

Research on Analysis of the EV Battery Industry in China and Situation in the Global Market

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Abstract. This paper delves into the dynamics of the Chinese electric vehicle (EV) battery market, providing an overview of its current status, recent developments, domestic policies, and industry competitiveness. Anticipated to witness substantial growth in the future, the global electric vehicle battery industry market is a focal point of analysis. A critical examination is conducted on the challenges facing the Chinese government concerning EV battery recycling and manufacturing pollution, accompanied by recommendations for addressing these issues. Additionally, a comparative analysis is presented, spotlighting prominent Chinese companies such as CATL and BYD, which play pivotal roles as leading suppliers in the global EV battery industry. Their contributions to industry advancement and technological progress are thoroughly evaluated. Furthermore, the paper scrutinizes the current landscape of the Chinese EV battery market, focusing on two primary battery types: lithium iron phosphate and ternary lithium-ion batteries. Insights gleaned from this analysis provide valuable guidance for policymakers and industry stakeholders, informing future policy considerations and shaping the trajectory of the EV battery industry in China and beyond. By offering a comprehensive examination of the Chinese EV battery market, this study serves as a valuable resource for understanding the evolving dynamics of the industry and navigating its complexities. It underscores the importance of proactive measures to address challenges and capitalize on opportunities, ultimately driving sustainable growth and innovation in the EV battery sector.

Keywords: Electric Vehicle Battery Industry; Lithium Iron Phosphate Battery; Ternary Lithium Iron Battery; Policy Implications; Comparative Analysis.

1. Introduction

This article provides a comprehensive analysis of the electric vehicle battery industry in China, with a focus on the -leading companies CATL and BYD. The goal of this article is to analyze and compare the previous and current situation in the EV battery market and future prospects. As for the main findings and insights of this study, the article analyzes the EV battery in China in terms of production capacity, technological innovation, government policy and support, and the key factors that affect the development of the EV battery industry.

1.1. Research Background

As human activity becomes more active, environmental conservation seems to be the most important long-term goal. Therefore, most countries take the use of renewable energy seriously. In the past, nobody treated environmental conservation seriously. In this situation, electric vehicles (EVs) have been treated as the product of a new era in modern society. The electric vehicle battery is highly related and acts as an essential component of electric vehicles. To improve the capabilities of electric vehicles, the development of electric vehicle batteries is necessary.

China is one of the largest manufacturers and exporters of electric vehicle batteries, with the highest market share that Chinese firms own. Here are the market shares for the electric vehicle battery industry in the global market in 2022 (Figure 1) [1].

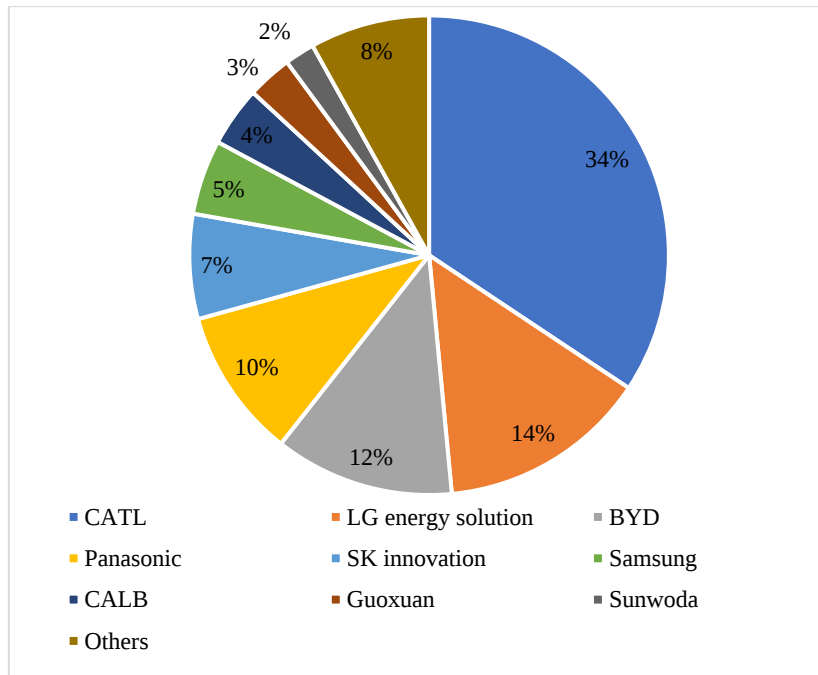


Figure 1. The Top 10 EV Battery Manufacturers in the World in 2022 [1]

