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Review

Development Strategies and Policy Trends of the Next-Generation Vehicles Battery: Focusing on the International Comparison of China, Japan and South Korea

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Abstract: In recent years, with the rapid spread of next-generation vehicles (NGVs), China, Japan, and South Korea (CJK) have been leading the development of vehicle batteries. As development strategies and policy trends of NGVs battery are changing in CJK, the competition among battery manufacturers is expected to become more intense in the future. However, there are few international comparative studies on the development policy, production, and sales of NGV batteries in CJK. Based on the review and investigation of the technical development, policy trends, and the world market share of vehicle batteries in CJK, this study spots trends in the features of development strategies and policies of NGV batteries in CJK, and further inspects the interrelationships in these three countries comprehensively. The result shows that CJK have different focuses on the development of NGVs battery technology and policymaking. It is predicted that in the future competition of the vehicle battery market, Japan is likely to be far surpassed by China and South Korea. Based on grasping the development strategies and policy trends of vehicle batteries in CJK, this study plays an important role in the academic research and policymaking of the production, sales, regeneration, and resource recycling of the NGVs and vehicle batteries.

Keywords: next-generation vehicles; vehicle batteries; China; Japan and South Korea; development strategies; policy trends; sustainable transportation

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1. Introduction

In recent years, in order to achieve carbon neutrality and a decarbonized society, solving the problems of global warming, resource depletion, and energy transformation has become an urgent priority. Generally, the emission of greenhouse gases is the main cause of climate change, with CO_2 considered as the main greenhouse gas [1]. As one of the most energy consuming and polluting activities, the transportation industry accounts for about 28% of the total CO_2 emission of all industries, having an important impact on the realization of a low-carbon society [2–4]. Thus, to reduce CO_2 emissions and realize sustainable transportation, NGVs are rapidly becoming popularized [5]. Usually, NGVs refer to electric vehicles (EVs), hybrid vehicles (HVs), plug-in hybrid vehicles (PHVs), and fuel cell vehicles (FCVs) [6]; this paper mainly discusses EVs and HVs. The CO_2 emissions of HVs are far lower than that of traditional fuel vehicles, while the CO_2 emissions of EVs can be much lower [7]. Thus, EVs have a good development prospect as an environmentally friendly green transportation.

At present, the number of EVs is increasing rapidly in China, the United States, and in European countries but, in some countries, such as Poland, the EV market is still immature [8]. This is mainly because of the high production costs and the short cruising range of EVs, as well as the difficulty in popularizing charging infrastructure [9]. The construction and regular maintenance of EV charging stations require high investments and operation costs [10]. In addition, the intermittency of renewable energy and the randomness of EV charging will seriously affect the stability of the power grid, resulting in higher operating expenses [11]. In this regard, the current research is committed to reducing the investments and daily operation costs by optimizing planning and improving the energy management system, which has accelerated the construction of charging infrastructure and smart grids [12,13].

With the maturity of technology and the construction of facilities, it is expected that NGVs will be popularized at a faster rate in the future. According to research, global sales of EVs are expected to soar from 1.1 million in 2020 to 11 million in 2025 [14]. On the other hand, the global vehicle batteries market is expected to increase from 150 GWH in 2020 to 1000 GWH in 2025 [15], but the share of the vehicle batteries is mainly monopolized by CJK. Indeed, CJK have accounted for about 80% of the global vehicle batteries market since 2018, and the share is expected to rise even higher [16]. However, to promote the popularization policy of NGVs and develop high-performance vehicle batteries, countries around the world must actively implement investments. With the coming of a transformation period of vehicle batteries market, it is expected that the competition among large battery manufacturers in CJK will further intensify. Based on this background, it is essential to research the development strategies and policy trends of the next-generation vehicle battery.

This study analyzes the latest trends in vehicle battery development in CJK from the three factors of technology, policy, and market, and further inspects the interrelationships comprehensively. We assume that, based on these analysis results, the development potentiality, issues of NGV batteries, and the characteristics of resource recovery strategies in the future can be accurately grasped. Furthermore, this research can provide important basic information for establishing academic research assumptions and research scenarios related to the production, circulation, abandonment, and reuse of NGVs and vehicle batteries.

