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The Estimation and Analysis of Decommissioned Quantity of New Energy Vehicle Traction Battery in China

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Abstract

With the rapid development of China NEV industry, large-scale decommissioning of traction batteries is coming. Waste traction battery recycling and utilization have been highly concerned by the government and the public. The prediction and analysis of decommissioned traction battery quantity are of great significance to carry out the planning of recycling industry layout in advance. This paper set up a model to forecast the decommissioned traction battery quantity from 2021 to 2030, of which the factors involve the quantity of used traction batteries in the past, vehicle type, vehicle application sceario, battery type, etc. It is estimated that from 2021 to 2030, the decommissioned quantity in China will grow rapidly, while in 2022 and 2026 the growth rate will be much more higher. The decommissioned quantity in 2030 will reach 128GWh.

Keywords

New Energy Vehicle; Traction battery; The decommissioned quantity; Estimation.

1. INTRODUCTION

As a national strategic emerging industry, new energy vehicles have developed vigorously in recent years. Especially after 2015, driven by related national subsidy policies and the rapid development of domestic supporting technologies such as batteries and motors, the cumulative output of new energy vehicles in China has exceeded 5.5 million vehicles, and the cumulative supporting battery power has exceeded 260GWh.

If the decommissioned power batteries are not properly disposed, a series of potential safety hazards will arise and serious environmental problems will arise. At the same time, the valuable metal elements such as lithium, cobalt, nickel, copper and aluminum and other materials such as graphite are not effectively recycled, which will cause great waste of resources for China, which has high dependence on foreign resources such as lithium, cobalt, nickel and manganese. Therefore, the standardized recycling of retired power batteries is an important factor to ensure the sustainable and healthy development of China's new energy automobile industry. Accurate and effective prediction of retired power batteries can provide important support for the management of relevant departments, and at the same time help comprehensive utilization enterprises to rationally plan production capacity, and promote the vigorous development of traction battery recycling industry. In this paper, considering the industry characteristics such as the sales volume and application scenarios of new energy vehicles, a prediction model of decommissioning amount is established, and the decommissioning amount of power batteries in the next 10 years is reasonably predicted, which provides the basis and support for the relevant competent departments to control the management policy system of traction battery recycling in China.

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2. FORECAST METHOD

At present, the prediction of the decommissioning amount of power batteries in the industry is mostly based on the market supply model and Stanford model. The market supply model mainly estimates the scrap amount of the product in the future according to the annual sales volume and average life of the product. Stanford model is improved on the basis of market supply model, and it is predicted according to the scrap percentage of products in different life periods. In this paper, based on the market supply model, considering the industry characteristics of new energy vehicles and power batteries, taking the sales volume of new energy vehicles over the years, the predicted sales volume in the future, the warranty period of batteries, vehicle types, battery types, and vehicle application scenarios as model factors, the decommissioning amount of power batteries of different vehicle types and different battery types is predicted.

Considering the change of new energy automobile industry policy and the uncertainty of battery technology development in the future, this paper limits the forecast time to 2020-2030. Because the average life of traction battery is 5-8 years. Therefore, it is necessary to predict the installed capacity of power batteries and the proportion of installed capacity in different vehicle application scenarios in the next five years. Based on the sales volume of new energy vehicles and the installed capacity of power batteries in the past years, according to the blueprint of "New Energy Vehicle Industry Development Plan 2021-2035", this paper forecasts the installed capacity in the next five years according to certain assumptions. Among them, the application proportion of new energy vehicles in different scenarios comes from the data analysis of the comprehensive management platform for national monitoring of new energy vehicles and traceability of traction battery recycling (hereinafter referred to as "national monitoring platform"). The service life of the battery is based on the assumption of vehicle use, and the application scenarios of passenger cars are divided into private, official, rental and rental purposes. Commercial vehicles are divided into passenger cars and special vehicles, and the service life of ternary, lithium iron phosphate and other batteries assembled on vehicles with different purposes is considered.

Based on the above information, the calculation formula of decommissioning amount is:

$$D_i = \sum_{j=1}^{4} \sum_{k=1}^{3} P(i - n_{jk}) * C_{jk}$$

(i=2020, 2021, ……2030)

In the formula: Di is the decommissioning amount of the new energy vehicle traction battery in the i-th year, unit: GWh. n_{jk} is the retirement age of the type k battery of the j type car, unit: year. $P(i\text{-}n_{jk})$ is the installed capacity of power batteries in the $i\text{-}n_{jk}$ year, in GWh. C_{jk} is the proportion of installed capacity of type k batteries for type j vehicles.

