



Research on the Reverse Logistics Network of New Energy Vehicle Power Battery in Liaoning Province

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Abstract. This study uses SWOT analysis method to comprehensively analyze the reverse logistics network of new energy vehicle power battery in Liaoning Province. Liaoning province with its geographical location, industrial base, policy support, scientific research strength, environmental awareness and logistics service system, facing the national new energy policy, rapid market growth and technological innovation opportunities, but also the reverse logistics system is not perfect, technology and equipment investment disadvantages, as well as the uncertainty of laws and regulations and market competition threats. Based on this, this research puts forward the strategies of improving the reverse logistics system, increasing investment in technology and equipment, and strengthening talent training, aiming to provide decision support for the sustainable and healthy development of the reverse logistics network of the new energy vehicle power battery in Liaoning Province and even the whole country, and promote the sustainable development of the new energy vehicle industry.

Keywords: new energy vehicles, power batteries, reverse logistics network, SWOT analysis

1 INTRODUCTION

In recent years, environmental pollution and energy shortage are increasingly restricting the development of China, and sustainable development has become the goal we pursue. Fuel cars require a lot of energy and also emit a lot of polluting gases, which greatly affects the sustainable development of society. According to statistics, the automobile industry accounts for nearly half of the total oil consumption, posing a huge challenge to energy and environment [1]. Under the background of China's active promotion of the "double-carbon" goal, new energy vehicles, as an important force in green and sustainable development, play a key role in the orderly construction of the energy system [2]. Although China's new energy vehicle technology has made significant progress, but due to the preemptive market of traditional fuel vehicles, the market competitiveness of new energy vehicles still needs to be improved, and the acceptance of consumers also needs to be further strengthened. Despite the rapid development of new energy vehicles under the promotion of national policies, consumers still hold a certain wait-and-see attitude towards them. [3] According to the latest data from the Traffic

Management Bureau of the Ministry of Public Security, by the end of September 2023, the number of motor vehicles in China has exceeded 430 million, of which 330 million, and the number of new energy vehicles has reached 18.21 million. Compared with 340,000 at the end of 2014, the number of new energy vehicles increased by more than 50 times in the past decade; it also achieved a significant 39% increase compared with 13.1 million at the end of 2022 [4].

As an important province in northeast China, Liaoning Province has also actively responded to the national call to vigorously promote new energy vehicles. By the first half of 2023, the retail sales of automobile goods in Liaoning Province reached 55.33 billion yuan, with a year-on-year growth of 14.9%, among which new energy vehicles increased by 142.7%; Automobile consumption accounted for 11.4% of the total retail sales of social consumer goods, 1.1 percentage points higher than the same period in 2022. However, with the large-scale use of new energy vehicles, the recycling and reuse problem of power batteries has gradually become prominent. As the core component of new energy vehicles, power battery has a limited life. Generally, the performance decline needs to be replaced. If these waste batteries are not treated, they will not only cause potential pollution to the environment, but also waste valuable resources.

Therefore, it is particularly important to establish an efficient and environmentally friendly new energy vehicle power battery reverse logistics network. Reverse logistics refers to the logistics process from consumers to manufacturers, and the main purpose is to recycle, reuse or dispose of waste products. In the field of new energy vehicles, the construction of reverse logistics network plays a vital role in the recycling, reuse and environmental protection treatment of power batteries. Reverse logistics is gradually deeply applied in domestic industries, and it is particularly important for the reverse logistics network design of new energy vehicle power batteries. With the rise of low-carbon economy and the deepening practice of the concept of sustainable development, scholars begin to pay attention to the environmental and social goals of reverse logistics network design. K.Nageswara Reddy and other [5] proposed a multi-layer and multi-cycle green network including vehicle selection, combining facility location and vehicle selection in different processing centers with emissions from transportation and operations. Najme Roghani Langar et al [6] built the model with minimum cost and minimum carbon emission, and verified the practicability by numerical example analysis using GAMS software. Considering the goals of profit, carbon emission and employment opportunities, the multi-objective network model of reverse logistics is constructed. Temucin Tolga et al [7] builds a multi-objective mixed integer nonlinear planning model with the goal of minimizing the total cost and total latency and maximizing the total average capacity utilization, and uses the heuristic method to solve the location and flow of the desired location. Sasikumar[8] Others use the hierarchical analysis method to build a multi-criterion decision model of reverse logistics operation mode, and the results show that the third-party professional service provider is responsible for the recovery business is the best mode. As the research gradually deepened, scholars began to use various methods for combinatorial analysis research. Pourmehdi et al. [9] is based on fuzzy network analysis method and TOPSIS method, introduces fuzzy set theory, and integrates failure mode and impact analysis to realize the optimization of reverse network recovery decision.