The remaining sections of this paper are organized as follows. Section 2 introduces the previous research and summarizes the current research status of NGV batteries. Section 3 makes a comprehensive evaluation of vehicle batteries in CJK from the perspective of technology, policy, and market trends. Section 4 compares the characteristics of the development strategies and policy trends of vehicle batteries in CJK, analyzes the relationship among the three countries, and finally discusses the resource recovery strategy for vehicle batteries.

2. Previous Research

Regarding the current situation and development trend of NGV batteries, the previous research mainly focused on three aspects, namely technology, policy, and market. In terms of technology, Liu et al. and Waag et al. analyzed the evolutions and challenges of state-of-the-art battery management technologies and summarized the monitoring and diagnosis methods for battery health and cycle life [17,18]. However, there were few analyses of technology related to battery materials and performance. In terms of policy, Albertsen et al. analyzed the current strategies and policies of EU automobile enterprises, focusing on the circular business models and the circular economy of automobiles in the EU [19]. Lebrouhi et al. studied four strategies related to Tesla's vehicle batteries [20]. Although such strategic analysis on the corporate side is important, to grasp the long-term future development trend, it is also necessary to analyze the policy trend of the whole country. In terms of the market, Wu et al. conducted an analysis based on the genetic algorithm, showing the importance of optimizing lithium trade relationships [21]. Piçarra et al. clarified the risks of the supply chain due to the high concentration of the cobalt market based on the German risk analysis method [22]. These studies examined the battery raw material market, but they did not mention the market for vehicle batteries themselves, or its changing trends.

In addition, it is also important to look into the future development trend of NGV batteries by comparing and analyzing the development strategies and policy trends of countries around the world, but there are few international comparative studies on the current state of development and characteristics of vehicle batteries. Yu et al. compared the recycling policies of end-of-life vehicles in Europe, Japan, and China, but there were few studies on vehicle batteries [23]. Liu et al. described the development of vehicle lithium-ion batteries (LIBs) in CJK, but they only analyzed it based on the battery performance and market price at that time, and failed to conduct an in-depth discussion of specific technology and policy trends [24]. If we only focus on the limited market, we will not see the relationships between policy, market, and technology. Therefore, this study becomes an analysis under certain conditions.

With the popularity of NGVs, the resource recovery of vehicle batteries has also become an important issue. Among them, the discussion on the reuse of vehicle batteries in the energy storage system (ESS) has become the focus. Chen et al. performed multi-objective optimization based on the genetic algorithm, and analyzed the advantages of ESS using used EV batteries [25]. Faessler et al. investigated the suitability of ESS consisting of repurposed EV batteries for grid balancing through the optimization procedure [26]. These researchers used different models and methods to evaluate the reuse of vehicle batteries in ESS systems.

Most of the above studies focused on specific conditions and cases, lacking the comprehensive analysis. Moreover, the research background was mostly in a specific country, with only a few offering a comparative analysis of CJK, which is not a conducive to grasping the development status of vehicle batteries. In this study, we evaluate the development strategies and policy trends of vehicle batteries in CJK from the three aspects of technology, policy, and market. Furthermore, through the comparative analysis of battery resource recovery strategies in CJK, we look at the future trends and derive new research topics.

3. Technology, Policy, and Market Trends of NGV Batteries

For NGV batteries, higher energy density, higher safety, and longer lifespan are important issues in the future. Along with the construction of recycling and reuse systems, it is expected that the vehicle battery market will further expand in countries around the world in respect to their own characteristics of specific development strategies and policy trends. This paper conducts a comparative analysis and consideration focusing on the technology, policy, and market trends of NGV batteries in CJK.

3.1. Technology Trends

In order to build a sustainable society, it is important to improve the energy efficiency and reduce carbon dioxide, a task for which secondary batteries with higher performance and functions are required. Although LIBs have been used in many fields, this does not mean that LIBs are the most suitable. In any case, it is necessary to develop batteries from various viewpoints, such as the battery energy density, input/output characteristic, safety, heat resistance, and elemental strategy [27].

