

Green Bonds Boost New Energy Vehicle Enterprises’ Technological Innovation and Development—BYD Accelerates Battery Technology Breakthrough by Using Green Bonds

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Abstract. Nowadays, the new energy vehicle industry has emerged as a core engine to drive the growth of the green economy under the background of global energy transition and the "dual carbon" goals. As climate change becomes increasingly severe recently, reducing carbon emissions and developing clean energy have become a unanimous global consensus. Many countries have enacted policies to support the upgrading of industrial chains related to new energy vehicles. China, which boasts one of the largest NEV markets worldwide, is striving to achieve peak carbon emissions and carbon neutrality by innovating the batteries of new energy vehicles to enhance the competitiveness of its automotive sector. The study takes BYD as a case to conduct a holistic analysis of the importance and the developmental potential of the green bonds to substantiate that the green bond fosters the innovation of batteries in new energy vehicles, meaning that the case study method is employed throughout the research.

Keywords: Green Bonds, New Energy Vehicle, BYD’s Technological Innovation of Batteries, Green Finance

1. Introduction

To address the exacerbation of climate change, green bonds serve as a green financial product that bear "dual significance" in green energy development and technological innovation. According to Zhang et al., green bonds play a pivotal role in facilitating the green technology innovation of enterprises by raising funds for the commitment of experimentations and development [1]. This study focuses on how green bonds support the sustainable development and technological innovation of BYD, encompassing the support mechanisms, including resource provision or structural support and actual effects over the use of green bonds for batteries innovation in BYD, as well as the distribution of resources in the entire process. Furthermore, the methodologies of the study integrate multiple research methods, including case study method, quantitative analysis method by providing data and quantitative analysis methods by elaborating documents or reports. The research question is to explore whether green bonds can effectively enhance enterprises’

technological innovation efficiency and improve the quality of NEV-related products. Therefore, this study aims to elaborate the social and environmental value of green bonds by revealing how it innovates batteries and brings actual effects on the BYD company, such as upgrading the new energy products, enhancing the consumption accessibility, and raising the awareness of sustainability.

2. Key concepts and relevant theoretical foundations

BYD has issued Corporation green bonds to support its battery innovation in new energy vehicles. These bonds, categorized as Issuer-Type bonds, aim to address environmental issues and enhance market recognition and competitiveness. In 2018, BYD issued 1 billion yuan each, with 50% allocated to battery material production and vehicle accessory manufacturing and the other 50% to supplement corporate cash flow. The green bonds' impact on technological innovation can be analyzed using Green Finance Theory and Sustainable Development Theory, including ESG Theory. Green Finance Theory allows for targeted allocation of funds to battery technology research and development, enhancing capital utilization efficiency and attracting social capital. Sustainable Development Theory, including ESG Theory, emphasizes the importance of addressing the needs of present generations without compromising future generations' ability to meet their own needs.

3. Issuance of BYD green bonds and current development status of new energy battery technology

3.1. The actual effect of green bonds on environmental protection

BYD's use of green bond funds in the innovation of new energy vehicles had a significant positive impact on environmental conservation. According to Xinyue Li, an expert of environmental science, the advancement of NEVs can reduce the consumption of and dependence on fossil energy, while also mitigating the impact of vehicle exhaust on ambient air [2]. After BYD issuing the green bonds in 2018 and 2019, 1 billion yuan in funds was raised and allocated to the development of new energy vehicles. Since 2020, BYD has produced multiple versions of new energy vehicles, such as Han EV in 2020, Qin Plus in 2021, Tang DM-i in 2021 and Yuan Pro. Once these versions of new-energy vehicles started to sell in the market, they were selling like hotcakes. From 2020 to 2024, approximately 9.93 million of new energy vehicles were sold, meaning that there was a significant reduction in carbon emissions since people started to use new energy vehicles rather than gas-powered vehicles. This reveals the social responsibility of BYD regarding how they make contributions to the environment by promoting the use of new energy. Furthermore, the new generation of battery technology is BYD's Blade Battery, which has several tremendous improvements compared with the previous one. According to the BYD's website about blade battery, the blade battery is much more sustainable than the one used before due to its longer lifecycle, implying reduced battery consumption in the future [3].