With the increasing global attention to sustainable energy and environmental protection, new energy vehicles have become an important development direction of the transportation industry in the future. As the core component of new energy vehicles, how to recycle power batteries efficiently and environmentally friendly after the end of their service life has become a key issue facing the industry. As an important industrial base in China, the construction and development of reverse logistics network is of great significance. This paper adopts SWOT analysis method to conduct an in-depth analysis of the advantages, disadvantages, opportunities and threats of the reverse logistics network of new energy vehicle power battery in Liaoning Province, aiming to provide decision support for the construction of efficient and environmentally friendly reverse logistics network.

2 SWOT ANALYSIS OF THE REVERSE LOGISTICS NETWORK OF THE NEW ENERGY VEHICLE POWER BATTERY IN LIAONING PROVINCE

2.1 Advantage Analysis

Under the background of the rapid development of the global new energy vehicle industry, the construction of power battery reverse logistics network is becoming more and more important. As the economic and cultural center of northeast China, Liaoning province has unique advantages and favorable conditions in the reverse logistics network of new energy vehicle power batteries. The following is a detailed analysis of the advantages of Liaoning province in this field.

(1) Excellent geographical location

Liaoning Province is located at the southern end of northeast China, adjacent to the Yellow Sea and the Bohai Sea, and has several important ports, such as Dalian ports and Yingkou ports. These ports not only connect with the major coastal cities in China, but also have extensive shipping links with all parts of the world. This unique geographical location makes Liaoning Province become an important logistics hub in Northeast Asia, providing convenient transportation conditions and broad market space for reverse power battery logistics.

(2) Strong industrial foundation

Liaoning province is one of the important industrial bases in China, with rich industrial resources and a strong industrial foundation. In terms of new energy vehicles and its related industrial chain, Liaoning Province has initially formed a certain industrial agglomeration effect, and has many well-known new energy vehicles and parts production enterprises. These enterprises provide a stable source base for power battery reverse logistics, but also provide a strong industrial support for the construction of reverse logistics network.

(3) Strong policy support

The Chinese government has been committed to promoting the development of the new energy vehicle industry, and has issued a series of preferential policies and special funds to support it. As an important production base of new energy vehicles, Liaoning

province has also received strong support from the national and local governments. These policies not only cover the production, sales and use of new energy vehicles, but also place special emphasis on the recycling of power batteries. The policy guidance and support provide a strong guarantee and impetus for the construction of power battery reverse logistics network in Liaoning Province.

(4) Strong scientific research strength

Liaoning province has a large number of universities and scientific research institutions, which have profound scientific research strength and rich research results in the field of new energy vehicles and power batteries. The support of scientific research strength provides a steady stream of power for the technological innovation and intelligent upgrading of power battery reverse logistics network. Through close cooperation with universities and scientific research institutions, Liaoning province can continuously introduce and digest advanced technologies, and promote the continuous optimization and upgrading of the reverse logistics network.

(5) Increasing awareness of environmental protection

With the increasing awareness of environmental protection, more and more consumers and enterprises begin to pay attention to the recycling of power batteries. Liaoning province has always been at the forefront of environmental protection publicity and education, and the public's awareness of environmental protection is generally high. The promotion of this environmental awareness helps to form a good atmosphere for the whole society to participate in the reverse logistics of the power battery, and provides extensive social support and participation for the development of the reverse logistics network.

(6) Perfect logistics service system

Liaoning province has accumulated rich experience in logistics service, and has a perfect logistics service system and advanced logistics management concept. These experiences and ideas can be learned from the construction of power battery reverse logistics network to improve the efficiency and effect of reverse logistics. At the same time, Liaoning province also has a number of professional logistics service providers and third-party logistics companies, they can provide comprehensive and efficient service support for power battery reverse logistics.

Liaoning province has many advantages in the reverse logistics network of new energy vehicle power battery. These advantages provide a strong support and guarantee for the province to build an efficient and environmentally friendly power battery reverse logistics network in Liaoning province. In the future, with the continuous development of the new energy vehicle industry and the continuous improvement of the power battery reverse logistics network, these advantages of Liaoning Province will be more fully played and utilized.

2.2 Disadvantage Analysis

Although Liaoning province has many advantages in the reverse logistics network of new energy vehicle power battery, there are also some disadvantages that cannot be ignored.

(1) The reverse logistics system is not yet perfect

At present, the power battery reverse logistics system in Liaoning Province is not fully mature. The lack of a unified and efficient reverse logistics network and a standardized recycling process may lead to inefficient recycling of power batteries, and may even pose a potential threat to the environment.

(2) Insufficient investment in technology and equipment

Power battery recycling, disassembly, reuse and other links need professional technical and equipment support. However, the current investment in technology and equipment in Liaoning province may be insufficient, which restricts the development of reverse logistics network.