China is among the world's largest electric vehicle (EV) markets, and its battery industries play a key role in supporting EV development. According to the International Energy Agency (IEA), China is the world's largest producer of lithium-iron batteries, accounting for more than one-half of the global market share. The IEA report also shows that China's lithium-iron battery production accounted for 76% of the world's production in 2022, is expected to account for 73% of the world's production by 2025, and may account for 68% of the world's production in 2030 (Figure 1). The main Chinese EV battery manufacturers include CATL, BYD, CALB, Sunwoda, etc.

In this study, the article mainly focuses on and analyzes CATL and BYD as the representative of China's EV battery industry due to their leading positions in terms of production scale, technology research, size of firm, and market share. Also, an analysis of competitors such as Japan, Korea, and the US will be provided.

1.2. Research Gap

The article analyzes the EV battery in China in terms of production capacity, technological innovation, government policy, and support, as well as the key factors that affect the development of the EV battery industry in the current situation. In addition, this study also focused on the past and future perspectives in government policy and support, the market share, international competitiveness of domestic products, and the key factors that affected the developments of the EV battery industry in the past. Furthermore, some predictions for the next decade will be provided, which follow the trend of China's five-year and ten-year plans.

1.3. Research Framework

The main results of the analysis reveal some key information about the EV battery industries in China. China leads in production capacity, technological innovation, and government support for EV batteries. Meanwhile, the industrial supply chain is complete. Given China's current leadership in the EV battery industry, China currently accounts for a significant share of global lithium-iron battery production capacity. However, an increase in the US influence over the market, supported by initiatives such as the Inflation Reduction Act and domestic manufacturing, may lead to a more balanced global capacity. This diversification is critical to reducing dependence on a single market, increasing the resilience of global supply chains, and mitigating risks associated with political, economic, or logistical disruptions. Additionally, the involvement of competitors could inspire innovative approaches to battery technology and sustainability. It may encourage the development of

next-generation battery technologies, and batteries may perform better, last longer, and safer. Thus, a focus on raw material recycling and ethical sourcing, as well as investments in green technologies, could set new standards for environmental sustainability in the industry that support the goal of environmental conservation.

Overall, the main result of the analysis reveals the current situation of China's EV battery industry. China leads in production output, technology innovation, and international competitiveness for EV batteries. Meanwhile, the industry supply chain in China is complete and more competitive than that of other foreigners. The EV battery industry in China is at the industry-leading level from a global perspective, and the challenges from competitors to China's dominance in the EV batteries industry could lead to a more dynamic, innovative, and sustainable global market. All these aspects ultimately benefit sustainable transportation and environmental protection.

2. Case Description

The electric vehicle battery industry in China is the leading industry in the global market. As Table 1 shows, there are 5 companies that are in the top 10 EV Battery Manufacturers in the world in 2022, with more than one-half of the market share in the global market. The EV battery market in China is the largest around the globe, and it has strong international competitiveness.

Although the EV battery industry in China seems to be the most powerful one, the development of the EV battery industry in China only took less than 2 decades to switch from a beginner to a leading manufacturer. This situation was highly related to government intervention and policy that supported the development of the EV battery industry. For instance, the National High-tech R&D Program, whitelist policy, Made in China 2025. These all contribute to the development of the EV battery industry and technological innovation.

In the future, the EV battery market in China is still expected to be the leading market as China's goal is to maximize the production of EV batteries and develop in terms of quality and quantity. Other competitors are still creating uncertainty due to the trade protectionism policy and their aim of reducing the reliance on imports, which may affect the exports from China.

