

A Study on the Financing Motives and Effects of Carbon-Neutral Bonds in the Green Power Industry: A Case Study of China Three Gorges New Energy

Zhonghuan Zhang^{1,a}, Mei Wang^{1,b,*}

*¹Shandong Agricultural University, 960 Wenquan Road, Tai'an, Shandong Province, China
a. 3343063953@qq.com, b. wangmei1206@126.com*

**corresponding author*

Abstract: With the escalating climate crisis, fossil fuel consumption has led to global warming and a series of environmental challenges. The green power industry plays a significant role in alleviating the energy crisis and reducing environmental pollution. In recent years, China's green bond market has seen continuous growth and improvement. As an innovative form of green bond, carbon-neutral bonds are vital tools for achieving sustainable development and offer a new financing channel for green power enterprises. This study aims to explore the financing motives and effects of carbon-neutral bonds within the green power industry. Focusing on Chinese green power enterprises that issue carbon-neutral bonds, the study uses China Three Gorges New Energy as a case example, employing event study and financial analysis methods to examine the market response and financial impacts of carbon-neutral bonds. Data for this research were sourced from cninfo.com and the CSMAR database. The findings reveal that China Three Gorges New Energy's primary motives for issuing carbon-neutral bonds include enhancing its green reputation to attract stakeholder support, reducing financing costs, and optimizing its financing structure. The issuance of this carbon-neutral bond demonstrated favorable market, financial, and environmental effects. This research provides an in-depth micro-level analysis of the specific applications of carbon-neutral bonds in the green power industry and offers guidance for future corporate carbon-neutral bond issuances.

Keywords: Carbon-Neutral Bonds, Green Bonds, Green Power, Motives, Effects.

1. Introduction

Energy is a crucial resource supporting human survival and societal progress [1]. Currently, global electricity generation largely depends on fossil fuels [2], which has led to global warming and a series of environmental challenges [3]. Actively promoting renewable energy generation is therefore essential for sustainable human development. However, the power industry faces numerous challenges in its green transition. For example, photovoltaic power generation involves significant resource consumption and pollutant emissions during the production, operation, and disposal of photovoltaic equipment, raising environmental concerns [2].

Countries around the world are highly attentive to environmental protection. In December 2015, the United Nations Climate Change Conference adopted the Paris Agreement, emphasizing the need

for enhanced international cooperation to address global climate change [4]. In 2018, the IPCC released a special report on Global Warming of 1.5°C, recommending the use of renewable energy sources to replace fossil fuels [5]. By November 2020, ahead of the United Nations Climate Summit, a total of 124 countries had made net-zero emissions commitments [6]. While achieving net-zero carbon emissions remains challenging [3], many countries have proposed action plans and initiatives and are actively implementing them [7].

China, the world's largest producer and consumer of energy and the leading emitter of carbon dioxide [8], announced its "dual carbon goals" in September 2020, committing to peak carbon emissions by 2030 and achieve carbon neutrality by 2060 [9]. The Chinese government continues to prioritize the green transition of the power sector, introducing a series of carbon policies, such as the launch of a national carbon emissions trading market in the power sector [10] and pilot low-carbon city policies [11]. China is also supporting the development of the green power industry through incentives such as tax benefits, subsidies, and financial facilitation [12].

Corporate development depends on adequate financial support, and carbon-neutral bonds have rapidly gained traction, gradually becoming an important means for green power enterprises to address financial pressures.

Currently, there is extensive research on green bonds, but studies focusing on carbon-neutral bonds remain relatively scarce. Scholars have confirmed a positive correlation between green bond issuance and stock price reactions, along with long-term positive impacts on corporate profitability and operational performance [13]. Similar to green bonds, carbon-neutral bonds serve as a credible signal of a company's environmental commitment, attracting environmentally-conscious investors [14]. While green bonds can fund a wider range of projects, carbon-neutral bonds are specifically designated for projects with carbon reduction benefits, featuring more targeted emission reduction objectives [15]. Consequently, carbon-neutral bonds often require stricter monitoring and reporting mechanisms to ensure funds are allocated to actual emission reduction initiatives [16]. Scholars have also identified several issues with carbon-neutral bonds. The current carbon-neutral bond market in China lacks a unified standard and certification system, making it difficult for investors to assess bond quality and potentially undermining market trust [17]. Some scholars have also noted that the issuance of green bonds may be a form of "greenwashing" without genuinely increasing green investment [18].

Based on an analysis of the research background and relevant literature, this study focuses on the issuance of carbon-neutral bonds by Chinese green power enterprises, using the leading company China Three Gorges New Energy as a case study. By employing the event study method and financial analysis, this research evaluates the financing effects of carbon-neutral bonds, providing case-level evidence for this specific sector. Drawing on the successful experience of China Three Gorges New Energy in issuing carbon-neutral bonds, other power companies can more effectively raise funds to support green and low-carbon projects, thereby contributing to sustainable development.

2. Theoretical Foundation

Environmental Economics Theory: Environmental economics theory examines the impact of economic activities on the environment, emphasizing the consideration of environmental costs and benefits in decision-making to achieve sustainable development [19]. Green bonds, as a financing tool, are intended to support environmental projects and reduce negative environmental impacts [20]. By issuing green bonds, companies can raise funds for renewable energy, pollution control, and other initiatives, helping balance economic growth and environmental protection [21]. However, in the application of carbon-neutral bonds, if companies fail to manage these funds effectively or choose unsuitable projects, it may lead to resource wastage and unmet environmental benefits.

