

Analysis of Technological Innovation and Competitive Advantage in New Energy Vehicle Industry: BYD as an Example

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Abstract. In the context of global energy transition and carbon neutrality goals, the new energy vehicle (NEV) industry is experiencing rapid growth, with China emerging as the world's leading market. At the forefront of this transformation, BYD has established itself as an industry benchmark through its vertically integrated supply chain and continuous technological innovation. This paper examines how BYD can enhance its core competitiveness through technological advancements and optimize its capital structure for long-term development, using a mixed-methods approach that integrates financial analysis, competitive landscape evaluation, and technological innovation pathways. The study highlights BYD's strategic advantages derived from vertical integration in cost control and its comprehensive product portfolio spanning multiple market segments. By combining proprietary technologies such as hybrid systems and electric platforms with capital optimization strategies, BYD demonstrates a sustainable model for market leadership. This research contributes to refining the competitiveness analysis framework for NEV enterprises and provides valuable insights for industry stakeholders and investors navigating the evolving landscape of clean mobility.

1 Introduction

Driven by the acceleration of the global new energy transition and the goal of carbon neutrality, the automotive industry is undergoing major changes. The new energy vehicle market is rising rapidly, and China has become the world's largest new energy vehicle market by virtue of its huge market demand and policy support, leading the global industry trend. This paper will start from the analysis of new energy automobile industry and analyse BYD as an example.

Against the backdrop of the rapid development of new energy vehicles, how BYD can enhance its core competitiveness through technological innovation while optimising its capital structure to support its long-term strategic development is an important issue for it. On the one hand, BYD has achieved product performance improvement and cost optimisation to enhance its market competitiveness with its core technologies such as blade battery and

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DM-i super hybrid. On the other hand, in the face of large-scale R&D investment and capacity expansion needs, how BYD can rationally allocate equity and debt financing, optimise its capital structure, and ensure the stability of its capital chain will be an important guarantee for its progress towards becoming a global leader.

The study of BYD's technological innovation and capital structure optimisation is of both theoretical and practical significance. Theoretically, exploring the interaction mechanism between industrial capital and technological innovation can improve the competitiveness analysis framework of new energy vehicle enterprises and provide a new perspective on the synergistic development of technology and capital. In practice, its experience in technological innovation to reduce costs and increase efficiency, enhance core competitiveness and optimise capital structure also provides reference and evaluation basis for peers and investors.

BYD, in recent years as a new energy vehicle market industry leader, the development of the industry has not a small contribution, this paper will start from the industry, BYD as a case study, through the financial data, the competitive landscape and technological innovation path of the three dimensions of the study, to analyse the logic of its capital operation and the source of its core competitive advantages.

2 Overview of new energy vehicle industry and policy environment

2.1 Global New Energy Vehicle Market Status and Trends

The global new energy vehicle market scale grows by leaps and bounds from 2016 - 2023, with sales surging from 777,000 to 13.8 million, and the growth rate stabilising in 2023, with the Chinese market playing a key role in this process. And 2012 - 2021 sales rose more than 270 times [1]. BYD, as China's new energy vehicle industry leader, 2016 - 2023 sales increased from 100,100 units to 3,024,400 units, part of the year growth rate is far above average. In the past, the global new energy vehicle market has grown rapidly, and the Chinese market has been a strong driver of BYD's outstanding performance. As the market growth rate may slow down in the future, BYD is expected to continue to lead by virtue of its strength (see Table 1 and Figure 1).

Table 1. Annual sales volume and growth rates of new energy vehicles (2016-2023).

Year	Annual sales volume of BYD	Year-on-year growth rate of BYD's annual sales volume	Annual sales volume in China	Year-on-year growth rate of annual sales volume in China	Annual global sales volume	Year-on-year growth rate of global annual sales volume
2016	10.01	62.17	50.7	53.13	77.7	42.31
2017	11.37	13.59	77.7	53.25	122.3	57.4
2018	24.78	117.95	125.62	61.67	201.8	65
2019	22.95	-7.39	120.6	-4	221	9.5
2020	42	83.9	136.73	13.38	324	46.6
2021	60.38	43.76	352.05	157.48	675	108.9
2022	186.35	208.64	688.66	95.61	1065	57.9
2023	302.44	62.3	949.52	37.88	1380	30

