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Analysis of the Characteristics and Development Trend of Reverse Logistics of GEM Co., Ltd. Used Power Battery

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ABSTRACT. *With the rapid development of the power battery industry, the problem of recycling and disposal of used power batteries has also followed. Since the power battery itself contains valuable metals and other substances that are highly susceptible to polluting the environment, it has become a top priority to speed up the construction of a reverse logistics recycling network for used power batteries and improve the recycling technology. Firstly, this article introduces and analyzes the GEM Co., Ltd. and the used power battery recycling market. Secondly, it summarizes the current status and characteristics of the GEM Co., Ltd. recycling process. Finally, on the basis of information technology, closed loop and external cooperation, the development trend of GEM Co., Ltd. was analyzed.*

KEYWORDS: *Used power batteries, Reverse logistics, Recycling, Development trends*

1. Introduction

In recent years, the two major problems of increased environmental pollution caused by a large number of traditional fuel vehicles and the increasing depletion of energy have become increasingly prominent. In order to alleviate the negative impact of these two problems on the ecology and society, actively promoting the development of the domestic new energy vehicle industry and encouraging consumers to preferentially purchase new energy vehicles have become the main tasks of relevant government departments in China. According to statistics from China Association of Automobile Manufacturers, since 2013, China's production and sales of new energy vehicles have begun to grow rapidly (As shown in Figure 1). Among them, the production and sales volume in 2018 was the highest. The annual production and sales volume were 1.275 million and 1.562 million respectively.

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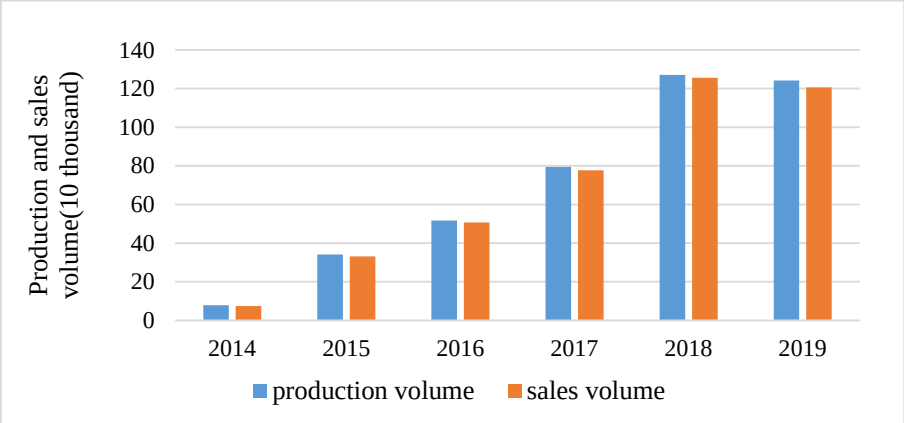

Figure. 1 China's production and sales volume of new energy vehicles in 2014-2019
Source: Official Website of China Association of Automobile Manufacturers

As one of the core components of new energy vehicles, the power battery has also ushered in the rise of production and sales since 2013. According to the statistics of GGII, China's power battery production in 2019 totaled 85.4GWh, a year-on-year cumulative increase of 21.0%, and sales volume totaled 75.6GWh, a year-on-year cumulative increase of 21.4%. However, behind the booming development of power batteries is the arrival of its large-scale retirement, considering that the power battery contains a very toxic and corrosive electrolyte and cobalt nickel manganese and other heavy metal materials, if not handled properly, it will cause environmental pollution and waste of resources. From the perspective of reverse logistics, the reverse logistics of power batteries is essentially a process from decentralization to concentration. This process itself has difficult to determine characteristics such as the number of recycling, the time and location of recycling, and the quality of recycling, therefore, optimizing the input port of the reverse logistics recycling network, improving recycling processing technology, and realizing the unity of economic and social benefits are the primary problems faced by various parties in the used power battery recycling market. Figure 2 shows the reverse logistics operation process of used power batteries.