Currently, the energy density of LIB on the market is 100 Wh/kg and 150 Wh/L, while that of gasoline is 10,000 Wh/kg and 10,000 Wh/L, which is 100 times the unit mass and 67 times the unit volume of LIB. The energy density of the high-pressure hydrogen used in the fuel cell vehicle in the 35 MPa high-pressure tank is 10 times the unit mass of LIB, showing that the energy density of LIB is too low compared with other fuels. The energy density of an all-solid-state battery and a lithium–oxygen battery, which are called next-generation LIBs, is only about 1000 Wh/kg and 2000 Wh/kg respectively, and, thus improving the energy density is a major issue. Moreover, there are also problems with the temperature, such as that energy cannot be released, and the output cannot be determined at a low temperature. Additionally, the swing amount of the state of charge (SOC) of the battery is closely related to the lifespan. If the SOC value is close to the full charge, it tends to reduce the battery's lifespan when placed in a high-temperature place. In this way, the lifespan will vary greatly depending on the actual application, the used method in the system, and the environment [28]. In addition, safety is a concern because the organic liquid of electrolyte in a LIB may ignite under high temperature or severe impact [29,30]. On the other hand, since the electrolyte of an all-solid-state battery uses inorganic materials, such as oxide or sulfide, excellent safety can be maintained without catching fire. As a result, the all-solid-state battery is considered to be the mainstream of technical development in the future [31,32]. According to the research report of the Fuji Keizai Group, the market for all-solid-state batteries will exceed 2 trillion yen (about 14.4 billion US dollars) in 2035 [33]. As with the LIB or all-solid-state battery, however, as long as it relies on rare metals, such as lithium and cobalt, it will be difficult to reduce production costs. Therefore, innovative batteries that do not require rare metals are also an important research subject in the future, but they are still in the basic research stage, and the practical application of innovative batteries is expected to be realized after 2030 [34].

Globally, vehicle batteries are evolving toward enhanced performance, but the technical development schedules and specific strategies of each country are different. As shown in Figure 1, CJK have each formulated development goals for vehicle batteries in the next 10 to 20 years, mapping out the technological path for the realization of the NGV society strategy. Japan began to develop advanced LIBs on the basis of current LIBs in 2020, mainly aiming at increasing energy density and cutting production costs. It will start the development of all-solid-state LIB from 2025, and will achieve universal popularization of it by 2030. Furthermore, from 2030, Japan will start to realize the practicality of an innovative battery, which is based on the chemical reaction of lithium–oxygen, lithium–sulfur and sodium–sulfur, or the intercalation reaction of multivalent ions, aiming at creating EVs with a cruising range comparable to that of gasoline vehicles. As for South Korea, it will successively develop a lithium–sulfur battery, all-solid-state battery, and lithium metal battery from 2025. In addition, Japan and South Korea are also vigorously investing in the development of fuel cells, especially South Korea, which aims to increase the number of FCVs to 5.9 million by the end of 2040 [35–37]. In China, compared to Japan and South Korea, the development goals of vehicle battery proposed by the Ministry of Industry and Information Technology (MIIT) are relatively vague. Indeed, the MIIT did not even give a clear definition of "new battery" and "battery technology change" in the goals and, thus, it is difficult to accurately grasp the direction of its development.