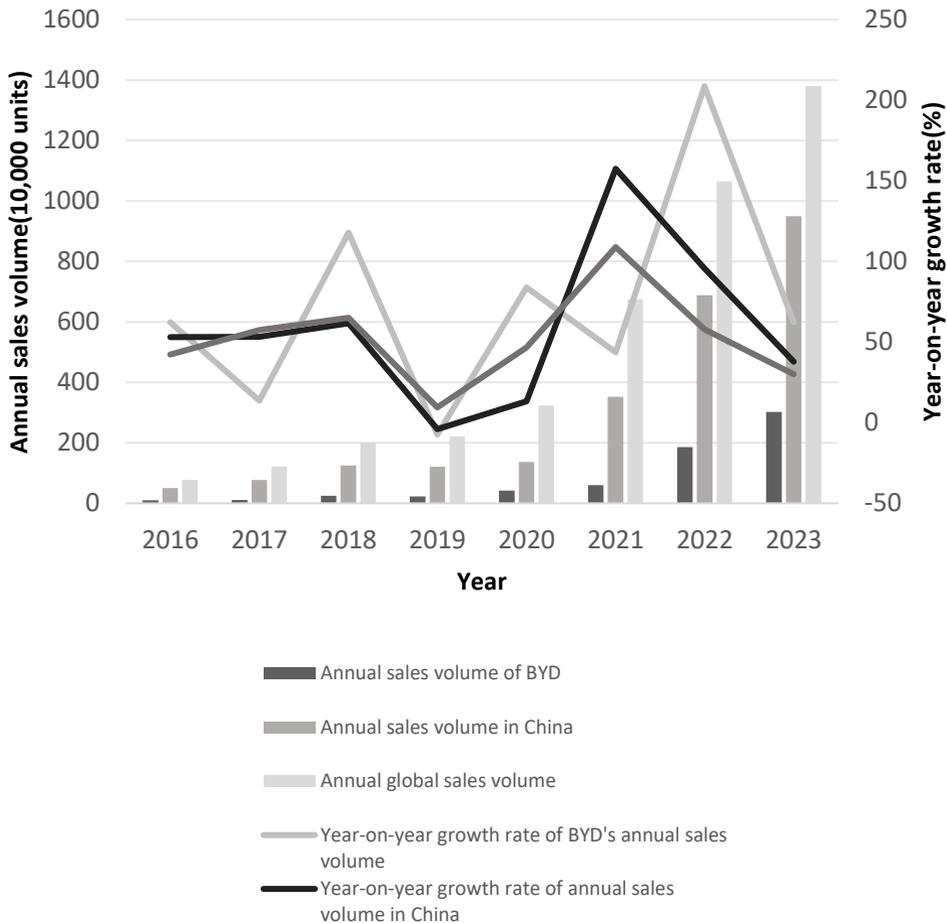


Fig. 1. Annual sales volume and growth rates of new energy vehicles (2016-2023).

2.2 China's new energy policy support

In 2022, China's new energy vehicle market share reached one quarter. According to the China Association of Automobile Manufacturers (CAAM), the output of new-energy vehicles in that year was 7.058 million units, with sales of 6.887 million units, a year-on-year increase of 96.9 per cent and 93.4 per cent, respectively, and the market share climbed to 25.6 per cent. This outstanding performance is attributed to the tax incentives. 2022 cumulative exemption of vehicle purchase tax for new energy vehicles amounted to 87.9 billion yuan, a year-on-year increase of 92.6% [2]. 2024, the growth of the new energy vehicle market is still strong, and the proportion of new energy vehicle retail sales reached 50.39% [3].

In the field of new energy vehicle charging facilities, as of the end of January 2025, the number of charging infrastructure in the country has rapidly climbed from less than 100,000 units to nearly 13 million units. Such a large-scale construction of charging infrastructure has built a solid foundation for the widespread popularity of new energy vehicles, especially in

the northern region. With the significant improvement of battery performance and the increasing improvement of charging facilities, the penetration rate of new energy vehicles in the northern region is expected to be further increased, and new energy vehicles in the northern market may usher in a broader space for development [4].

2.3 Challenges and opportunities in industry development

In recent years, the speed of technological innovation in the development of new energy vehicles has been considerable and there have been considerable breakthroughs, but the speed of further technological breakthroughs remains a challenge in the development of the new energy vehicle industry. In addition, in urban areas, the number of charging piles is quite limited, and the distribution situation is very uneven. In 2022, the number of new energy vehicles in cities around the world will reach 5 million, and by 2030, it is predicted that the number will exceed 30 million. However, the pace of growth in the number of charging piles is lagging far behind the growth rate of vehicle ownership [5]. At the same time, the battery cost problem also continues to exacerbate consumer concerns about the range of new energy vehicles. In January, 2025, lithium carbonate market quotes for 75,100 yuan per tonne, lithium hydroxide quotes for 70,000 yuan per tonne, compared with last week's decline has been narrowed, the range of 0.1%-0.2% between [6]. But this is not an opportunity for the development of new energy vehicle industry. Major new energy vehicle companies can raise funds, cooperation with local governments, etc., to accelerate the speed of technological breakthroughs, to pre-empt the iteration of the update, to create a more cost-effective, more complementary to the construction of the current facilities products.