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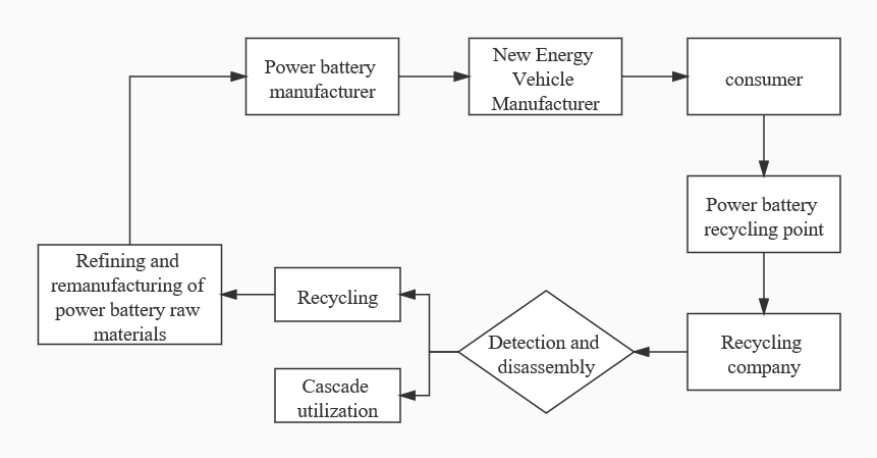

Figure. 2 Reverse logistics flow chart of used power batteries

As one of the participants in the recycling market, GEM Co., Ltd. stands out in the market by virtue of its strong recycling capacity and recycling manufacturing capacity in the field of used power batteries. Therefore, this article will analyze the network layout, recycling process, recycling metal recycling manufacturing and development trend in the field of waste power battery recycling of GEM Co., Ltd.

2. Overview of GEM Co., Ltd.

GEM Co., Ltd. was incorporated in Shenzhen in 2001 and was listed on the Shenzhen Stock Exchange in January 2010. The company is a third-party recycling company that focuses on waste recycling and recycling, and is a green environmental protection company. At present, GEM Co., Ltd. has formed two core businesses of "deep mining in urban mines" and "remanufacturing of power battery materials", of which the "remanufacturing of power battery materials" business has realized a green circular development model from recycling to remanufacturing. The total amount of waste resources recovered and processed by the company is over 4 million tons per year, and it has grown into a leading enterprise in this industry.

GEM Co., Ltd. has actively deployed in the construction of waste reverse logistics recycling network, and built 16 waste recycling industrial parks in China and "used battery recycling and power battery material manufacturing industrial chain", "cobalt nickel tungsten recycling and cemented carbide manufacturing industrial chain" , "Electronic waste recycling and high value utilization industry chain", "Scrap car recycling and overall resource recycling industry chain", "Waste residue sludge wastewater treatment industry chain" 5 waste recycling industry chains, with 3 powers Battery recycling and power battery cascade recycling center, 7 battery material remanufacturing centers, and 2 rare and rare metal recycling

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processing centers.In terms of recycling and disposal of used power batteries, GEM Co., Ltd. has achieved the recycling of recyclable resources in both depth and breadth.

At the time of the large-scale decommissioning of used power batteries, as a representative of domestic reverse logistics companies, GEM Co., Ltd. adheres to the industrial development concept of "limited resources and unlimited circulation" and devotes itself to research and development of used power battery recycling treatment and recycling technology to continuously improve its For the treatment capacity of used power batteries, expand the scale of treatment, and strive to provide more quality services to domestic and foreign customers.

3. Development status of used power battery recycling market

3.1 Recycling policy

China's used power battery recycling industry is in its infancy, in order to standardize the development of the industry, strengthen recycling management, and improve the comprehensive utilization of resources, the Chinese government has successively issued a number of related policies.

(1) In January 2017, the State Council of China stated in the "Promotion Plan for Extended Producer Responsibility System" that power battery manufacturers should establish a product life cycle traceability system to ensure that products can enter the used power battery recycling system after retirement, to achieve the purpose of product standard recovery and safe disposal

(2) In January 2018, the Ministry of Industry and Information Technology and other departments issued in the "Interim Measures for the Management of Recycling and Recycling of New Energy Vehicle Power Battery" jointly issued, that the design of power battery products should take into account the convenience of product recycling at the beginning of design, Encourage power battery manufacturers to cooperate with comprehensive utilization enterprises, and start recycling of used power batteries in accordance with the principle of first utilization after recycling

(3) In January 2020, the Ministry of Industry and Information Technology clearly stipulated the relevant technical requirements for the stepped utilization and recycling of retired power batteries in the "Specification Conditions for Comprehensive Utilization of New Energy Automobile Waste Battery" (2019 Edition), and stated that the current On the basis of recycling technology, the comprehensive utilization rate of resources is further improved, and the comprehensive energy consumption is reduced.