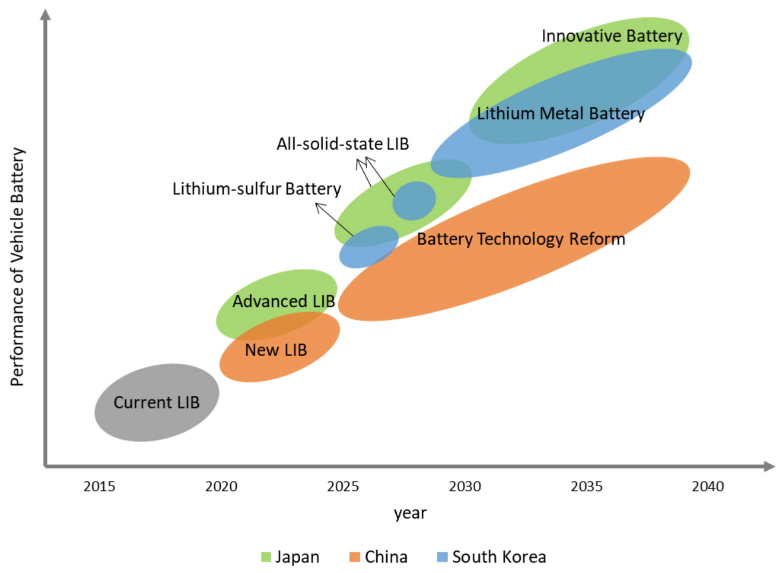

Figure 1. Technical development goals for vehicle batteries in CJK [38–40].

In addition to the technical development of material and performance improvement, the research on the resource recovery of used batteries is also underway. Firstly, at present, rare metals are recovered from cathode materials mainly by three methods, namely direct recycling, pyrometallurgy, and hydrometallurgy [41,42]. Then, in the waste management hierarchy, it was pointed out that reuse is preferable to recycling [43]. From the business perspective, it is important to reuse the used vehicle batteries in other fields, such as automotive replacement batteries, electric bikes, and ESS, in order to extend the lifespan of the batteries [44,45]. In order to promote the development of recycling and the reuse of vehicle batteries, the estimation of the number of used batteries, and the environmental life cycle assessment of the usage conditions and recycling methods are also being actively conducted [46–49]. However, battery recycling and reuse are still in their early stage, and many technical issues must be overcome [50]. On the other hand, the development of batteries that do not require rare metals is also one of the strategies for the securing of resources. In 2021, Nguyen et al. from Texas A&M University used redox polypeptides as battery electrodes, which showed excellent stability and degradability [51]. Batteries that do not require rare metals are still in the experimental stage, but their practical application is worth the wait.

3.2. Policy Trends

Although CJK have adopted different policies and strategies in the development of vehicle batteries, they continue to make minor adjustments with the changes in NGVs and the battery industry. This leads to a great impact on the technical development and market trends of batteries all over the world. Table 1 briefly summarizes the policies related to NGV battery in CJK in recent years. It can be noted that policies pertaining to the vehicle battery have primarily focused on technology development goals or strategies, while, in China, it is more focused on policies of resource recovery. Next, the paper will analyze the policies in CJK, respectively.

Table 1. Vehicle battery-related policies in CJK.

Country	Year	Policy Name	Policy Feature
Japan	2018	Long-term Goal	Development Goal
	2020	Green Growth Strategy for 2050 Carbon Neutral	Development Strategy
	2021	Development of Next-generation Batteries and Next-Generation Motors	Development Strategy
China	2017	Automotive Industry Medium- to Long-term Development Plan	Development Plan
	2020	New Energy Vehicle Industry Development Plan (2021–2035)	Resource Recovery System
	2021	New Energy Vehicle Battery Secondary Use Management Measures	Resource Recovery Strategy
South Korea	2018	Notice Concerning the Return of EV Batteries	Recycling Regulation
	2019	NGVs Industry Development Strategy	Development Strategy
	2021	K-Battery Development Strategy	Development Strategy

In Japan, the Ministry of Economy, Trade, and Industry (METI) put forward a "Long-Term Goal" at the Automotive New Era Conference in 2018, and presented the basic policies and concrete actions regarding the electrification of Japanese automobiles [39]. From the perspective of the goal of vehicle batteries in the "Long-Term Goal", as an important five year plan starting in 2018, it is clearly stated that the industry–academia–government technical development of next-generation batteries, including all-solid-state batteries and innovative batteries, will be officially promoted [52]. In addition, the "Green Growth Strategy for 2050 Carbon Neutral" promulgated in 2020 further emphasized the practical application of all-solid-state batteries and innovative batteries, and formulates specific action plans for lowers prices and R&D/technical demonstration for practical use [53]. Furthermore, in the "Development of Next-Generation Batteries and Next-Generation Motors" promulgated in 2021, aiming for 100% electric vehicle sales by 2035, more specific battery R&D, recycling, and reuse promotion strategies were put forward [54].