3 Competitive landscape analysis of new energy vehicle industry - based on porter's five forces model

3.1 Strength of existing competitors in the industry

At present, the new energy vehicle industry is an oligopoly, dominated by Tesla and BYD. They have significant advantages in technology, brand and market share, and there are big differences in product performance, intelligence and range, such as Tesla's leading autopilot and BYD's superior battery technology. In addition, the industry price competition is fierce, especially in the low-end market, millet, zero run by low price to seize the share. Technological innovation, market demand and policy support constitute the driving force that drives the new energy vehicle industry forward [7]. It can be seen that technological innovation is the key to competition in the new energy vehicle industry, and innovations in areas such as batteries, autonomous driving, and intelligent cockpits can enhance the competitiveness of enterprises. In the next few years, industry integration will accelerate, market concentration will be further increased, Chinese new energy vehicle enterprises such as BYD and Azure accelerated overseas, and have already made gains overseas.

3.2 Strength of existing competitors in the industry

In terms of core components, Ningde Times, LG Chem and other battery, motor, electronic control suppliers have strong bargaining power. On raw materials, lithium, cobalt, nickel, etc. are affected by global price fluctuations, increasing cost pressure on enterprises. However, like BYD vertically integrated supply chain, can control costs, proposed price capacity. In the future, the enterprise will also diversify the supply chain to reduce the risk of borrowing

technological innovation (such as solid-state, sodium-ion batteries) to reduce the dependence on rare metals, reduce the cost of raw materials.

3.3 Bargaining power of downstream consumers

Nowadays, consumers have more options for purchasing new energy vehicles, with brand, performance and price influencing their purchasing decisions. Government subsidies and tax incentives reduce the cost of purchasing a vehicle and increase willingness to buy. Improvement of charging infrastructure, such as the number and distribution of charging piles, directly affects the experience of using the vehicle. As the market matures, consumers' awareness and acceptance of new energy vehicles may further increase, making more rational decisions, and companies may also introduce quality after-sales and charging services to improve consumer satisfaction and loyalty.

3.4 Bargaining power of downstream consumers

Despite the rapid growth of the new energy vehicle market, traditional fuel vehicles still account for a large share of the low-end and mid-range markets. Hybrid vehicles pose a threat to pure electric vehicles as a transitional product due to their low cost of use and high range. Hydrogen fuel cell vehicles have advantages in scenarios such as long-distance transport and heavy-duty vehicles. However, advances in battery technology will improve the range and charging convenience of pure electric vehicles, reducing the threat of substitution, and government policy support will also drive the market to pure electric vehicles.

3.5 Bargaining power of downstream consumers

The new energy vehicle industry has many barriers, covering technology, capital, policy and brand. Its technology threshold is high, and core technology research and development such as battery, motor and electronic control require a lot of capital investment. The initial investment in the project is huge, involving production lines, R&D, promotion, etc., and new entrants need strong capital. New entrants need to adapt to different policy support and subsidies in different countries. The brand influence of existing companies is strong, and it takes time for new entrants to build brand trust. Technology companies may acquire or build their own entry, new entrants can also integrate the supply chain to reduce costs and improve competitiveness.

4 Analysis of BYD's technological innovation and capital structure

4.1 Bargaining power of downstream consumers

4.1.1 Power Battery

As a leader in the new energy vehicle industry, BYD has made a lot of achievements in technological innovation. In March 2020, BYD officially adopted the unique blade structure design to launch the blade battery, which significantly improved the volume utilisation and energy density of the battery. In the same year, the blade battery was first carried in BYD Han models, helping it become a market hit. BYD also continued to optimise blade battery technology in 2024 with the launch of the fifth generation of DM technology, which further

improved battery performance. BYD has been focusing on the sulphide battery path solid-state batteries since 2016, the key to which lies in changing the electrolyte from liquid to solid, with three main technology routes: polymers, oxides and sulphides. In addition, BYD pioneered the use of engine plus electric motor multi-engine drive free intelligent switching, pure electric hybrid two drive modes, and through the DM II dual-mode technology to achieve environmental protection and energy saving at the same time, to provide extraordinary power.