Pecking Order Theory: Proposed by Myers in 1984, pecking order theory suggests that companies prioritize internal financing, followed by debt financing, and lastly, equity financing when seeking

funds [22]. Internal funds have the lowest cost [23], while debt financing is less costly than equity financing [22]. Green bonds offer companies a stable source of funds with relatively low financing costs [24], making them more suitable for supporting long-term environmental projects [25]. Nevertheless, the strict use-of-proceeds restrictions and disclosure requirements for carbon-neutral bonds pose certain challenges for issuing companies.

Signaling Theory: Signaling theory highlights that companies convey information about their quality or intentions to the market through certain actions [26]. Issuing green bonds can be viewed as a signal of a company's commitment to environmental goals, thereby attracting more investors [27]. This signal helps reduce information asymmetry and enhances the company's market reputation, potentially attracting further green investments [28]. Additionally, by issuing green bonds, companies demonstrate their active response to government calls, which may lead to more policy support and incentives [29]. However, the market may doubt the sincerity of a company's environmental commitment; failure to meet these commitments could damage the company's reputation.

3. Current Status Analysis

3.1. Status of Carbon-Neutral Bonds

Policy: In March 2021, the National Association of Financial Market Institutional Investors in China formally defined carbon-neutral bonds, making China the first country in the world to establish a market mechanism for carbon-neutral bonds. In October 2023, the Shanghai and Shenzhen Stock Exchanges further expanded the types of projects eligible for carbon-neutral bond funding. In April 2024, the central government explicitly emphasized the need to actively develop carbon-neutral bonds and sustainability-linked bonds.

Issuance Scale: China's green bond market was launched in 2016 and has since grown to become the world's largest issuer and the second-largest market for green bonds. Driven by the rapid overall growth of green bonds, carbon-neutral bonds attracted significant market enthusiasm upon introduction. In 2021, a total of 203 carbon-neutral bonds were issued, raising RMB 278.233 billion, significantly contributing to the expansion of the green bond market. However, in 2022 and 2023, the popularity of carbon-neutral bonds decreased, with both the issuance volume and their share of green bonds declining. By the end of 2023, a cumulative total of 448 carbon-neutral bonds had been issued domestically, amounting to RMB 638.543 billion, accounting for 30.81% of the number and 27.70% of the total value of green bonds. Despite a cooling trend since the "first year of carbon neutrality" in 2021, carbon-neutral bonds remain an essential component of green bonds in the short term. The reduced issuance interest largely stems from the narrower scope of eligible uses for carbon-neutral bond funds compared to standard green bonds, with no clear issuance advantages.

Issuer Structure: Similar to green bonds overall, carbon-neutral bonds are primarily issued by state-owned enterprises (SOEs). In 2023, SOEs accounted for approximately 90% of both the number and value of carbon-neutral bonds issued. By the end of 2023, SOEs had cumulatively issued RMB 3.24 trillion in green bonds, representing 77.61% of the market, highlighting their stronger familiarity with green concepts and a more precise understanding and application of green projects. Meanwhile, the enthusiasm and market participation of private enterprises remain areas for improvement.

Issuer Credit Ratings: Excluding bonds without credit ratings, the credit ratings of carbon-neutral bond issuers from 2021 to 2023 were all AA or above, with over 80% rated AAA, indicating generally high credit quality. This concentration of high credit ratings contributes to the overall stability of the green bond market, promoting healthy and orderly market development.

Industry Distribution of Issuers: In 2022, the power production and supply industry led with a 37.12% share of carbon-neutral bond issuance. In 2023, this industry continued to rank first in

issuance volume, aligning with its role as a key industry for carbon reduction and its relevance to carbon-neutral bond funding requirements.

Currently, China's carbon-neutral bond market is still in its early stages and faces numerous challenges that require further exploration.

3.2. Analysis of the Development Status of the Green Power Industry

The green power industry aligns with the nation's environmental protection initiatives and possesses vast growth opportunities. Currently, coal-based energy accounts for about 61% of China's energy structure; however, its share in total national power generation capacity has seen a significant decline, from 62.24% in 2017 to 51.96% in 2022. According to the National Energy Administration's plan, by 2030, China's total power capacity is expected to reach 3.8 billion kilowatts, with clean energy accounting for 67.5% of the total, making it the dominant power source.

At present, there are 183 listed companies in China's green power industry, with a total market capitalization of RMB 4.01 trillion. In the A-share market, green power companies account for 4.88% of the total market capitalization, a 0.26% increase from 2023, indicating the industry's growing influence in the capital market and recognition from investors.

Wind and solar power have achieved remarkable results in China's green power sector. In 2020, China's grid-connected wind and solar power capacities were the highest globally, with electricity generation reaching 466.5 billion kWh and 261.1 billion kWh, respectively, representing year-on-year increases of 15.1% and 16.6%. As a leading enterprise in the green power industry, China Three Gorges Energy has developed onshore wind power projects across 25 provinces and solar projects across 22 provinces. By 2022, its offshore wind power installed capacity reached 4.8752 million kilowatts, capturing a 16.01% market share nationwide and ranking first in both operational and under-construction capacity. With rising demand for renewable energy and ongoing project advancements, Three Gorges Energy is poised to further expand its market share and drive growth in the green power industry.