3. Analysis of the Effects

The article explained that the development of the EV battery industry has a serious impact on the global market for EV batteries. Here are some evaluations:

3.1. Policy Effect: Reasons for Analysis of China's Growth

The main reason for the rapid development of the Chinese EV battery industry is the need for more government support and policy incentives. This article mentions three key policies in three time periods:

In the past, the earliest government policy that the Chinese government provided was called the National High-tech R&D Program, also called 863 programs, which included the development of EV batteries [2]. It condenses China's strategic needs for the development of high technology, and it's one of the five-year plans that continue to play an important role from 2001 to 2005. The primary purpose was to develop high technology in several industries.

In recent years, a key policy provided by the Chinese government has been called the Normative conditions for the EV battery industry, which includes a whitelist [3]. This policy aims at testing the basic requirements of the enterprise, production conditions, and technical capabilities. The firms will enter the whitelist if they are capable of meeting all the requirements, and the firm on the whitelist will receive the priority of receiving a subsidy. Only Chinese firms existed on that whitelist, although it faced the whole of Asia. This policy was abolished in 2019, and lots of Chinese firms gained huge

benefits through this policy from 2019 to 2023. The main purpose was to expand the EV battery industry in the domestic market.

There's also a government plan called Made in China 2025 [4]. This includes multiple sides to strengthen the comprehensive national strength and enlarge international competitiveness. The key purpose is to develop the manufacturing industry, create technological innovation, and lead China to become the top 1 manufacturing country. The EV industry plays one of the most important roles, and EV batteries are the fundamental components of electric vehicles. So, the EV battery production was expanded a lot during this plan. This plan is prepared for 2015 up to 2025. This government plan was chosen to enlarge international competitiveness.

Overall, these policies are the main reasons that encourage the EV battery industry in China to expand significantly within two decades.

3.2. Representative Companies: Reasons for Analysis of Chinese Companies' Market Share

This study selects two representative domestic companies in China to illustrate international competitiveness.

Background: In the early stages, there were two most popular battery batteries: the lithium iron phosphate battery and the ternary lithium battery. Lithium iron phosphate battery takes advantage of a relatively low cost, safety, and longer battery life. The ternary lithium battery takes advantage of energy density.

3.2.1. Development of company.

CATL used to be a department of Amperex Technology Limited (ATL), and ATL is a Japanese company that supplies batteries for Apple. But it separated into CATL in 2011. With the development of technological innovation, there was more progress in developing the energy density of the ternary lithium battery [5]. The batteries can supply enough energy for an electric vehicle to keep working for more than 300 kilometers, which suits the demand for the ride-hailing market. Furthermore, the Chinese government published a policy called the Normative condition [4]. The ternary lithium battery perfectly passes all the assessments. CATL received a huge subsidy and welfare from the government due to their target of manufacturing ternary lithium batteries. CATL grew dramatically since the government supported them. In 2017, CATL became the largest supplier of EV batteries worldwide, and CATL became the largest supplier of EV batteries worldwide and the only corporation in China for Tesla. The market value for CATL is \$ 218.815 billion.

BYD is an industry-leading company that manufactures both electric vehicles and electric vehicle batteries. In the early stage of China's electric vehicle development, the application scenarios were more inclined to commercial vehicles, and lithium iron phosphate batteries became the first choice of battery factories. BYD was the largest manufacturer of lithium iron phosphate batteries in China at that time. However, a significant switch in government choice for batteries made the market share for CATL transcend the market share for BYD [5]. In 2020, BYD published their new technology called Blade Batteries (another branch in Lithium iron phosphate battery), which shocked the whole global market, and more electric vehicles decided to use Lithium iron phosphate batteries in production again.

3.2.2. Technological progress.

The focus for CATL is specializing in innovating ternary lithium-iron batteries, and they have succeeded and kept developing several key technologies, such as slow capacity attenuation and the capability of batteries in terms of mileage, charging, temperature, and value preservation. These areas are all at the industry-leading level. Also, the high nickel plus silicon anode and CTP (which is a technology that claims to be able to reduce the weight of the entire pack significantly) can be mass-produced. These are their comparative advantages.