3.2. The state of BYD's battery technological research and development

From 2020 to 2025, BYD has made abundant achievements in battery technology research and development by continuously innovating new battery technologies. Initially, the blade batteries were officially launched by BYD in 2020. This battery adopted lithium iron phosphate technology, increasing volume utilization by over 50%, and boosting the driving range by more than 50% as well. Additionally, BYD internally manages upstream, midstream and downstream operations

related to battery innovations, including developing raw materials, manufacturing and packaging, and it was supported by the green bonds issued in 2019 and 2020. In 2021, the blade batteries replaced the ternary lithium batteries, and the electrical vehicles produced in that year, including the 2021 Tang EV, 2021e2, Qin Plus EV, and Song Plus EV were all equipped with the blade batteries. Since 2022, the blade battery technology has been applied in many pure electric buses, enabling upgrades that optimize urban bus operation scenarios and enhance eco-friendliness. Starting from 2025, the second generation of blade battery is going to be launched, and this reformation brings multiple improvements relative to the first generation. The most significant change of the second generation is the energy density increase remarkably from 140Wh/kg to 190-210Wh/kg, enabling the vehicles to breakthrough the 1000 kilometers barrier and reduce energy consumption.

3.3. BYD's battery innovation mechanism and effects supported by green bonds

BYD, a Chinese battery company, has been supported by green bonds, raising a total of 2-billion-yuan for battery research and development. These bonds have been issued by the company, which has received government support to reduce fossil fuel consumption through new energy vehicles (NEVs) [4]. Some provincial governments in China have provided interest rate subsidies for the issuance of green bonds, lowering the financing cost. Green bonds have provided stable funding for BYD's battery innovation, enabling it to enhance efficiency and reduce costs. The cost-effectiveness of green bonds for fundraising is confirmed by a study on the motivation and economic effects of corporate green bond financing. Additionally, BYD and ByteDance have collaborated to enhance efficiency in battery innovation, sharing algorithms, experimental data, and computing tools [5].

4. Comparative analysis and limitations of green bonds

4.1. Vertical analysis and horizontal analysis of BYD

A vertical analysis of BYD reveals a great improvement after the issuance of green bonds in 2018 and 2019, particularly in patent filings and profit growth.

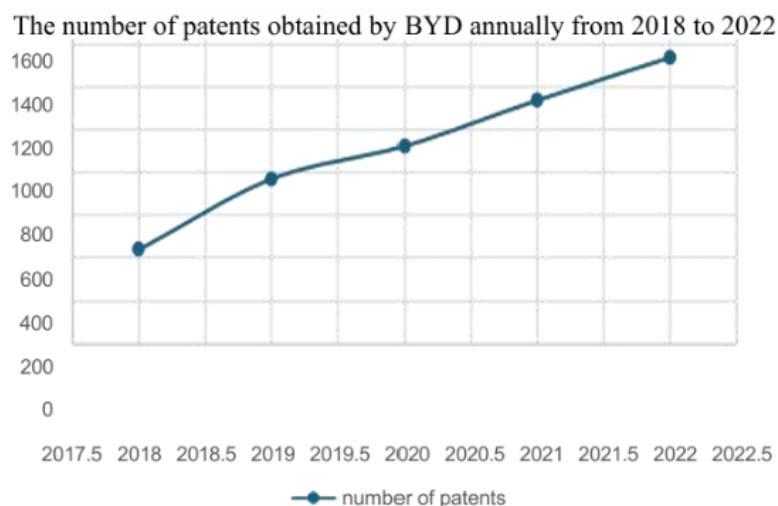


Figure 1. The patents received by BYD annually from 2018 to 2022 from BYD group technology analysis report 2023 [6]

Table 1. The growth rate of the by BYD annually from BYD group technology analysis report 2023 [6]

year	number of patents	growth rate
2018	436	7.57%
2019	767	68.81%
2020	922	16.81%
2021	1137	18.91%
2022	1337	14.96%

Both table and line graph indicate the annual number of patents obtained by BYD from 2018 to 2022, along with the growth rate of these patents over the same period. Overall, there was a consistent upward trajectory in the number of patents obtained by BYD annually from 2018 to 2022, growing from 436 to 1337, showing a significant improvement in research and development and technological development. Most significantly, there was a surge in the growth rate of patents from 2018 to 2019, which was the year of the issuance of green bonds. This reveals that the green bonds act as a catalyst for the technological breakthroughs.