3. PREDICTION OF TRACTION BATTERY DECOMMISSIONING

3.1. Proportion of Installed Capacity in Different Application Scenarios of New Energy Vehicles

According to the statistics of the national monitoring platform, by the end of 2019, the cumulative proportion of passenger cars and commercial vehicles was 80% and 20% respectively. Among passenger cars, private and official vehicles account for about 56.2%, and rental and rental vehicles account for about 22.4%. Among commercial vehicles, the proportion of passenger cars and special vehicles is close, accounting for about 10.8% respectively. By the end of 2020, private, official passenger cars, rental and rental passenger cars accounted for 60%

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and 20% respectively, while the proportion of passenger cars and special vehicles was still close. Among the vehicles sold in 2020, about 86% are private and official vehicles, about 14% are rented and leased vehicles, and 10% are buses and special vehicles in commercial vehicles.

3.2. Installed Capacity of Traction Battery

According to the Technical Roadmap 2.0 for Energy Saving and New Energy Vehicles issued by China Automotive Engineering Society (hereinafter referred to as the "Roadmap"), the sales volume of new energy vehicles will reach about 20% of the total sales volume of new vehicles by 2025. Based on this, this paper predicts that the annual sales of new energy vehicles will continue to rise steadily and reach 5 million vehicles by 2025. The actual sales volume from 2014 to 2020 and the sales volume forecast of new energy vehicles from 2021 to 2025 are shown in Figure 1.

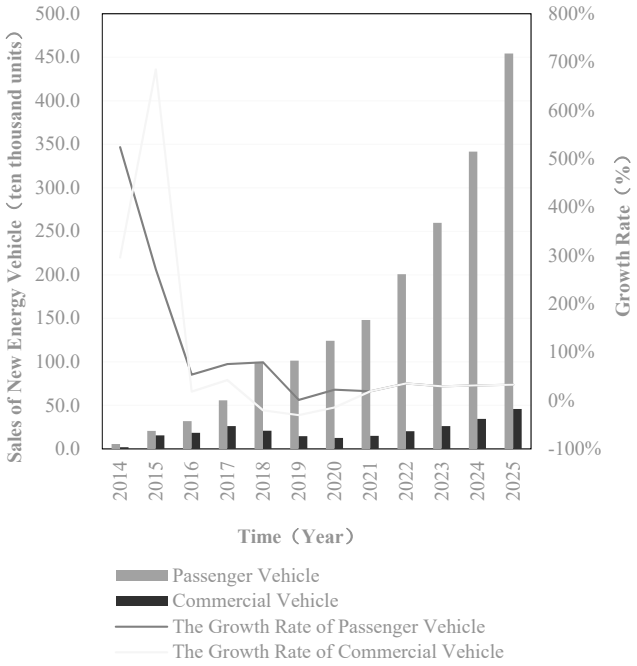

Figure 1. Sales of NEV in 2014-2025

As the road map does not cover the installed capacity of batteries and the proportion of battery types, it is necessary to make a prediction in combination with the current industrial development situation. In 2020, the installed capacity of power batteries will reach 63.6GWh, among which the installed capacity of ternary power batteries will be 38.9GWh, accounting for 61.1% of the total installed capacity. The installed capacity of lithium iron phosphate traction battery is 24.4GWh, accounting for 38.4% of the total installed capacity. The installed capacity of other batteries is 0.33GWh, accounting for 0.5% of the total installed capacity. In view of the increasing market attention to the safety of power batteries in recent years and the rising market share of lithium iron phosphate batteries in 2020, this paper predicts that the annual installed capacity of power batteries will reach 76GWh, 103GWh, 133GWh, 175GWh and 233GWh respectively from 2021 to 2025, and the installed capacity of various types of power batteries will remain basically unchanged.

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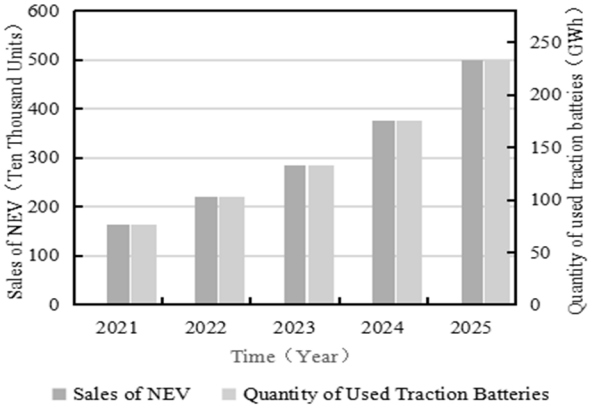

Figure 2. Sales of NEV and Quantity of used traction batteries in 2021-2025

Combined with 3.1 installed ratio data of different vehicle application scenarios, the installed capacity of power batteries calculated in this paper is shown in Figure 3. In 2018, the installed capacity of batteries increased significantly. The installed capacity of ternary batteries has steadily increased year by year. In 2018, the installed capacity exceeded that of lithium iron phosphate batteries, while the installed capacity of other batteries decreased year by year. It is predicted that by 2025, the installed capacity of ternary batteries will exceed 60%. In the field of commercial vehicles, the installed capacity of lithium iron phosphate is relatively high, and the installed capacity in 2016 is more than four times that of commercial vehicles in the same year. Ternary batteries are mainly used in the field of passenger cars, with installed capacity accounting for 89.8% and 94.7% of the total installed capacity of passenger cars in 2018 and 2019, respectively.