The focus for BYD is to specialize in innovating Lithium iron phosphate batteries. Their key technology is the Blade Battery, which is another type of Lithium iron phosphate battery [5]. Compared with the traditional shape of the cell, the blade battery effectively increases space utilization. More cells can be loaded in the same space, the volume utilization rate is increased by more than 50%, and the cruising range is increased by more than 50%, which reaches the same level as the ternary lithium battery with high energy density.

3.3. Other Factors that Affect the Development of EV Batteries

Other than the policy incentives, there are other factors that may affect the development of EV batteries.

3.3.1. Domestic supplychain and raw material access.

China has a well-established supply chain for EV batteries, with significant control over raw materials like lithium, cobalt, and nickel. This vertical integration has bolstered its industry's global competitiveness and has led China's EV battery market to become the world's leading industry.

3.3.2. Technological innovation.

Chinese firms such as CATL and BYD gain the highest market shares in the EV battery industry. They are advancing in battery technology and focusing on improving energy density and reducing costs.

3.3.3. International trade and relations.

For China as it has become the largest producer of EV batteries worldwide, China is also the biggest exporter in the global market, and it has leveraged international trade to expand its market reach.

3.4. Problems

There are two main problems that need to be considered seriously by the Chinese government: Whether the benefits of using electric vehicle batteries exceed the drawbacks? How does recycling of electric vehicle batteries carry on?

The Chinese government faces two crucial challenges regarding electric vehicle (EV) batteries: assessing the net benefits of their use and implementing effective recycling processes.

Firstly, it is imperative to evaluate whether the advantages of utilizing EV batteries outweigh the disadvantages. While EVs contribute to reducing greenhouse gas emissions and dependence on fossil fuels, concerns exist regarding battery production's environmental impact and resource depletion. Additionally, factors such as battery lifespan, performance, and safety must be carefully considered to ensure overall benefits.

Secondly, addressing the recycling of EV batteries is essential for environmental sustainability. Proper recycling methods are necessary to mitigate pollution from battery disposal and recover valuable materials for reuse. Challenges include developing efficient recycling technologies, establishing collection and recycling infrastructure, and addressing economic incentives for recycling.

To tackle these issues, the Chinese government should prioritize research and development efforts to improve battery technology and recycling processes. Collaboration with industry stakeholders, investment in infrastructure, and implementing supportive policies can facilitate progress in these areas. Additionally, public awareness campaigns can educate consumers on the environmental benefits of EVs and the importance of responsible battery disposal.

By addressing these challenges proactively, the Chinese government can promote the sustainable development of the EV industry, reduce environmental impact, and enhance resource efficiency. This proactive approach aligns with global efforts to combat climate change and transition towards a greener economy.

4. Suggestions

In this part, the study provides suggestions and methods to deal with the problems that are given in section 3.4.

4.1. Drawbacks of Producing EV Batteries

Lithium-iron batteries, which can be called EV batteries, are normally used in electric vehicles. Electric vehicles definitely bring benefits to society. On the other hand, pollution has been happening since the production of EV batteries started.

There are four main areas where different types of pollution will exist.

4.1.1. Air pollution.

There are three main methods to deal with odor waste gas. First, for the physical method, the labor mainly uses the water washing method and physisorption. Secondly, for the chemical methods, the labor mainly uses medicines, liquid absorption methods, and chemical adsorption methods. Third, the biological method includes bio-dropping, biofiltration, and bio-absorption. As technological innovation, the efficiency of disposing of odor waste gas is expected to rise, and the methods will become more diverse.

4.1.2. Noise pollution.

The production equipment and extra facilities are needed during production, such as mixers, coaters, auxiliary equipment, cooling towers, water pumps, etc. These facilities will produce noise during production, and it's possible to exceed the standard emissions. Then, it may affect the quality of the surrounding acoustic environment and endanger human health [6].