3.3. Analysis of the Relationship between the Green Power Industry and Carbon-Neutral Bonds

For green power enterprises, the financial pressures of large-scale green projects limit their growth. In 2023, China's clean energy investment reached approximately RMB 6.3 trillion, a 40% year-on-year increase. However, uncertainties due to the two-part tariff policy and intensified market competition have led to project delays and cancellations. Additionally, the long investment return cycles and high risks associated with renewable energy projects are not compatible with the shorter terms of standard financing tools, resulting in a mismatch between funding needs and available resources, which exacerbates financing challenges. As a result, companies are keen to diversify financing channels to better meet their capital needs.

Compared to other financing tools, funds raised through carbon-neutral bonds are dedicated to the construction, operation, acquisition, and debt repayment of green projects. In terms of information disclosure, issuers are encouraged to engage third-party professional agencies to produce evaluation and certification reports, publicly disclosing quantitative measurements of carbon reduction benefits. This yields multiple benefits for carbon-neutral bonds, including enhanced market credibility and recognition and the attraction of investors focused on environmental and social responsibility.

As a leading enterprise in the green power sector, China Three Gorges Energy actively promotes the concept of green development, committed to advancing the development and utilization of renewable energy. By issuing carbon-neutral bonds, Three Gorges Energy not only secures essential funding for its green power initiatives but also creates new opportunities for profit growth.

4. Analysis of Carbon-Neutral Bond Financing Cases in the Green Power Industry

4.1. Company Overview of China Three Gorges Renewables

China Three Gorges Renewables (Group) Co., Ltd. (abbreviated as CTGR), was established in September 1985 with a registered capital of RMB 28.571 billion. Listed on the main board of the Shanghai Stock Exchange in June 2021 under stock code 600905, CTGR is a publicly traded subsidiary of China Three Gorges Corporation, primarily focusing on green power generation.

In recent years, CTGR's main business has been in wind and solar power generation, with proactive expansion into pumped storage, new energy storage, and hydrogen energy. As a leading enterprise in the green power industry, by the end of 2023, CTGR's operations covered 30 provinces, autonomous regions, and municipalities across China, with a total installed capacity exceeding 40 million kilowatts. The company's total assets surpass RMB 310 billion, placing its profitability among the top in the domestic industry.

4.2. Carbon-Neutral Bond Issuance

On May 6, 2022, China Three Gorges Renewables (Group) Co., Ltd. issued a green medium-term note titled "22 Three Gorges Renewables MTN002 (Carbon-Neutral Bond)" with a maturity of three years and a coupon rate of 2.75%. The main underwriter of this carbon-neutral bond was Agricultural Bank of China Co., Ltd., and it was publicly issued on the national interbank bond market.

As shown in Table 1, the credit rating of this green medium-term note was AAA, with a total issuance amount of RMB 2 billion. According to the "Green Bond Prospectus" released on April 28, 2022, all funds raised were used to repay loans for the company's wind and solar power projects. As stated in the "Notice of Change in Use of Proceeds," while specific projects financed by the bond have varied since its issuance, the direction of funds remains unchanged.

Table 1: Information on China Three Gorges Renewables' Second Green Medium-Term Note (Carbon-Neutral Bond) Issued in 2022

Bond Information	
Bond Name	22 Three Gorges Renewables MTN002 (Carbon-Neutral Bond)
Bond Code	102281065
Total Issuance Amount	RMB 2 billion
Issuance Price (Per 100 Face Value)	RMB 100
Bond Term	3 years
Interest Rate	2.75%
Interest Payment Frequency	Annually
Interest Start Date	May 10, 2022
Maturity Date	May 10, 2025
Bond/Issuer Rating	AAA/AAA

4.3. Analysis of Financing Motives

The issuance of green bonds by China Three Gorges Renewables (CTGR) is driven by both external and internal motivations. Externally, it aligns with the national policy supporting green bonds, meeting the demands of economic development and green transformation in society. This study focuses on the internal motivations, mainly enhancing corporate reputation and reducing financing costs.

4.3.1. Enhancing Green Reputation and Gaining Stakeholder Support

In recent years, China's development of new energy, notably wind and solar power, has been highly successful, laying a solid foundation for achieving carbon peak and carbon neutrality goals. With increasing national emphasis on environmental protection, green reputation has become crucial for corporate growth.

Media attention and coverage significantly influence a company's reputation. According to media reports, CTGR and its subsidiaries faced a total of 65 administrative penalties between 2017 and 2019 for reasons including unauthorized land use and illegal occupation of grasslands. In September 2021, a related company, China Three Gorges New Material Co., was fined RMB 700,000 for "air quality violations." Its subsidiary was criticized for severe mountain degradation and vegetation loss due to raw material extraction. Such negative reports have harmed the company's long-term reputation, prompting a need to improve its green reputation. Issuing carbon-neutral bonds sends a positive signal to investors [30], significantly aiding in maintaining a "green company" image and enhancing green reputation [31]. By issuing carbon-neutral bonds, CTGR not only demonstrates a commitment to sustainable development but also highlights its proactive role in advancing clean energy, garnering media attention and positively impacting its green image.