4.1.2 Intelligent driving system

Under the trend of fusion of intelligence and electrification, BYD has actively laid out the field of intelligent driving and launched the ‘Whole Vehicle Intelligence’ strategy, which realizes the efficient fusion of electrification and intelligence through the Xuanji Intelligent Architecture. The architecture consists of ‘one brain, two ends, three networks and four chains’, which breaks down barriers between systems, captures changes in the internal and external environments in real time, and completes decision-making and execution within milliseconds. BYD Intelligent Driving System is centred on the ‘Eye of the God’, and is available in three versions to suit different price levels, with the C version of pure vision suited to the 100,000 class, the B version with LIDAR to support urban NOA, and the A version with three LIDAR to support navigation in urban areas without a map. At the same time, BYD pioneered the Xuanji AI big model, covering more than 300 scenes, giving the vehicle intelligent evolution characteristics.

Through these layouts, BYD not only improves the safety and comfort of the vehicle, but also achieves personalised settings to meet different user needs.

4.1.3 Autonomous production of core components

BYD has built a strong supply chain control capability and formed a solid moat through the independent production of core components. It has formed a closed loop of the whole industry chain of upstream, midstream and downstream, and has basically realised self-production, self-research and self-supply of core components from electric core, MCU, IGBT to triple power system and thermal management. This vertical integration mode not only reduces the production cost, but also improves the risk resistance of the supply chain. For example, in 2023, BYD's self-supplied power battery installed capacity accounted for about 94.8%, which significantly reduces the production cost [8]. In addition, BYD has further improved the stability of its supply chain through its scattered layout and supply chain localisation. This deeply integrated supply chain system gives BYD a significant competitive advantage in the global new energy vehicle market and lays a solid foundation for its long-term development.

4.2 Analysis of BYD's financial performance and capital allocation

4.2.1 Revenue growth dismantling

BYD's revenue growth was mainly attributed to the growth in sales of new energy vehicles, the expansion of its product line, and the increase in its market share. BYD achieved revenue of 502.251 billion yuan in the first three quarters of 2024, an increase of 18.94 per cent year-on-year. According to BYD's production and sales snapshot, BYD's total sales volume in 2024 was 4,272,000 units, up 41.3% y/y. Among them, 417,000 new energy passenger

vehicles were sold overseas, up 71.9% y/y. Meanwhile, BYD continues to introduce new models and technologies, such as the full-scale roll-out of DiPilot100, which enhances the competitiveness of its products. Moreover, BYD's share of the domestic new energy vehicle market maintains a high level of about 35%, based on the calibre of the passenger association [9].

4.2.2 Profitability assessment and balance sheet health

From 2015 - 2023, many of BYD's financial indicators show an upward trend. Net profit margin fluctuates but overall upward, reaching 5.20% in 2023, showing cost control and profitability enhancement; total asset turnover is generally rising, peaked at 1.0741 in 2022, asset utilization efficiency; equity multiplier fluctuates upward, 4.6967 in 2023, high debt but leverage enhancement of profitability; ROE fluctuates and upward overall, reaching 24.0481% in 2023 The ROE is fluctuating and generally upward, reaching 24.0481% in 2023, and profitability is significantly enhanced.

Taken together, BYD's net profit margin, total asset turnover and ROE are all on the rise, especially at a high level in 2023, demonstrating the company's excellent improvement in cost control, asset utilization and profitability. Despite the high equity multiplier, the increase in ROE shows that the company has successfully leveraged its leverage to effectively improve profitability. In addition, the indicators of short-term solvency, such as current ratio and quick ratio, performed well, which means that the company has strong short-term solvency and is in a sound financial position (see Table 2).

Table 2. Annual financial situation of BYD (2015-2023) .

