the future will not be covered. The electricity cost is 0.7\$/kWh and will remain constant the income tax rate is 25%.

The result from table 3 shows that the current NPV and IRR are both negative, the PP is 11 years, indicating that the profitability of current quick swapping business model is very weak. Without government subsidy, the profitability is even weaker.

Table 3: Hangzhou quick swapping model profitability analysis

Subsidy	NPV/Thousand\$	IRR	PP/year
Yes	-313.6	-26%	11
No	-471	-33%	13

#### 4.2.2 Sensitivity Analysis

The sensitivity of Initial Investment, marginal cost, charging fee, charging frequency is analysed.

From view of cost, as can be seen in figure 7, the initial investment has greater effect on profitability, for the reason of high cost land renting and back up batteries. With the lowered battery cost in the future, the initial investment is still promising to decline. The management cost account for most of the marginal cost and it may increase slightly in the future.

In terms of benefit, both swapping fee and swapping frequency are very sensitive. In terms of swapping fee, its increase space is also very limited. The swapping frequency has great potential of improving the profitability, for there the current service amount is far lower than 432

maximum daily swaps. Through calculation, the IRR will reach 8% when the daily swap reaches 90 times. With more swapping, the amount of backup battery shall be increased, lowering the margin of business unit, so an optimised service amount shall be estimated for each business unit.

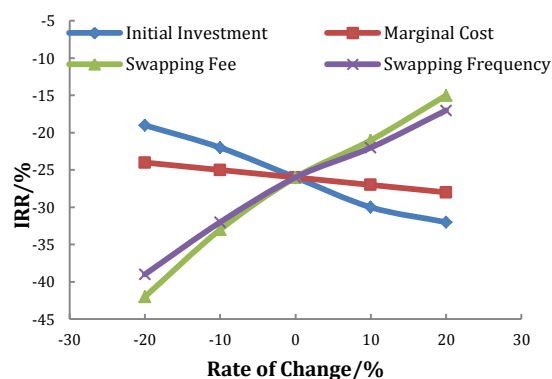


Figure 7: Profitability Sensitivity Analysis for the Quick Swapping Business Model

## 5 Conclusion

(1)The Shenzhen quick charging business model is founded by vehicle OEM and charging facility TPO. OEM provide vertically integrated EV with high performance, and TPO operate charging network. This is similar to current gasoline vehicle business model.

(2)The Hangzhou quick swapping business model is founded by grid cooperation. User only need to buy EV glider. Grid act as operator and power supplier, through horizontal integration of battery leasing and swapping service, it provides user with a bind EV solution. This is similar to business model of telecommunication.

(3)The profitability for both EV business models are very weak, NPV and IRR are both negative. As shown on table 4, the result shows that the NPV and IRR of the two models for business units are both negative, indicating a low profitability.

Table 4: Result of the Profitability Calculation for Two EV Business Models

Business Model	NPV/Thousand \$	IRR / %	PP / Year
Quick Charging	-512.5	-34	14
Quick Swapping	-313.61	-26	11

(4) For Shenzhen quick charging model, the improvement of profitability is facing a “gap” effect, there is hardly potential to enhance profitability in current situation. An alternative

business model is needed to bring in more profit for EV business model of Shenzhen.

(5) For Hangzhou quick swapping model, increasing charging frequency can greatly promote profitability. Therefore, the promotion of market scale should be its major concern.

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