Government support also plays a crucial role in corporate growth, and the green reputation boost from issuing carbon-neutral bonds helps CTGR secure further government support. Since its 2021 listing, CTGR has received various government subsidies, including research and development subsidies and environmental project grants. In 2021, CTGR received RMB 30 million in government subsidies, and by June 2024, its deferred income balance, entirely from government grants, totaled RMB 65 million. Additionally, most of CTGR's accounts receivable consist of government subsidies for new energy. In 2022, CTGR collected RMB 8 billion, and in 2023, RMB 6.8 billion in subsidies. As the funds for these subsidies are backed by national credit, CTGR packages them into financial assets for issuing green bonds, thereby facilitating fund recovery.

4.3.2. Reducing Financing Costs and Optimizing Financing Structure

Table 2 summarizes key accounting changes relevant to this study for CTGR from 2020 to 2022. Since CTGR went public in 2021, the earliest available data is from 2020. By the end of 2021, CTGR's projects under construction exceeded RMB 57.5 billion, largely consisting of wind and solar power projects. Due to the transition of newly operational projects into fixed assets, the projects under construction decreased in 2022. The company's R&D investment in core business areas has continued to grow, reflecting increased financing needs due to the expanding scale of project investment.

Regarding financing structure, CTGR utilizes various external financing sources, including long-term loans, bonds payable, notes payable, and non-financial institution loans categorized as other payables. Between 2020 and 2022, the company's long-term loans surged from RMB 49.71 billion to RMB 99.46 billion, while bonds payable increased from RMB 2.99 billion to RMB 6.63 billion, both showing substantial annual growth. Additionally, due to the specific nature of its note business, CTGR is required to deposit a certain proportion of margin funds with financial institutions for services such as bank acceptance drafts. Financial statements from 2020 to 2022 show that deposits and margin funds within other receivables totaled RMB 320 million, RMB 680 million, and RMB 850 million, respectively, constraining the company's liquidity. The significant amounts in long-term loans and bonds payable (mainly ordinary bonds) have led to relatively high financing costs. CTGR's financial expenses were RMB 2.84 billion, RMB 2.85 billion, and RMB 3.99 billion for 2020, 2021, and 2022, respectively, with notable growth, indicating considerable financial pressure due to high financing costs. Therefore, CTGR aims to optimize its financing structure by issuing carbon-neutral bonds to replace high-interest financing options.

Table 2: Changes in Relevant Accounts for CTGR from 2020 to 2022

Balance Sheet/Income Statement Selected Items	2020	2021	2022
Construction in Progress	31,230,376,778.86	57,504,548,422.58	35,491,271,019.14
R&D Expenses	1,311,935.70	7,419,746.07	14,328,051.07
Financial Expenses	2,844,231,671.23	2,852,703,637.59	3,986,790,887.82
Long-term Loans	49,705,295,524.81	78,185,245,510.74	99,456,430,726.36
Bonds Payable	2,993,129,880.97	5,491,709,027.71	6,634,781,410.85
Notes Payable	1,359,359,301.50	3,015,382,286.14	2,180,219,163.18
Other Payables	3,306,214,931.69	3,633,191,363.72	3,107,243,703.54

On April 20, 2022, the People’s Bank of China authorized the National Interbank Funding Center to announce the Loan Prime Rate (LPR), setting the 1-year LPR at 3.7% and the LPR for terms over 5 years at 4.6%. The coupon rate for “22 Three Gorges New Energy MTN002 (Carbon Neutral Bond)” was set at 2.75%, significantly reducing future interest costs compared to taking out a bank loan at the LPR during the same period. Table 3 summarizes Three Gorges Energy’s bond issuance before 2022. As shown, the interest rate on carbon-neutral bonds is lower than that on regular bonds, with the second issuance of carbon-neutral bonds in 2022 having the lowest coupon rate and the largest issuance amount. Carbon-neutral bonds offer the company lower financing costs and larger issuance sizes. Additionally, the issuance terms of carbon-neutral bonds generally align with the life cycle of green industry projects [32], better meeting the company’s funding needs and supporting its long-term objectives.

Table 3: Three Gorges Energy’s Bond Issuance Before 2022

Bond Abbreviation	Issuance Date	Credit Rating	Issuance Amount	Issuance Term	Coupon Rate
21 Three Gorges New Energy MTN001	March 15, 2021	AAA	RMB 1 billion	3 years	3.6%
21 Three Gorges New Energy ABN001	March 29, 2021	AAA	RMB 1.115 billion	994 days	3.97%
21 Three Gorges New Energy MTN002 (Carbon Neutral Bond)	May 7, 2021	AAA	RMB 1.5 billion	3 years	3.45%
21 Three Gorges New Energy ABN002 (Carbon Neutral Bond)	December 27, 2021	AAA	RMB 885 million	1,057 days	3.48%

5. Analysis of the Financing Effects of Carbon Neutral Bonds

5.1. Market Effect Analysis

Stock price represents a company’s value in the capital market, reflecting investors’ expectations for significant corporate events. This study uses the event study method to calculate the cumulative abnormal return (CAR) over a specific event window, analyzing the stock price effects of Three Gorges Energy’s issuance of green bonds.