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3.2 Large-scale decommissioning

In the context of the continuous increase in the installed capacity of power batteries (as shown in Figure 3), the service life of the power battery is limited to about 5 years, and the capacity of the power battery in service should not be less than 70%-80% of the initial rated capacity Application standards, China has entered the early stage of the large-scale retirement of power batteries since 2018. According to the forecast statistics of China Industry Information Network (as shown in Figure 4), the total decommissioning of power batteries in 2018 was 1.2 GWh, an increase of 122% from 2017, and the total decommissioning of power batteries in 2020 will reach 12.9 GWh, compared with 2019 The annual growth rate is 143%, and the total retired power battery will reach 111.7 GWh in 2025, a year-on-year increase of 56% in 2024. In the face of a large number of retired power batteries flooding into the market year after year, China's power battery reverse logistics recycling network will face a severe test.

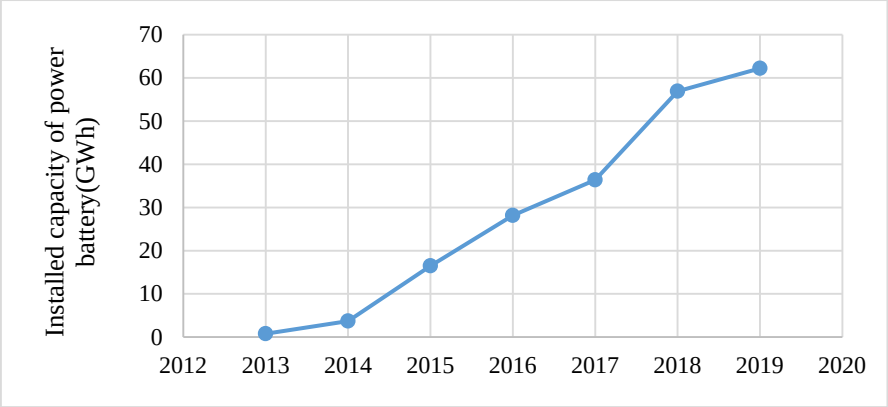

Figure. 3 Installed capacity of power batteries in 2013-2019
Source: Official Website of China Association of Automobile Manufacturers

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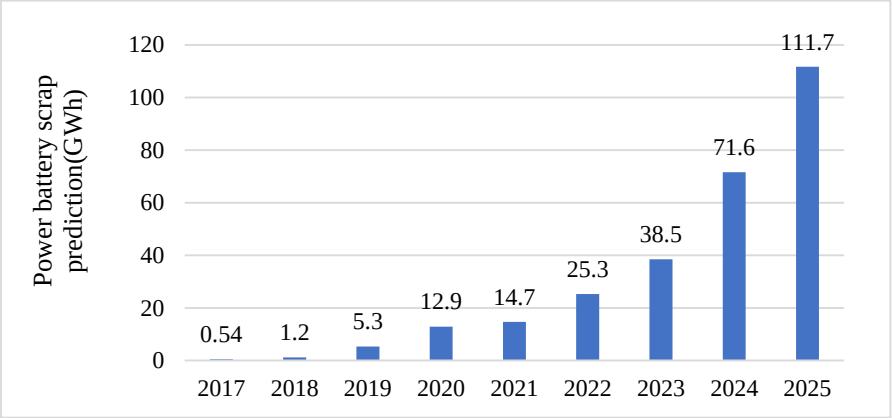

Figure. 4 Power battery scrap prediction
Source: China Industry Information Network

3.3 Insufficient recycling capacity

(1) At present, many new energy vehicle manufacturing companies in China have established used power battery reverse logistics recycling outlets, but these outlets are mostly concentrated in Beijing-Tianjin-Hebei, the Yangtze River Delta urban agglomeration, the Pearl River Delta urban agglomeration and other regions with large numbers of new energy vehicles. For large areas where recycling sites are scarce, recycling of used power batteries is still a pain point.

(2) Most of the used power batteries are concentrated on the personal consumption side, with a wide distribution range and a sparse and disordered distribution state, making it difficult to collect them centrally. In addition, most consumers do not know enough about the reverse flow of used power batteries, resulting in a certain number of retired power batteries flowing into small workshops with immature recycling technology.

(3) There are many types of power batteries in social circulation, different design and manufacturing standards, and different dismantling standards. The asymmetry of information in these upstream and downstream industries has made it more difficult to recycle power batteries.