(3) Lack of professional talents

Power battery reverse logistics is a complex system involving multiple disciplines and fields, which requires professionals with knowledge of battery technology, logistics management, environmental regulations and other aspects. At present, the talent reserve of Liaoning province in this respect may not be enough to meet the needs of the rapid development of reverse logistics network.

(4) Large financial pressure

The construction and improvement of power battery reverse logistics network requires a lot of capital investment, including infrastructure construction, technology research and development, talent training and other aspects. However, financing may be a difficult problem, especially under the downward pressure of the economy, the shortage of funds may become a bottleneck restricting the development of reverse logistics network.

2.3 Opportunity Analysis

In the context of increasing attention to the global energy structure transformation and environmental protection, new energy vehicles and their related industrial chains have ushered in unprecedented opportunities for development. As shown in Fig 1, China's waste lithium batteries is expected to reach 2.312 million tons by 2026. Liaoning province, as an important province in northeast China, has also ushered in a rare opportunity for development. The following is a thorough analysis of the opportunities Liaoning faces in this field.

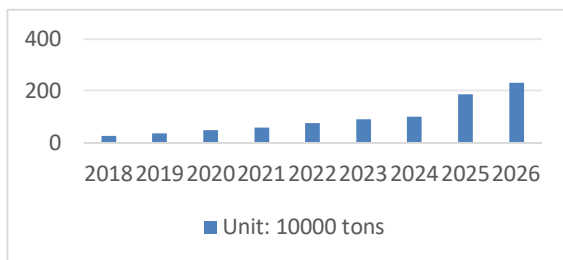


Fig. 1. Prediction of theoretical recovery amount of waste lithium batteries in China

(1) The promotion of national new energy policies

In response to global climate change and improve air quality, the Chinese government has vigorously promoted new energy vehicles and formulated a series of relevant policies. These policies not only include economic incentives such as car purchase subsidies and tax breaks, but also involve specific requirements on the infrastructure construction of new energy vehicles and the recycling of power batteries. In particular, the supporting policies for power battery recycling provide strong policy support and broad market space for the development of reverse logistics network in Liaoning Province.

(2) Rapid growth of the new energy vehicle market

With the deepening of consumers' understanding of environmental protection and energy conservation, as well as the continuous progress of new energy vehicle technology, the new energy vehicle market has shown a rapid growth trend. As shown in Fig 2, the growth rate of new energy vehicles, a trend that directly stimulates the demand and production of power batteries, thereby promoting the development of the reverse logistics network. This growth directly drives the demand and production of power batteries, which in turn promotes the development of reverse logistics network. As an important industrial and transportation center, Liaoning Province's geographical location and market size make it an important hub of power battery reverse logistics. The surge of market demand undoubtedly provides a huge power for the expansion of reverse logistics network.

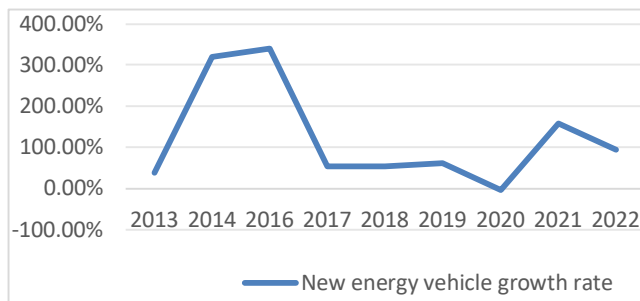


Fig. 2. New energy vehicle growth rate

(3) Technological innovation and intelligent upgrading

At present, new energy vehicles and their related technologies are in the stage of rapid iteration and innovative development. Technological innovation in the recycling, disassembly and recycling of power batteries emerges in an endless stream, which provides technical support for the efficiency improvement and cost reduction of the reverse logistics network. At the same time, with the application of advanced technologies such as the Internet of Things, big data and artificial intelligence, the intelligent level of reverse logistics network is also constantly improving. These technological innovations and intelligent upgrading provide unprecedented opportunities for Liaoning province to build an efficient and environmentally friendly power battery reverse logistics network.

(4) Opportunities for international cooperation and green trade

Under the background of globalization, international cooperation and exchanges are increasingly frequent, which brings new opportunities for the development of reverse logistics network in Liaoning Province. On the one hand, Liaoning Province can introduce foreign advanced power battery recycling technology and management experience to improve the operation level of local reverse logistics network; on the other hand, with the increasing attention to environmental protection and sustainable development, green trade has become a new trend of international trade. Liaoning province can take this opportunity to expand the international market, promote the reverse logistics service to the world, and achieve international development.

(5) Strategic opportunities for circular economy and green development

Circular economy and green development have become an important trend of global economic development. Under the guidance of this strategy, the recycling of power batteries not only has economic value, but also has profound social significance. As an old industrial base, Liaoning Province has rich industrial resources and a strong industrial foundation. The development of reverse logistics network can not only help to promote the green transformation of the local economy, but also inject new vitality into the sustainable development of the regional economy.