First, we define the event date and the event window. In this study, the first issuance announcement date of “22 Three Gorges New Energy MTN001 (Carbon Neutral Bond)”—April 28, 2022—is set as

Day 0. Referring to the event window selection in Pereira et al.'s green bond study, this study also sets the 10 trading days before and after the event [-10,10] as the event window [33]. After verifying that no other events interfered during this period, the estimation window is set to the 100 trading days before the event, denoted as [-110, -11] [34].

Next, we calculate the expected return. The daily closing prices of Three Gorges Energy and the Shanghai A-Share Index are used to calculate the respective returns, as per the following formula:

$$\begin{aligned} R_t &= \frac{P_t - P_{t-1}}{P_{t-1}} \\ R_{mt} &= \frac{P_{mt} - P_{mt-1}}{P_{mt-1}} \end{aligned} \quad (1)$$

where R_t represents the actual return of Three Gorges Energy stock on day t , and R_{mt} represents the actual return of the market index on day t ; P_t and P_{mt} are the closing prices of Three Gorges Energy and the Shanghai A-Share Index, respectively.

Furthermore, to calculate the expected return, this study references the research of Goyal et al. and uses the market model method to estimate the expected return [35]. The formula is as follows, $R_{it} = 0.3268R_{mt} - 0.0005$, which further leads to the abnormal return (AR) and cumulative abnormal return (CAR) data for the event window period, as shown in Figure 1:

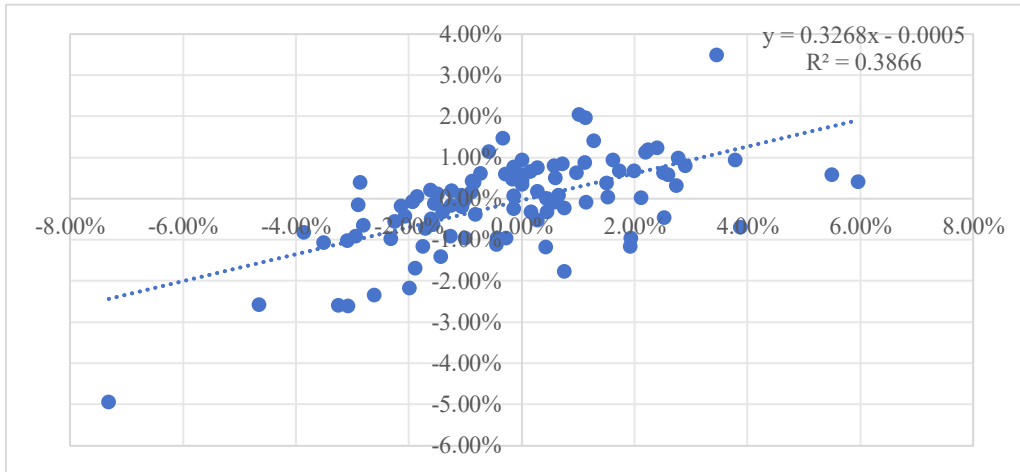


Figure 1: Scatter Plot of Regression Fit

As shown in Figure 2, the cumulative abnormal return (CAR) of Three Gorges Energy fluctuated between -5.11% and -0.03% before the issuance of the green bond. The CAR began to steadily rise from the issuance day, stabilizing above 5% by Day 5. This indicates investors' support and approval of the issuance of "22 Three Gorges New Energy MTN001 (Carbon Neutral Bond)," reflecting a positive attitude in the stock price fluctuations.