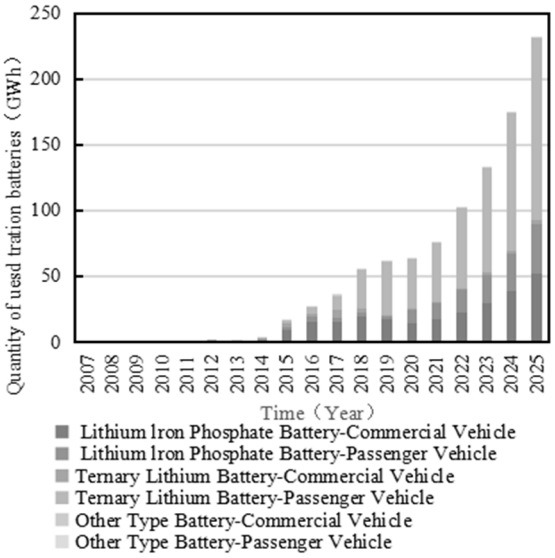

Figure 3. Quantity of Used Traction Batteries in 2007-2015

3.3. Service Life of Traction Battery

In this paper, the service life of traction battery is estimated from three dimensions: different vehicle models, different vehicle application scenarios and different battery types (as shown in Table 1). Considering that the utilization rate of private and official passenger cars is relatively low, it will generally not exceed the warranty period of 8 years or 200,000 kilometers. Considering the calendar life of battery, it is estimated that the service life of traction battery for this kind of car is 8 years. However, passenger cars, buses and special-purpose vehicles for

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rent and lease have a high utilization rate, and the daily driving distance is about 200-400km, which exceeds the warranty in about 2-3 years. The vehicle is charged and discharged once a day, with a cycle of 350 times a year. The service life of the ternary battery is 1500-2000 times, and the capacity decay is accelerated in the later period. The estimated service life is 5 years. The cycle life of lithium iron phosphate battery exceeds 2000 times, and its capacity decays and decelerates in the later period, with an estimated service life of 6.5 years. Other types of batteries are between the two, which is estimated to be 6 years.

Table 1. Lifecycle of Traction Battery

Model	Purpose	Battery type	Scrap time (year)
Passenger car	Private, official	Ternary	8
		Lithium iron phosphate	8
		Other	8
	Rent, lease	Ternary	5
		Lithium iron phosphate	6.5
		Other	6
Commercial vehicle	Passenger train	Ternary	5
		Lithium iron phosphate	6.5
		Other	6
	Special car	Ternary	5
		Lithium iron phosphate	6.5
		Other	6

3.4. Prediction and Analysis of Decommissioning Amount of Power Batteries of Different Vehicle Types

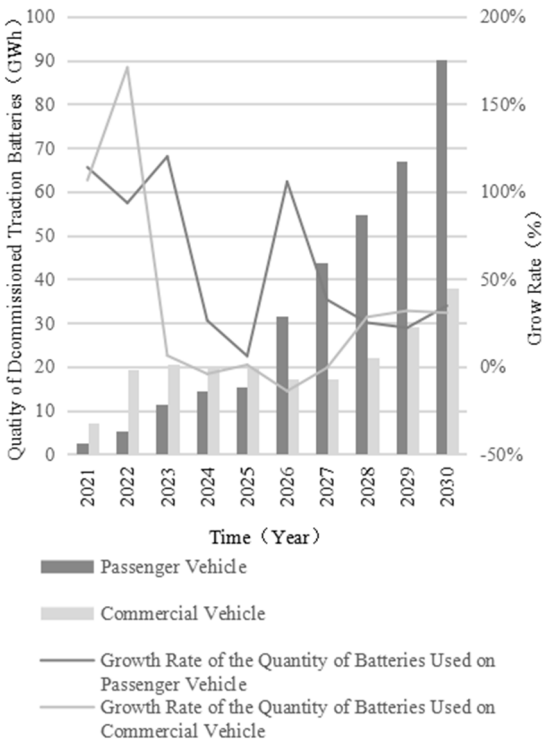

Figure 4. Quantity of Decommissioned Traction Batteries in 2021-2030 (Different Vehicle Type)

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According to the above calculation of installed capacity and service life of power batteries, using the model formula in this paper, the prediction of annual decommissioning capacity of power batteries of different vehicle types from 2021 to 2030 is shown in Figure 4. It is estimated that in 2025, the annual decommissioning amount of power batteries will be about 35.42GWh, including 15.40GWh for passenger cars and 20.03GWh for commercial vehicles. In 2030, the annual decommissioning amount of power batteries is about 128.24gwh, including 90.28gwh for passenger cars and 37.97gwh for commercial vehicles.