Therefore, the workshop or factory needs to be arranged reasonably, and the high-noise equipment, such as water pumps and standby diesel generators, should be kept away from the office and living area. Extra facilities are required to support and reduce noise pollution, such as vibration damping pads.

4.1.3. Solid waste pollution.

When solid waste has been produced, it should be followed by the law “the People’s Republic of China on the Prevention and Control of Environmental Pollution by Solid Waste” [7]. All the waste will be separated into different areas to achieve classification. The renewable waste will be transported to the related recycling facilities, and the dangerous waste will be recorded to avoid illegal emissions. The related department also recommends that the companies formulate a hazardous waste management plan, establish hazardous waste management accounts, and truthfully record relevant information. The system shall report the danger to the local ecological and environmental authorities. At the same time, the company must follow the laws of “Pollution Control Standards for Hazardous Waste Storage” [6].

4.2. Recycling of EV Batteries

In China, the main trend in the EV battery is producing the Lithium Iron Phosphate Battery and Ternary Lithium Iron Battery. With the development of these two products, the environmental pollution and resource waste caused by the retirement of batteries are becoming increasingly serious. Some ideas have been discovered to develop the idea of green environmental protection, limited steps, low cost, and automation of waste battery recycling [8].

Many waste battery materials contain valuable elements such as lithium, nickel, and cobalt. These elements can be recycled and reused in other manufacturing areas. In the early stage, with a lack of technological innovation, the Chinese government used physical repair and regeneration methods to recycle the waste batteries. Due to the high requirements for quality of waste batteries, the research focus switched to the wet leaching recovery process. In this situation, many other substitute methods

are also investigated such as mechanical flotation separation, rGO, plasma waste graphite, and electrolyte recovery that are mainly based on supercritical CO₂ extraction technology, dissolution distillation, and precipitation method. They have all made huge progress in recycling waste batteries.

Although there are several methods for recycling, based on the current recycling process and industrial status of waste lithium-iron batteries, the problems still exist. For instance, the research on the recycling mechanism is not sufficiently possible, immature directional conversion technology, comprehensive utilization is still developing, there is a lack of high-tech equipment, there is low added value of recycled products, the possibility of serious secondary pollution is excessive, and the lack of policy incentive related to recycling [9].

Therefore, it is necessary to strengthen cooperation between experts and producers to find out the reasons why failure exists when lithium iron battery carries on their function and to construct the evaluation standards for material failure modes. Also, the development of new technology for recycling and reusing waste ternary lithium iron batteries is required to increase the efficiency, and the short process is an urgent need to realize the sustainable development of China's electric vehicle industry. Finally, the Chinese government needs to accelerate the development of the recycling system with policy support, and a complete industry standard is urgently needed [9, 10].

5. Conclusion

In conclusion, this comparative analysis of the EV battery industry in China shows that China is experiencing significant growth and are actively working to establish a robust and competitive next-generation battery industry. China has shown strong motivation and clear strategic planning for the development of the advanced battery industry. China is accelerating the development of its local battery industry through policy incentives and more investment in technology innovation. Also, it has a complete industrial chain and government support and continues to maintain its leading position in the global market.

Through government initiatives, research and development, and industry collaboration, China aims to overcome technological challenges, secure a reliable supply chain, and meet the growing demand for advanced batteries. The battery industry is making significant contributions to supporting the development of new energy vehicles and renewable energy on a global scale. Technological innovation and growth in market demand are still the main driving forces for the industry's development, while globalization layout and sustainable development, including recycling of used batteries will also have a significant impact on the industry's future development. In contrast, the solution to deal with pollution through the manufacturing process and recycling is unlikely to succeed in the short term.

The study illustrates the recent situation of the EV battery industry in the global market and domestic market in China. As for future prospects, there will be an increasing demand for EV batteries due to a significant rise in demand for electric vehicles. China, as it acts as the largest supplier of EV batteries in the global market, increases the production of EV batteries will be needed to adapt to the large demand. The study also shows that recycling and reducing pollution are the key hassles. The representative companies CATL and BYD may also put effort into treating these problems as one of their research interests.

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