(4) At present, the construction and operation of the reverse logistics recycling network of used power batteries are still dominated by third-party recycling companies. There are few cooperative projects in the joint construction of recycling networks by multiple parties, resulting in a single operation of the recycling network and weak recycling capacity.

(5) The backward processing equipment, insufficient utilization of ladder technology and recycling technology, the lack of standards and regulations in the

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transportation and storage of hazardous materials, and the lack of professional recycling personnel have increased the difficulty of setting up and operating reverse power recycling networks for used power batteries.

4. Characteristics of reverse logistics of GEM's used power batteries

At present, GEM Co., Ltd. has initially completed the layout of the reverse logistics recycling network for used power batteries. The specific network structure is shown in Figure 5.

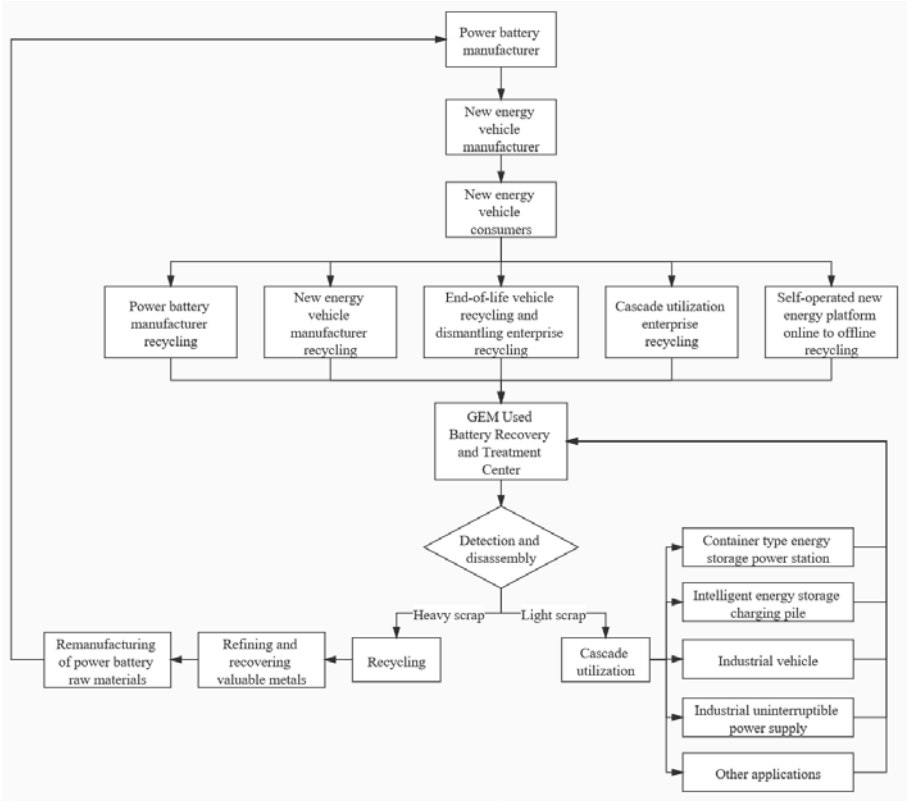

Figure. 5 Flow chart of the reverse logistics recycling network of GEM Co., Ltd.

4.1 Recycling port network layout characteristics

The recycling link is the starting port of the reverse logistics recycling network of used power batteries. The quantity of recycled products, the quality of the products, and the level of value all affect the healthy operation level of the subsequent links of the recycling network. In response to the above-mentioned

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widespread uncertainties, when planning the recycling of used power batteries, GEM took Jingmen City, Hubei Province as the comprehensive utilization center for used power batteries, and Wuhan, Wuxi, Tianjin, Shenzhen, Lankao County and Fengcheng. As a recycling center for used power batteries, a reverse logistics recycling network for used power batteries in the "1+N" mode has been established nationwide. On the whole, GEM's recycling terminal covers major areas in North China, East China, Central China, and South China, and the layout of recycling ports has been initially completed.

In addition, as a third-party recycling company, GEM has strengthened cooperation with domestic and foreign power battery manufacturing companies, new energy vehicle manufacturing companies, scrapped automobile recycling and dismantling companies, and cascade utilization companies, actively building used power battery recycling outlets, and developing shared channels. Through the online and offline recycling methods of GEM's self-operated new energy platform, the layout of recycling ports is improved, and the recycling capacity of used power batteries in a larger area is improved.