According to the forecast, the Lithium iron phosphate battery is the main battery equipped for commercial vehicles, and its service life is about 6.5 years. Due to the rapid increase of sales volume of commercial vehicles in 2015, the decommissioning amount of power batteries of commercial vehicles has increased greatly in 2022, reaching 19.42GWh. Due to the rapid growth of passenger car sales in 2014 and 2015, the number of retired power batteries will also maintain a high growth rate in 2022 and 2023, which are 93.5% and 120.1% respectively. At the same time, due to the sharp increase in the installed capacity of power batteries in 2018, another wave of retirement of passenger car batteries will be ushered in in 2026.

3.5. Prediction and Analysis of Decommissioning Amount of Power Batteries with Different Battery Types

In this paper, the battery type is taken as another dimension, and the decommissioning amount of power batteries with different battery types is predicted as shown in Figure 5. The decommissioning amount of Other power batteries will gradually decrease after reaching the peak in 2023. The decommissioning capacity of Ternary batteries will double in 2022 and 2026, and will exceed 70GWh in 2030. After the rapid growth of Lithium iron phosphate battery in 2022, the decommissioning amount will decrease in 2025-2027, and will increase greatly in 2028, and the decommissioning amount will exceed 50GWh by 2030.

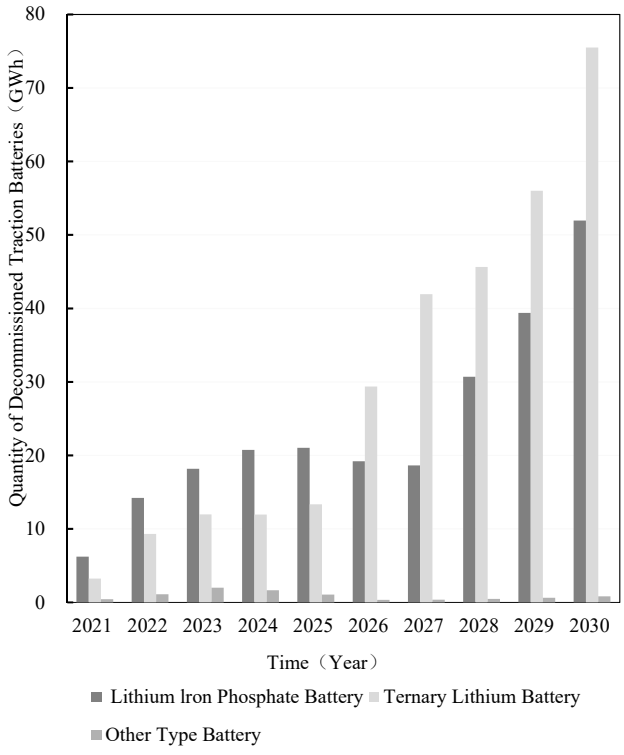

Figure 5. Quantity of Decommissioned Traction Batteries in 2021-2030 (Different Battery Type)

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4. CONCLUSIONS

In this paper, considering different factors such as vehicle types, vehicle application scenarios and battery types, and based on the analysis data of the national monitoring platform, the decommissioning amount of power batteries from 2021 to 2030 is predicted. The calculation results show that the decommissioning amount of power batteries in China is increasing year by year, and there will be two decommissioning tides of power batteries in 2022 and 2026, with the decommissioning amount of 24.6GWh and 48.9GWh respectively. In 2030, the annual total decommissioning capacity of power batteries will reach 128GWh. In terms of battery types, the decommissioning amount of Lithium iron phosphate batteries is expected to increase greatly in 2022 and 2028, while the decommissioning amount of Ternary batteries will increase exponentially in 2022 and 2026. In terms of vehicle types, the battery decommissioning capacity of commercial vehicles is expected to rise rapidly in 2022, and then will fall relatively in 2026, while the traction battery of passenger cars will have a decommissioning outbreak in 2026.

In the face of the huge decommissioning of power batteries in the future, the relevant competent departments should improve the management policy system of traction battery recycling, strengthen the binding force on relevant subjects, formulate supporting measures, strengthen industry standard management, and promote the comprehensive utilization of resources of decommissioned power batteries through formal recycling channels. The upstream and downstream enterprises in the industrial chain should strengthen their sense of responsibility, fulfill the traceability requirements of policies, and promote the standardized recovery and handover of retired power batteries.

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