Year	Return on Equity ROE (dimensionless)	Equity Multiplier	Total Asset Turnover (times)	Net profit attributable to the parent company's shareholders (in billion yuan)	Net Profit (in billion yuan)	Total Operating Revenue (billion yuan)	Total Profit (billion yuan)
2023	24.0481	4.6967	1.0266	300.4081	313.4407	6023.1535	372.6864
2022	16.1305	3.8314	1.0741	166.2245	177.131	4240.6064	210.7973
2021	4.0083	3.2696	0.8701	30.4519	39.6727	2161.424	45.18
2020	7.4523	3.4906	0.7896	42.3427	60.1396	1565.9769	68.8259
2019	2.884	3.4853	0.6547	16.1445	21.1886	1277.3852	24.3113
2018	5.0456	3.3817	0.698	27.8019	35.5619	1300.5471	43.8564
2017	7.6538	3.0413	0.6555	40.6648	49.1694	1059.147	56.2064
2016	12.0937	3.1186	0.7942	50.5215	54.8001	1034.7	65.6841
2015	9.7934	3.6333	0.7638	28.2344	31.382	800.0897	37.9499

4.3 Assessment of capital sources and utilization efficiency

BYD, as a global leader in new energy vehicles, is in a period of rapid expansion with outstanding performance in the international market. To support its global layout, it is in urgent need of a large amount of capital, and the financing is mainly used to strengthen its capital reserves, accelerate its overseas R&D expansion, replenish its working capital and meet the needs of its corporate development, as well as to optimise its shareholder structure by attracting high-quality institutional investors to boost market confidence.

BYD has conducted a number of large-scale financing in the past 15 years, especially between 2015 and 2020, with larger-scale financing activities every year. In the long run,

these financings have provided strong financial support for BYD's business expansion and technology development, and enhanced the company's competitiveness (see Table 3).

Table 3. Annual Financing Overview of BYD.

Year	Financing Type	Financing Amount (Billion Yuan)	Main Purposes
2011	A-Share IPO	14.22	Initial Capital
2015	Bond Issuance	15	Project Investment
2016	Bond Issuance	6	Project Investment
2016	Secondary Offering	144.73	Project Investment
2017	Bond Issuance	15	Project Investment
2018	Bond Issuance	141	Project Investment
2019	Bond Issuance	242	Project Investment
2020	Bond Issuance	24.71	Project Investment
2025	H-Share Placing	435	Overseas Business Development, R&D Investment, Supplementing Working Capital

BYD mainly through the H-share placement and flash placing financing. 2025 March 4, BYD to 335.2 Hong Kong dollars per share to place 129.8 million H shares, financing about 43.5 billion Hong Kong dollars, for nearly a decade in the global automotive industry large-scale equity refinancing project, won the sovereign fund and other top long-term investors, such as the United Arab Emirates strategic investor or bring international cooperation. However, the Q3 2024 report showed that BYD's capital was under pressure in that quarter, with cash flow out exceeding inflow, and operating cash flow unable to cover capital expenditures and other expenses. In the third quarter of 2024, BYD invested 33,319.21 million yuan in research and development expenses, such a high amount of research and development investment, or one of the reasons that lead to negative free cash flow [9].

Overall, although BYD's short-term cash flow is under pressure, its high R&D investment and active expansion of overseas business demonstrates the importance it attaches to future development, and it is expected to reap rich returns in the long run. Its accounts payable and bills totaled 240.460 billion yuan, accounting for 46.96% of current liabilities, reflecting the pressure of supply chain management, but also reflects the strong bargaining power of the industry chain. Despite its high debt ratio, the company's growing operating cash flow and R&D expenses demonstrate its good operating quality and growth potential.

5 BYD core competitive advantage profiling - based on SWOT model

5.1 Strengths

BYD has outstanding advantages in the field of new energy vehicles, with original technologies such as 'blade battery' to build competitive barriers, and relying on China's largest vehicle cloud database, the world's largest R&D team and self-built AI

supercomputing centre to achieve technological leadership. Moreover, the whole vehicle intelligent driving technology is a crucial item in the development and innovation for new energy vehicles [10]. BYD's largest production and manufacturing system drives the industrial chain, accelerates the popularity of Smart Driving, and continuously pushes new innovations to consolidate the lead. In addition, BYD's vertically integrated cost reduction and stable chain, deep ploughing in the country to obtain high recognition, and actively go overseas to layout the market in many countries [11].

5.2 Weaknesses

As BYD needs to keep pushing the envelope to create a better competitive advantage, the company needs to invest heavily in research and development, but this also leads to its short-term profitability being limited. Moreover, BYD's long-term debt-servicing ability is mediocre compared to Tesla, the global leader in the new energy vehicle industry. Therefore, it is necessary for BYD to use financial leverage scientifically and reasonably, so as to reduce its gearing ratio [12]. Furthermore, although BYD has performed well in the field of new energy vehicles, its brand recognition and influence in the high-end market still need to be further improved, especially when competing with traditional luxury brands. In addition, BYD's layout of the international market started late, and the gap with overseas brands, such as Tesla, still exists. This is a fact that cannot be ignored.