Using horizontal analysis by comparing the annual revenue of BYD and its competitors can reveal what role does green bonds play in helping a business to make progress.

Table 2. The comparison of the revenue of three different companies from 2018 to 2023 from the tesla financial statement [7], BYD 2023 annual report [8], XPeng annual report [9]

The annual revenue of three different companies from 2018 to 2023 (billion Yuan)			
year	Tesla	BYD	Xiaopeng
2018	136.9	130.1	0.1
2019	164.9	127.7	2.32
2020	219.4	156.6	5.84
2021	345.7	216.1	20.9
2022	590.3	424	26.8
2023	701.2	602.3	30.7

Table 3. The annual revenue growth rate of each company from 2018 to 2023

Annual Revenue Growth rate (2018 to 2023)			
year	Tesla	BYD	Xiaopeng
2019	20.50%	-1.80%	2220%
2020	33.10%	22.60%	151.70%
2021	57.60%	38%	257.90%
2022	70.70%	96.20%	28.20%
2023	18.80%	42%	14.60%

Two tables above show the annual revenue and the annual revenue growth rate of three companies from the year of 2018 to 2023. Overall, Tesla remains the largest in absolute revenue, BYD has demonstrated the most impressive and sustained high-growth trajectory in recent years.

This can be attributed to strategic capital investments, such as the 2018–2019 green bonds, which funded its large-scale production and technological expansion.

4.2. The limitations of the use of green bonds for BYD

The limitations of BYD's green bond utilization include three aspects: issuance thresholds, R&D risks, and market condition impacts. For the issuance thresholds, the financial information and the main purpose of the project should be transparently shown to the government. Apart from that, BYD is allowed to issue green bonds not exceeding 6 billion yuan, of which 3 billion yuan is used for projects in the fields of new energy vehicles and components and 3 billion yuan is used to supplement working capital according to "the National Development and Reform Commission" [10]. This shows the barriers of government that requires BYD to meet many requirements and standards to issue their green bonds. In terms of the risks of research and development, green bonds are usually raised with a time limitation and fixed plan. However, the research and development always face unpredictable technical bottlenecks, which may force delays in original schedules. Therefore, the uncertainty of technological output may fail to meet the requirements. As far as the impact of market conditions is concerned, the cost offactors of production is always fluctuating, such as lithium, copper and nickel are used in producing batteries. Hence, the commercialization of battery innovations is affected by the instability of market conditions with fluctuations of costs.

5. Conclusion

Green bonds have served as a pivotal driver for BYD's R&D breakthroughs in battery technology, primarily by securing stable capital inflows and reducing the firm's financing costs. This financial support has directly undergirded the advancement of the company's battery-related technological capabilities, laying a solid foundation for innovation in this core business segment. The successful translation of green bond proceeds into concrete technological outputs depends on BYD's targeted deployment of these resources—specifically concentrating on two pivotal domains: enhancing core battery materials and innovating production techniques. Moreover, the interaction between BYD's vertical integration structure and technology R&D has strengthened the amplification effect of green bonds, enabling the company to more effectively convert financial inputs into technological advantages. Despite its contributions, this research has several limitations. Firstly, as a single-case study focused on BYD, the generalizability of its findings to other enterprises or industries is limited. Secondly, the scope of analysis does not cover interactive effects between green bonds and other green financial instruments, like green credit, resulting in an incomplete understanding of how multi-dimensional green financial instruments operate collectively. Two primary avenues are suggested for future investigation. One involves broadening the research scope to incorporate a wider array of players across the battery sector, which would strengthen the generalizability of findings related to green bonds' technology-driving role. Another promising direction is to delve deeper into specialized fields such as battery recycling, to gain nuanced insights into green bonds' capacity to foster innovation in specific technological niches.

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