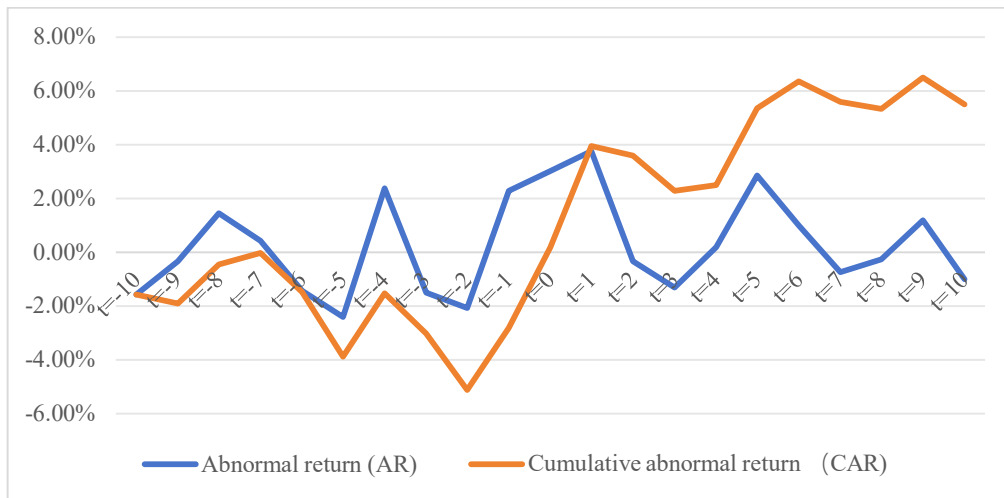


Figure 2: Trend of Abnormal Returns and Cumulative Abnormal Returns

5.2. Financial Effect Analysis

5.2.1. Solvency

From 2021 to June 2024, Three Gorges Energy's current ratios were 0.909, 0.908, 1.016, and 0.940, while the quick ratios were 0.906, 0.903, 1.008, and 0.934, all of which are above the industry average. After the issuance of carbon neutral bonds in 2022, both the current ratio and quick ratio increased, enhancing the company's short-term debt repayment capacity. As a capital-intensive enterprise, the construction and operational cycles of green power projects are long and require substantial investment. With the launch of new projects and increased R&D, the company's funding requirements have risen. After issuing carbon neutral bonds, Three Gorges Energy's debt-to-asset ratio increased from 66.44% in 2022 to 69.84% in June 2024, indicating a rise in the company's debt burden. However, the interest coverage ratio improved from 3.33 in 2021 to 3.56 in June 2024, showing that the company is capable of repaying interest on its debts, ensuring overall debt repayment ability.

5.2.2. Profitability

In recent years, Three Gorges Energy has increased its power generation capacity with new projects coming online, leading to higher power generation and grid connection electricity. After issuing carbon neutral bonds, operating revenue rose from CNY 16.42 billion to CNY 23.81 billion, while net profit increased from CNY 6.086 billion to CNY 8.38 billion. The increased electricity sales and profits after the issuance of carbon neutral bonds have positively impacted the company's profitability. From 2021 to June 2024, Three Gorges Energy's net profit margin declined from 0.393 to 0.321, yet it remains significantly higher than the industry average. Following the issuance of carbon neutral bonds, the return on equity (ROE) slightly increased from 0.099 in 2021 to 0.101 in 2022, surpassing the industry average. Overall, the issuance of green bonds has somewhat enhanced the company's profitability.

5.2.3. Operating Capability

In 2022, the accounts receivable turnover ratio for Three Gorges Energy increased from 0.988 to 1.039, indicating improved management capability over accounts receivable after the issuance of carbon neutral bonds. The company maintains a relatively low inventory level, comprising less than

0.1% of total assets. Once projects are completed and operational, they can quickly convert into revenue, resulting in a high inventory turnover ratio. However, the inventory turnover ratio decreased from 61.28 in 2021 to 41.33 in 2023, indicating a decline in inventory management efficiency, although it remains at a healthy level overall. In 2022, the total asset turnover ratio for Three Gorges Energy increased by 0.01, slightly improving asset utilization efficiency. The operating efficiency indicators over the past three years have remained relatively stable with minimal fluctuations, demonstrating a positive trend in the overall operational capacity of Three Gorges Energy and stable operational efficiency.

Table 4: Relevant Financial Indicators

Main Indicators	2021	2022	2023	First Half of 2024
Current Ratio	0.909166	0.907727	1.015668	0.940105
Industry Average - Current Ratio	0.690616	0.700747	0.709268	—
Quick Ratio	0.905752	0.903014	1.008117	0.933607
Industry Average - Quick Ratio	0.608169	0.629948	0.641454	—
Debt-to-Asset Ratio	0.647346	0.664440	0.693671	0.698443
Interest Coverage Ratio	3.334480	3.274827	3.280151	3.555564
Return on Equity (ROE)	0.098938	0.100950	0.090089	0.049462
Industry Average - Return on Equity (ROE)	-0.0125	0.0193	0.0581	—
Net Profit Margin	0.393061	0.352043	0.312245	0.320811
Industry Average - Net Profit Margin	0.0814	0.1244	0.1537	—
Accounts Receivable Turnover Ratio	0.988364	1.039476	0.835483	0.380672
Inventory Turnover Ratio	61.281401	56.099372	41.329478	18.404975
Total Asset Turnover Ratio	0.086077	0.099005	0.092277	0.046850

5.3. Environmental Effect Analysis

By issuing carbon neutrality bonds, companies can secure dedicated funding for green projects, thereby promoting sustainable development. According to the carbon neutrality bond duration certification assessment report released by China Three Gorges New Energy in April 2024, the “22 Three Gorges New Energy MTN002 (Carbon Neutrality Bond)” has invested in seven new energy generation projects, all of which have been completed. In 2023, these projects are expected to achieve a CO₂ reduction of 1.0441 million tons and save 437,600 tons of standard coal. By issuing carbon neutrality bonds, China Three Gorges New Energy has alleviated its financing pressure, allowing for more funds to be allocated to environmental protection. The 2023 Sustainable Development Report published by China Three Gorges New Energy indicates that the company’s investment in ecological and environmental protection exceeded 227 million yuan in 2023, resulting in an annual standard coal savings of approximately 16.64 million tons, a year-on-year increase of 13%, and a CO₂ reduction of about 42.71 million tons, also reflecting a year-on-year increase of 13%. China Three Gorges New Energy has established a comprehensive and effective environmental protection management system, process, and framework, implementing green production and green operations across the board. The series of energy-saving and emission-reduction achievements by China Three Gorges New Energy fully demonstrate the company’s commitment to serving the “dual carbon” goals and advancing sustainable development.