5.3 Opportunities

Nowadays, the demand for new energy sources overseas is growing, driven by global carbon neutrality targets. Moreover, good ESG performance is highly beneficial to enhance corporate value [13]. BYD is aggressively expanding into overseas markets, especially Japan, with plans to launch plug-in hybrid vehicles (PHVs), which will help it further expand its global market share. Meanwhile, it is promoting the popularization of Smart Driving technology and plans to launch 3 million new energy vehicles equipped with Smart Driving capability by 2025, which will help it take the lead in the field of smart driving. In addition, support from domestic and international new energy vehicle policies, such as Shanghai's new energy vehicle replacement subsidy policy, will further boost BYD's sales growth. BYD's cooperation with Nvidia, Huawei, Horizon and other head enterprises to achieve the deep integration of hardware and software, is more expected to drive the growth of demand for upstream sensors, in-vehicle chips, high-precision maps and other core links.

5.4 Threats

With the popularity of smart driving technology, other car companies are also actively laying out, such as Changan Automobile's Beidou Tianshu 2.0 plan and Tesla's energy storage super factory going into production. This will intensify market competition. And BYD's overseas business continues to expand, facing the risk of exchange rate fluctuations. The company has responded to this risk through its foreign exchange derivatives trading business, but uncertainties in the market environment may still affect its financial position. In addition, the rapid iteration of intelligent driving technology requires BYD to continue to invest in research and development to maintain its technological leadership, or it may be overtaken by competitors. Moreover, international trade frictions may make exports more difficult, and BYD is also exposed to the risk of fluctuating raw material prices.

6 Conclusion

BYD can build a significant advantage by achieving cost control through vertical integration. At the same time, BYD can also form a comprehensive product matrix by adapting to different market segments. Looking ahead, for the development of the new energy automobile industry, governments should also implement the infrastructure and laws and regulations related to the new energy automobile industry. BYD should also strengthen the penetration of the international market, pay attention to the cultural difference strategy, and pay attention to the level of debt and improve the efficiency of the use of funds in order to achieve long-term sound development.

References

1. L. Zhang. Research on the development of new energy vehicles under the goal of carbon neutrality. Shanghai University of Finance and Economics, 2023.
2. C. News. Tax incentives and other policies to spur China's new energy vehicle market to explode in 2022. (2023-01-13). <https://www.chinanews.com/cj/2023/01-13/9934510.shtml>
3. C. Research Network. China new energy vehicle industry market trends and investment opportunities in 2025: technological innovation, policy support and market demand. (2024-11-28). <https://www.chinairn.com/scfx/20241128/105300970.shtml>
4. State Council Information Office. China's energy transition. (2024-08). http://www.scio.gov.cn/zfbps/zfbps_2279/202408/P020240829600355886895.pdf
5. C. Research Network. New energy vehicle industry development analysis and forecast report: three major pain point solutions. (2025-03-07). <https://www.chinairn.com/news/20250307/180453602.shtml>
6. Finance. New energy vehicle industry observation: industry chain price bottoming out; solid state battery cooperation accelerates technological breakthrough. (2025-03-09). <https://finance.jrj.com.cn/2025/03/09162048614778.shtml>
7. M. Wang, X. Wu. Development Path Innovation of Strategic Emerging Industries--Based on the Analytical Perspective of Innovation Ecosystem. *Sci. Technol. Manag. Res.* **35(9)**, 41-46 (2015)
8. K. Zhuang. China's power battery global market share exceeds 60% BYD accelerates blade battery external supply | Lithium Monthly Observations. (2024-03-01). <https://www.jiemian.com/article/10856609.html>
9. BYD Company Limited. BYD Company Limited Third Quarterly Report 2024. (2024). <https://www.bydglobal.com>
10. Z. Wang, X. Li, F. Sun. Development trend of new energy vehicle technology in the context of industrial integration. *Journal of Beijing Institute of Technology Nature Edition*, **40(1)**, 1-10 (2020)
11. Y. Guo. Research on BYD's overseas strategy in the context of Belt and Road. In *Proceedings of SE*. **2(1)**, 46-48 (2024)
12. J. Liu, H. Li. Financial capability analysis of new energy vehicle enterprises - based on Tesla and BYD. *World Econ. Inq.* **11(4)**, 290-298 (2022)
13. L. Gao, Y. Niu, K. Xu. Value assessment of new energy automobile enterprises considering ESG factors--Taking BYD as an example. *Finance and Accounting Monthly*, **45(01)**, 95-101 (2024)