In China, environmental regulations have become stricter since 2010, and EVs have been promoted as a national policy. In recent years, however, China has accelerated the construction of a system for battery recycling and reuse to deal with the large number of used vehicle batteries generated by the rapid popularization of EVs. In particular, the recent “New Energy Vehicle Industry Development Plan (2021 – 2035)” and “New Energy Vehicle Battery Secondary Use Management Measures” further emphasized the battery recycling responsibility of relevant enterprises, and promoted the establishment of a resource recovery system for used batteries [55,56]. China has established a preliminary battery recycling and reuse policy system based on the principle of extended producer responsibility, but the legal enforcement and relevant penalties are so weak that the actual effect of implementation is doubtful [57,58].

On the other hand, South Korea’s vehicle batteries recycling policy is slightly behind those of China and Japan. The “Notice Concerning the Return of EV Batteries” promulgated in 2018 set the detailed rules of recycling used vehicle batteries for the first time [59]. In addition, according to the “NGVs Industry Development Strategy” issued in 2019, South Korea will focus on the development and popularization of LIBs and fuel cells among the NGV batteries in the future [38]. In particular, the “K-Battery Development Strategy” promulgated in 2021 is regarded as a national strategy of South Korea, which is ready to promote the development and popularization of vehicle batteries in earnest [60].

3.3. Market Trends

In this battle for the supremacy of NGV batteries, Japanese capital has occupied the initial market with technical superiority. In recent years, however, due to technical development and policy changes in CJK, the market of NGVs and vehicle batteries in these three countries has ushered in a new phase.

According to Table 2, although the proportion of new vehicle sales of NGVs in China is increasing year by year, the whole proportion of NGVs in China is still low due to a number of existing gasoline vehicles, while the sales share of NGVs in the Korean automobile market is rapidly increasing [61–63]. On the other hand, the sales volume of NGVs in Japan is gradually declining, the share in new car sales of which remains at about 30%. In addition, the three countries take specific NGVs as the main development targets. China mainly focuses on EVs, while Japan and South Korea mainly focus on HVs and FCVs [64]. Unlike EVs, HV batteries are mostly nickel-metal hydride batteries [46]. Therefore, compared with China, where the number of vehicle sales is large and the number of EVs is increasing dramatically, the penetration rate of LIBs in Japan and South Korea is limited.

Table 2. Vehicle sales in CJK from 2018 to 2020 [61–63].

Country	Year	Vehicle (Hundred Thousand)	NGVs (Hundred Thousand)	Main NGVs Type (Hundred Thousand)	NGVs/Vehicle
China	2018	28.1	12.6	EV (9.8)	4.5%
	2019	25.8	12.1	EV (9.7)	4.7%
	2020	25.3	13.7	EV (11.2)	5.4%
Japan	2018	5.3	15.0	HV (14.6)	28.5%
	2019	5.2	14.8	HV (14.4)	28.4%
	2020	4.6	13.8	HV (13.5)	30.0%
South Korea	2018	1.8	2.9	HV (1.9)	15.9%
	2019	1.8	3.7	HV (2.3)	20.6%
	2020	1.6	4.4	HV (2.5)	27.1%

As shown in Figure 2, the changes in the sales volume of vehicle batteries in CJK in recent years are consistent with the sales situation of NGVs [65,66]. Since 2017, the installed capacity of a vehicle battery in South Korea has increased practically exponentially, especially in 2020 and 2021, during which the growth rates exceeded 100%. China's growth rate of installed capacity has been low until 2020, but in 2021 the growth rate reached 143%, representing 52% of the worldwide installed capacity. In contrast, Japan's installed capacity of vehicle batteries has been stagnant and has even contracted in recent years. It can be seen that the Japan's vehicle battery market is in a stagnation state. In contrast, China and South Korea have a superior market prospect for vehicle batteries. From 2017 to 2021, the average growth rate of installed capacity of vehicle batteries in China and South Korea was 90% and 53%, respectively, of which South Korea has a higher growth rate. Therefore, we assume that the vehicle battery market in China and South Korea is likely to grow further in the future, and it is likely that China's global market share will be surpassed by South Korea.