2.4 Threat Analysis

Although Liaoning Province is facing huge opportunities for development in the reverse logistics network of the new energy vehicle power battery, there are also some potential threats, which may have a negative impact on the development of the reverse logistics network.

(1) Uncertainty of laws and regulations

At present, the laws and regulations on power battery recycling are not perfect, and there are certain uncertainties in the policy environment. In the future, if relevant laws and regulations change, it may have an impact on the power battery reverse logistics network in Liaoning Province and increase the operational risk.

(2) Increased market competition

With the vigorous development of the new energy vehicle market, more and more enterprises begin to get involved in the field of power battery recycling, and the market competition is increasingly fierce. This could pose a threat to Liaoning's reverse logistics network, reducing its market share and profitability.

(3) Rapidity of technical update new energy vehicles and related technologies are changing with each passing day, and the recycling technology of power batteries is also constantly updated. If the reverse logistics network of Liaoning Province can not keep up with the pace of technological update in time, it may face the problems such as backward technology and low efficiency, thus losing the market competitive advantage.

(4) Improvement of environmental protection requirements with the improvement of global environmental awareness, the environmental protection requirements for power battery recycling are also constantly improving. If Liaoning's reverse logistics network does not meet increasingly stringent environmental standards, it may face legal risks and environmental penalties.

3 DEVELOPMENT STRATEGY OF REVERSE LOGISTICS NETWORK OF NEW ENERGY VEHICLE POWER BATTERY IN LIAONING PROVINCE

Based on the above comprehensive analysis of the reverse logistics network of new energy vehicle power batteries in Liaoning Province, we can formulate the following development strategies to give full play to its advantages, overcome disadvantages, seize opportunities, and deal with potential threats.

(1) Improve the reverse logistics system

Liaoning province should make use of its geographical location and industrial base to build a unified, efficient and reverse power battery logistics network covering the whole province. Through reasonable planning of the layout of recycling points, the recycling channels are diversified and convenient, strengthen the coordination between reverse logistics and forward logistics, optimize the logistics process and reduce logistics costs.

(2) Increase investment in technology and equipment

In view of the disadvantage of lagging technology and equipment, Liaoning Province should increase the investment in technology research and development and equipment renewal in power battery recycling, disassembly and reuse. Take advantage of the advantages of strong scientific research strength in the province, cooperate closely with universities and scientific research institutions, introduce and digest advanced technology, and improve the automation and intelligence level of reverse logistics.

(3) Strengthen the training of professional talents

In order to solve the problem of lack of professional talents, Liaoning Province should strengthen the training and introduction of professionals in the field of power battery reverse logistics. By setting up relevant professional courses, carrying out vocational training, and cooperating with universities, professionals with various knowledge of battery technology, logistics management and environmental laws and regulations will be trained to provide talent guarantee for the development of reverse logistics network.

(4) Expand the channels of funding sources

In order to relieve the capital pressure, Liaoning province should actively expand the capital source channels. On the one hand, seek financial support from the government, increase investment in the reverse logistics network of power battery and; on the other hand, guide and encourage social capital to enter this field, attract social investment through public-private partnership and government purchase of services, and form a diversified financing mechanism.

(5) Strengthen the implementation of laws, regulations and policies

In view of the insufficient implementation of laws and regulations, Liaoning Province should strengthen the publicity and implementation of laws and policies related to power battery reverse logistics. By strengthening law enforcement, strictly punishing illegal acts, establishing a reward mechanism for reporting, ensure the effective implementation of laws and policies, and provide legal guarantee for the healthy development of reverse logistics network.

(6) Promoting coordinated industrial development Liaoning province should make use of its advantages of industrial base and industrial agglomeration effect to promote the coordinated development of new energy vehicles and power battery related industry chain. By strengthening the cooperation and exchanges between enterprises, promote technological innovation and resource sharing, reduce production costs, improve product quality and service level, so as to enhance the competitiveness of the whole industrial chain.

In Liaoning province in the new energy automobile power battery in the development of reverse logistics network should give full play to its geography, industry, scientific research and policy advantages, by perfecting the system, increasing investment, training talents, broaden the funding channels, strengthen law enforcement, promote industrial coordination and establish information sharing platform strategy, promote power battery reverse logistics network continued health.

4 CONCLUSION

This study fills the research gap in the field of reverse logistics network of new energy vehicle power battery in Liaoning Province, and provides valuable reference and guidance for the development of new energy vehicle power battery reverse logistics network in Liaoning Province and even the whole country. Through an in-depth analysis of the advantages, disadvantages, opportunities and threats of Liaoning Province in this field, this study provides decision support for the construction of an efficient and environmentally friendly reverse logistics network, and provides an important reference for promoting the sustainable development of the new energy vehicle industry.

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