4.2 Recycling characteristics

The detection and dismantling process is the first step to realize the scientific recycling of used power batteries. According to the detection and disassembly results of related instruments, the used power batteries are divided into two types of recycling methods: cascade utilization and recycling.

The use of cascades belongs to light scrap. This scrap level means that the used power batteries can be disassembled and reassembled and used in places where their comprehensive performance requirements are low. In the cascade utilization link, GEM has applied used power batteries that have been tested and disassembled and reorganized in container-type energy storage power stations, intelligent energy storage charging piles, industrial vehicles, and industrial UPS (uninterruptible power supplies). The complete cycle application of the power battery has improved its full life cycle value and obtained good social and economic benefits.

Recycling is heavy scrapped, and this scrap level indicates that the used power battery pack needs to be disassembled, broken down, and chemically refined to realize the recovery and reuse of valuable metals such as nickel, cobalt, manganese, and aluminum. In the field of recycling technology, GEM has built a complete recycling system from fine dismantling to material recycling. It currently has three green dismantling lines for used power battery packs, with an annual processing capacity of up to 250,000 sets. Through large-scale dismantling and extraction of valuable metals in used power batteries, GEM has not only improved the comprehensive utilization of resources and created new economic value, but also reduced the problems of environmental pollution and social security risks caused by used power batteries.

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4.3 Recycled metal recycling manufacturing

China is highly dependent on imports of nickel, cobalt, lithium and other valuable metals in power battery raw materials. Therefore, large-scale refining of valuable metals in used batteries and used power batteries can not only reduce the dependence on upstream resources in the industrial chain, increase the self-sufficiency rate, increase the effective supply of valuable metals to domestic power battery manufacturers, but also increase the The utilization rate of resources of valuable metals realizes the green recycling of resources.

The terminal link of the reverse logistics recycling network of GEM's used power batteries is recycled metal recycling manufacturing, that is, the use of refined valuable metals to make new energy battery raw materials, and then supply power battery manufacturers to achieve green recycling of resources, Figure 6 Shows the production and sales of raw materials for GEM New Energy Battery. In recent years, with the widespread use of ternary power batteries in new energy vehicles, GEM has made the ternary power battery core material "ternary precursor" as the main development direction of recycled metal remanufacturing, and increased technical research. Intensity, within a few years, it has successively conquered the core manufacturing technology of high nickel ternary precursors and single crystal ternary precursors, and realized the recycling mode of power battery raw materials from recovery, disassembly, refining to remanufacturing.

In 2019, the shipment of GEM ternary precursors exceeded 60,000 tons, an increase of more than 50% year-on-year, and accounted for more than one-fifth of the world market share, of which 70% of the ternary precursors were supplied to CATL, Samsung SDI, LG Chemical, ECOPRO, etc. The world's leading power battery manufacturing enterprise and huge market share have laid a solid foundation for GEM to develop the recycled metal remanufacturing industry and continuously expand and improve the scale of the used power battery reverse logistics recycling network.

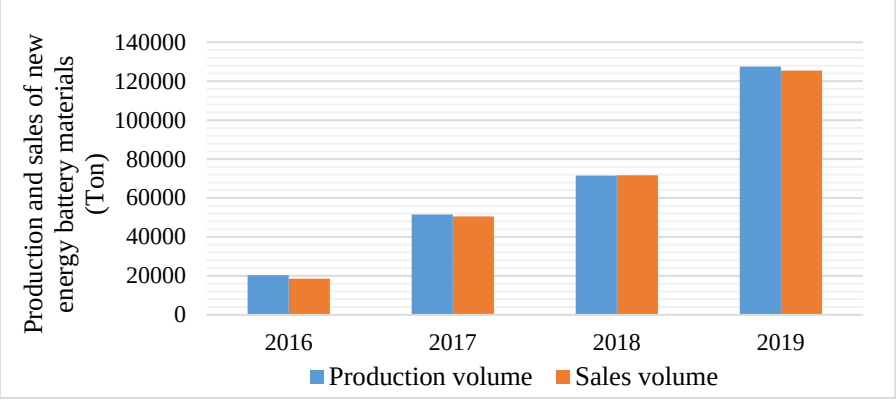

Figure. 6 GEM's 2016-2019 new energy battery materials production and sales
Source: GEM 2017-2019 Annual Report

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5. Analysis on the development trend of reverse logistics of GEM used power battery