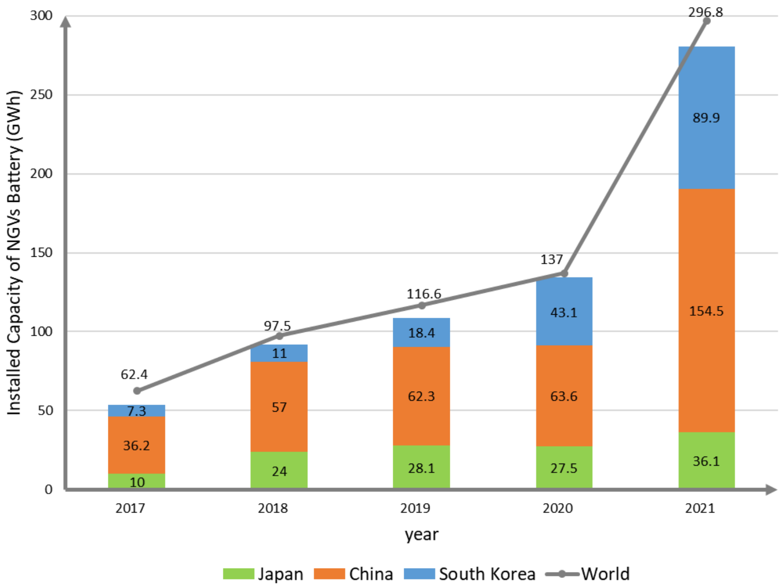

Figure 2. Sales trend of vehicle batteries in CJK from 2017 to 2021 [65,66].

On the other hand, with the rapid expansion of the NGV market, an enormous resource investment is required for battery manufacturing [67]. The demand for nickel will increase from 100,000 tons in 2020 to 1 million tons in 2030, while the demand for cobalt will increase to 220,000 tons in 2025, when the supply–demand gap of cobalt is expected to reach 20% [68,69]. Furthermore the supply chain disruptions due to the rapid consumption growth of raw materials will hinder the popularization of NGVs [70]. Therefore, the recovery, recycling, and reuse of used vehicle batteries, as well as the development of substitute materials (new materials) for batteries are very important.

4. Discussion and Conclusions

Based on the above-mentioned technology, policy, and market trends of NGV batteries in CJK, we analyze and discuss the characteristics and mutual relations of the development strategies and policy trends of these three countries. First, in terms of technology, although it is difficult to clearly figure out the vehicle battery development goals in China, we assume that China has no high-level battery technology that can compete with Japan and South Korea for at least some time in the future. Furthermore, it also lacks consistency, making it difficult for the battery manufacturing industry to formulate specific strategies in China. In contrast, Japan is steadily advancing technical development in accordance with the battery evolution goal of the METI, while South Korea is formulating a more specific strategy for the development of the next-generation LIB. Additionally, in terms of policy, Japan is committed to battery development through industry–academia–government collaboration under the development strategies of the METI. China's battery-related policies are led by the government, and recently the Chinese government has attached great importance to the resource recovery of vehicle batteries. Furthermore, in South Korea, the formulation of battery-related policies is led by chaebol with huge assets, which will focus not only on LIB but also on the development and popularization of fuel cells in the future. Finally, in terms of market, the share of vehicle batteries in Japan has become stagnant in recent years, while the shares of China and South Korea are increasing. Considering the recent momentum of South Korea, it is highly possible that South Korea may overtake China and become the world's top vehicle battery market. As mentioned before, the actual situation of vehicle battery development in CJK is basically consistent with their respective national strategies. It is clear that the development policies of NGV batteries in each country indicate the direction of technical development and play an important role in the establishment of technical development strategies of enterprises. However, it is difficult to find the relationship between the development policies and market trends of NGV batteries. We assume that the market for NGV batteries has a strong correlation with technological development trends, particularly that the R&D, reduction in production costs, and improvement of the safety of batteries are the factors that have a decisive impact on the vehicle battery market.