6. Conclusion and Implications

6.1. Conclusion

This study uses China Three Gorges New Energy as a case study to explore the motivations and effects of carbon neutrality bond financing. The research finds that there are multiple motivations for China Three Gorges New Energy to issue carbon neutrality bonds, including enhancing the company's green reputation to gain stakeholder support, reducing financing costs, and optimizing the financing structure. The issuance of carbon neutrality bonds has brought positive short-term market effects to the company, resulting in favorable financial effects and positive environmental effects.

6.2. Implications

6.2.1. Government Perspective

Firstly, the government needs to further improve the construction of the green finance system by formulating and implementing relevant supporting policies to promote the issuance of carbon neutrality bonds and the implementation of green projects. Local governments should be encouraged to establish incentive systems for green bond issuance, such as green channels, interest subsidies, and tax reductions, to lower the financing costs of carbon neutrality bonds and enhance market participants' confidence in issuing green bonds. Secondly, it is essential to accelerate the improvement of the information disclosure mechanism for green bonds, further standardizing the transparency of information disclosure related to the issuance and use of green bonds, effectively curbing "greenwashing" behaviors by bond issuers. Finally, the government should further expand the capacity of carbon neutrality bonds, optimize the structure of issuers of carbon neutrality bonds, and encourage more private enterprises to participate in the carbon neutrality bond market while exploring other areas that address climate change and have significant carbon reduction benefits. By enhancing the scalability of green financing tools such as carbon neutrality bonds, more large enterprises can be attracted to invest in green projects, thus promoting sustainable economic and social development and a green low-carbon transition.

6.2.2. Media Perspective

From the media's perspective, it is necessary to increase public understanding of carbon neutrality bonds and their environmental benefits, guiding people to pay attention to sustainable development, and actively reporting on the issuance cases of carbon neutrality bonds to provide upstream and downstream clients with a deeper understanding of enterprises.

6.2.3. Corporate Perspective

Firstly, enterprises should actively shift their development mindset and financing methods, improve their credit ratings, and continuously increase the proportion of green financing tools. For green power enterprises with large-scale ongoing projects and high investment demands, carbon neutrality bonds can be used to replace high-cost financing products, thereby optimizing the financing structure and reducing the risk of funding chain disruptions. Secondly, companies need to establish sound issuance and management systems, strengthening the disclosure of environmental information and the use of raised funds, such as environmental benefits, electricity generation from clean energy projects, and emission reduction effects. It is crucial to fulfill green commitments through green investments and technological innovations to enhance the efficiency and environmental benefits of power generation facilities, using green financial tools to support sustainable development goals. Finally, companies need to strengthen internal controls, focusing on the internal governance of

subsidiaries and affiliated companies, and paying attention to corporate reputation and green image. China Three Gorges New Energy must ensure that its subsidiaries and affiliated companies strictly comply with environmental protection regulations during the site selection, construction, and operation of wind farms to prevent ecological damage and environmental pollution incidents.