5.1 Operation informatization

Logistics information technology is an important foundation for creating modern logistics. As a leading enterprise in the waste reverse logistics industry, GEM pays more attention to the construction of reverse logistics information systems. In recent years, GEM has built a real-time monitoring system and an intelligent environmental protection information platform based on radio frequency technology (RFID) for renewable resource industry chain data, which basically realizes the recycling, transportation, storage and recycling of used power batteries entering the reverse logistics recycling network All-round real-time monitoring, and benefiting from information integration, GEM can also use the real-time monitoring system to efficiently screen the recovered products. In addition, the environmental management monitoring information system created by GEM can monitor the environmental operation in each circulation park in real time to ensure that all links realize green operations. In the future, under the influence of the rapid expansion of the used power battery market, GEM will definitely strengthen the construction and optimization of the used power battery information system.

5.2 Closed loop cycle trend

Subject to the contradiction between the scarcity of nickel and cobalt and other valuable metals and the surge in market demand, as well as the constraints of ecological protection, GEM has formed a new energy full life cycle value chain from battery recycling-raw material recycling-material recycling-battery pack recycling-new energy vehicle service after years of creation. Among them, through the three core links of battery recycling, material recycling, and battery pack recycling, GEM connects power battery manufacturers, new energy vehicle manufacturing companies and other companies with themselves into a closed-loop supply chain (see Figure 7).

In the closed-loop supply chain, through the comprehensive recycling of valuable metals such as nickel and cobalt, GEM can not only improve the resource recycling rate, reduce resource waste, but also reduce its threat to the ecological environment and reduce pollutant emissions. To reduce the operating costs of GEM, power battery manufacturers and new energy vehicle manufacturing companies, increase corporate profit margins, achieve the unity of economic and environmental benefits, and ultimately achieve the sustainable development of the power battery industry.

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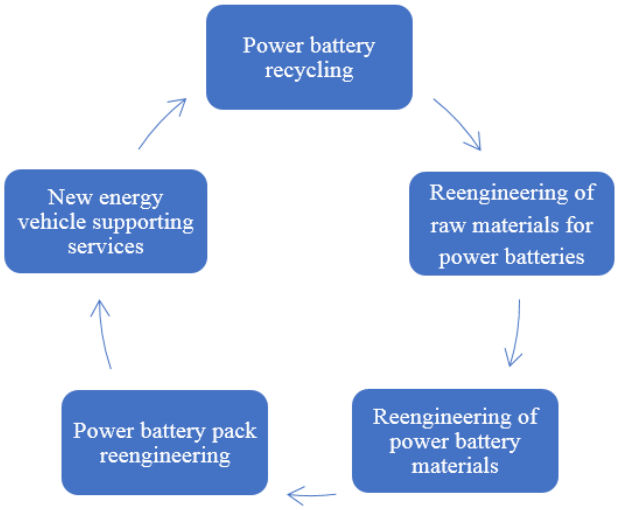

Figure. 7 GEM's closed loop cycle diagram of used power batteries

5.3 Foreign cooperation trend

The used power battery recycling market is an emerging field. Many market participants in the market, including new energy vehicle manufacturing companies, power battery manufacturing companies and third-party recycling companies, are in the initial stage of recycling network construction capabilities. Therefore, To quickly improve the market's recycling capacity, it requires the market participants to adopt a multi-link cooperation model to jointly build a reverse logistics recycling network for used power batteries.

As a third-party recycling company, GEM, under the background of rapid expansion of the used power battery market, in order to strengthen contacts with upstream and downstream supply chain companies and improve its large-scale recycling processing capacity, the company is actively seeking cooperation with the outside world. More than 180 OEMs and battery factories have signed cooperation agreements for power battery recycling. The scope of cooperation includes the recycling of used power batteries, the cascade utilization of decommissioned power batteries, and the construction of used power battery recycling systems. The rapid recovery of the recycling amount and the optimization of the circulation system of the power battery from the consumer end to the scrap end.

6. Conclusion

The used power battery recycling market is a direct driving force for the construction of a reverse power recycling network for used power batteries. With the

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trend of the recycling market expanding, GEM has actively deployed a recycling network, devoted itself to the research on recycling technology, and built from the consumer side to the scrap side. The green recycling system on the reproduction side has initially realized the closed-loop development model of used power batteries.

In the future, GEM needs to pay more attention to empower the resource recycling system, increase investment in research and development of recycling technology, strengthen the training of reverse logistics talents, strengthen cooperation between enterprises, expand the scope of services, improve the level of reverse logistics services, and promote better enterprises development of.

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