In this battle for the supremacy of vehicle batteries, CJK are engaged in fierce competition for the global share of batteries while revising the development strategies and policies of NGV batteries. Particularly, CJK are actively investing in the construction of production and sales networks in Western countries. For example, in 2021, SK Innovation of South Korea announced that they would build a joint plant for EV Batteries with Ford Motor of the United States [71] while, in 2022, Panasonic of Japan announced that it would supply the new type of EV battery "4680" to Tesla [72]. Overseas sales of CATL in China account for only about 20% of total sales, but the company has announced that they will focus on overseas markets in the future [73]. Currently, China and South Korea have the overwhelming share of the sales of vehicle batteries, but we assume that future competition will further intensify around the Western markets.

On the other hand, although competition between CJK is inevitable, the three countries are still actively seeking cooperation to deepen information sharing and exchange on battery technology development strategies. Private enterprises in Japan and South Korea have a good sense of partnership and have built a win–win relationship. Initially, China was reluctant to attract foreign capital. In recent years, however, along with the decrease in subsidies for local new energy vehicles, the competitiveness of domestic enterprises has decreased. Even so, in order to flaunt itself as an automobile power in eco-cars, advanced overseas technologies and know-how are indispensable, and China is also beginning to aspire to the entry of foreign capital [74]. In summary, with the popularization of NGVs and vehicle batteries, we assume that competition and cooperation between countries will further deepen.

Moreover, a large number of used batteries will be generated from all over the world in the future. To deal with this, CJK also focus on the formulation of battery resource recovery strategies. Among them, Japan is committed to the development of recycling technology for vehicle batteries, while China and South Korea have been delayed in the construction of used battery collection networks and recycling systems. In Japan, automobile manufacturers are building the collect, evaluate, recycling, and reuse system for used batteries, but it is difficult to recycle resources domestically as most of the used NGVs are exported. In recent years, China has been actively implementing policies related to the reuse and recycling of vehicle batteries, but since there is not much movement in the recycling industry, the actual operational effect of these policies is limited. We assume that the resource recovery system of used batteries in China is still immature. As for South Korea, the release of policies related to battery recycling and disposal occurred even later, and we assume that the construction of a resource recovery system of used batteries will be a major issue for South Korea in the future.

Although CJK have promoted technical development and market expansion of NGV batteries as national strategies, with the popularization of NGVs, resource depletion will become a more serious issue and, as a result, resource nationalism will become more apparent in the future [75]. In other words, to popularize NGVs and develop NGV batteries, it is essential to develop international resource recovery strategies and build an international recycling system. In the future, it is important for automobile manufacturing countries, such as CJK, to efficiently collect used batteries, and promote recycling and reuse in appropriate ways. To this end, smooth communication on policy and technology development among CJK will be necessary.

This review paper investigates the development strategies and policy trends of the NGV battery, focusing on the international comparison of CJK. The study makes it clear that countries have formulated different popularization strategies according to the actual conditions of the automobile industry in their countries. In general, Japan and South Korea are leading in battery technology development, while China and South Korea have market advantages. In the future, with the progress of battery technology, as well as the expansion of the NGV market in CJK, the competition for the development, popularization, and reuse of vehicle batteries will be further intensified. Meanwhile, however, it is also necessary that battery manufacturers in various countries strengthen their technology and policy communication to improve the battery industry and support the development of NGVs.

In addition, based on the overview of recovery, reuse, and recycling technologies of vehicle batteries and relevant policies, this paper analyzes and discusses various factors. However, it does not specifically consider the actual conditions and topics of battery reuse and recycling systems in each country, as well as their possibilities and feasibility in the paper. In the future, we intend to further deepen the discussion of this review paper by conducting research on the sustainability evaluation of NGV batteries based on these perspectives.

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Abbreviations

NGVs	next-generation vehicles
CJK	China, Japan and South Korea
EVs	electric vehicles
HVs	hybrid vehicles
PHVs	plug-in hybrid vehicles
FCVs	fuel cell vehicles
LIBs	lithium-ion batteries
ESS	energy storage system
SOC	state of charge
METI	Ministry of Economy, Trade and Industry

MIIT	Ministry of Industry and Information Technology

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