References

- [1] Caineng, Z. O. U., Xiong, B., Huaqing, X. U. E., Zheng, D., Zhixin, G. E., Ying, W. A. N. G., ... & Songtao, W. U. (2021). *The role of new energy in carbon neutral*. *Petroleum exploration and development*, 48(2), 480-491.
- [2] Zhang, H., Yu, Z., Zhu, C., Yang, R., Yan, B., & Jiang, G. (2023). *Green or not? Environmental challenges from photovoltaic technology*. *Environmental Pollution*, 320, 121066.
- [3] Wang, F., Harindintwali, J. D., Yuan, Z., Wang, M., Wang, F., Li, S., ... & Chen, J. M. (2021). *Technologies and perspectives for achieving carbon neutrality*. *The Innovation*, 2(4).
- [4] Delbeke, J., Runge-Metzger, A., Slingenberg, Y., & Werksman, J. (2019). *The paris agreement*. In *Towards a climate-neutral Europe* (pp. 24-45). Routledge.
- [5] Chen, L., Msigwa, G., Yang, M., Osman, A. I., Fawzy, S., Rooney, D. W., & Yap, P. S. (2022). *Strategies to achieve a carbon neutral society: a review*. *Environmental Chemistry Letters*, 20(4), 2277-2310.
- [6] Black, R., Cullen, K., Fay, B., Hale, T., Lang, J., Mahmood, S., & Smith, S. (2021). *Taking stock: A global assessment of net zero targets*. *Energy & Climate Intelligence Unit and Oxford Net Zero*, 23.
- [7] Wei, Y. M., Chen, K., Kang, J. N., Chen, W., Wang, X. Y., & Zhang, X. (2022). *Policy and management of carbon peaking and carbon neutrality: A literature review*. *Engineering*, 14, 52-63.
- [8] Dai, H., Su, Y., Kuang, L., Liu, J., Gu, D., & Zou, C. (2021). *Contemplation on China's energy-development strategies and initiatives in the context of its carbon neutrality goal*. *Engineering*, 7(12), 1684-1687.
- [9] Shi, X., Zheng, Y., Lei, Y., Xue, W., Yan, G., Liu, X., ... & Wang, J. (2021). *Air quality benefits of achieving carbon neutrality in China*. *Science of the Total Environment*, 795, 148784.
- [10] Zhang, Y. J., & Shi, W. (2023). *Has China's carbon emissions trading (CET) policy improved green investment in carbon-intensive enterprises?*. *Computers & Industrial Engineering*, 180, 109240.
- [11] Wen, S., Jia, Z., & Chen, X. (2022). *Can low-carbon city pilot policies significantly improve carbon emission efficiency? Empirical evidence from China*. *Journal of Cleaner Production*, 346, 131131.
- [12] Lin, B., & Zhang, A. (2023). *Government subsidies, market competition and the TFP of new energy enterprises*. *Renewable energy*, 216, 119090.
- [13] Zhou, X., & Cui, Y. (2019). *Green bonds, corporate performance, and corporate social responsibility*. *Sustainability*, 11(23), 6881.
- [14] Flammer, C. (2021). *Corporate green bonds*. *Journal of financial economics*, 142(2), 499-516.
- [15] Miola, I., Junqueira, G.D., Prol, F.M., Vecchione-Gonçalves, M., Ferrando, T., & Herrera, H. (2021). *Title: Green bonds in the world-ecology: capital, nature and power in the financialized expansion of the forestry industry in Brazil*. *Relaciones Internacionales*, 161-180.
- [16] Bacchiocchi, A., Ille, S., & Giombini, G. (2024). *The effects of a green monetary policy on firms financing cost*. *Journal of Economic Interaction and Coordination*, 1-31.
- [17] Shah, S.B., Sopin, J., Techato, K., & Mudbhari, B.K. (2023). *A Systematic Review on Nexus Between Green Finance and Climate Change: Evidence from China and India*. *International Journal of Energy Economics and Policy*.
- [18] Shi, X., Ma, J., Jiang, A., Wei, S., & Yue, L. (2023). *Green bonds: Green investments or greenwashing?*. *International Review of Financial Analysis*, 90, 102850.
- [19] Suryanti, R., Jahidin, J., & Fadlil, M. (2024). *Artificial Intelligence in Education: Bibliometric and Systematic Literature Review from 2019 – 2024*. *International Education Trend Issues*.
- [20] S Algethami, J., Al-Saidi, H. M., Alosaimi, E. H., A Alnaam, Y., Al-Ahmary, K. M., & Khan, S. (2024). *Recent Advancements in Fluorometric and Colorimetric Detection of Cd²⁺ Using Organic Chemosensors: A Review (2019-2024)*. *Critical reviews in analytical chemistry*, 1–20. Advance online publication.
- [21] Manos, R., & Green, C.J. (2001). *FINANCE AND DEVELOPMENT RESEARCH PROGRAMME WORKING PAPER SERIES*.
- [22] Abdullazade, Z. (2019). *Pecking Order Model of Corporate Financing: Review of Literature*. *ERN: Firms Temporal Investment & Financing Behavior (Topic)*.
- [23] Martinez, L.B., Scherger, V., & Guercio, M.B. (2019). *SMEs capital structure: trade-off or pecking order theory: a systematic review*. *Journal of Small Business and Enterprise Development*.
- [24] Jakšić, P., & Cicmil, D. (2022). *Municipal Bonds as a Way of Financing Local Governments in the Republic of Serbia and Countries of the Region*. *Proceedings of the 27th International Scientific Conference Strategic Management and Decision Support Systems in Strategic Management*.

- [25] Bužinskė, J., & Stankevičienė, J. (2023). *Analysis of Success Factors, Benefits, and Challenges of Issuing Green Bonds in Lithuania*. *Economies*.
- [26] S Algethami, J., Al-Saidi, H. M., Alosaimi, E. H., A Alnaam, Y., Al-Ahmary, K. M., & Khan, S. (2024). *Recent Advancements in Fluorometric and Colorimetric Detection of Cd²⁺ Using Organic Chemosensors: A Review (2019-2024)*. *Critical reviews in analytical chemistry*, 1–20. Advance online publication.
- [27] Chen, X. (2023). *Research on the Application of Blockchain Technology Based on the Credit Mechanism for the Issuance of Green Bonds*.
- [28] Ouyang, H., Guan, C., & Yu, B.R. (2023). *Green finance, natural resources, and economic growth: Theory analysis and empirical research*. *Resources Policy*.
- [29] Noble, B.S., & Carlson, T.N. (2022). *CueAnon: The (not so) Strategic Endorsement of Political Conspiracy Theories*.
- [30] Tuerhong, P. (2023). *Does Green Bond Issuance Help Firms Attract Institutional Investors: Evidence from China*. *Financial Engineering and Risk Management*.
- [31] Xi, B., & Jing, H. (2021). *Research on the impact of green bond issuance on the stock price of listed companies*. *Kybernetes*, 51, 1478-1497.
- [32] Chen, Z., Huang, L., & Wu, N. (2023). *The positive impact of green bond issuance on corporate ESG performance: from the perspective of environmental behavior*. *Applied Economics Letters*, 31, 1247 - 1252.
- [33] Pereira, M., Gomes, L., Maldonado, I., & Pereira, C. (2024). *Impact of green bond issues on Euronext firms' stock abnormal returns*. *Journal of Infrastructure, Policy and Development*.
- [34] Kalainathan, K. (2022). *The Stock market reaction to the Unexpected Events in Sri Lanka*. *Peradeniya Management Review*.
- [35] Goyal, P., & Soni, P. (2023). *The impact of Credit Suisse takeover on Indian banking and financial services sector stocks: an event study analysis*. *Journal of Economic Studies*.