The Effect of Issuing Carbon Neutral bonds in Power Enterprises: a Case Study of Datang International

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Abstract. This study takes "Datang Power Generation GN001" carbon neutral bond issued by Datang International Power Generation Co., Ltd. as an example to discuss the effect of carbon neutral bond issuance. Carbon neutral debt is a green financial instrument that has emerged in recent years to support companies in achieving their carbon neutral goals. By analyzing the specific case of Datang Power Generation, this paper will delve into the process of issuing carbon neutral bonds, the market reaction, and the impact on enterprises and the environment. The findings help to understand the role and potential of carbon-neutral debt as a new form of financing and provide a reference for other businesses and policy-makers. At the same time, this study will also provide empirical evidence for evaluating the actual effects of carbon neutral debt in promoting sustainable development and addressing climate change.

Keywords: Carbon-neutral bonds; Event study method; Carbon finance; Market effect.

1   Introduction

Global climate change is becoming increasingly serious, with rising temperatures and frequent extreme weather events, which have had a huge impact on human society and the ecological environment. The international community is generally aware that mitigating climate change and protecting the environment has become a top priority and more active and effective measures are needed. In order to achieve the two-carbon goal, high-carbon emission enterprises have to carry out low-carbon transformation, but this requires huge financial support[1]. Traditional financing channels may not be able to provide sufficient support[2], so new green debt financing tools have become an important choice for enterprise transformation[3]. As a new financing tool, carbon neutral debt has the advantages of low issuance cost and large amount of capital support, which can provide strong support for enterprises[4]. Since 2021, China has issued a total of 536 carbon neutral bonds, with a total issuance scale of 581.361 billion yuan[1], and as of

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[1] [Insight Research Report: [Shanxi Securities] Carbon neutral from the macro perspective: China's "dual carbon" policy and carbon emissions, green finance status quo]

August 31, 2023, the stock of carbon neutral bonds is 397, with a balance of 318.333 billion yuan, effectively guide funds to invest in the transformation and upgrading of low-carbon industries. In 2022, China's carbon dioxide emissions will reach 10.550 billion tons, accounting for 30.7% of the world's total. Among them, the power industry ranks first in carbon emissions of various industries, accounting for about 40% of the total emissions of the energy industry[5]. Therefore, this paper takes "Datang Power Generation GN001" carbon neutral bond issued by Datang International Power Generation Co., Ltd. as an example to study the effect of carbon neutral bond issuance.

2   The Effect of Carbon Neutral bond Issuance

2.1   Market Effect

2.1.1 Event Study is a Research Method to Test Market Reaction.

Determination of the occurrence date and window period of the event.
The research event of this paper is Datang International issued a carbon-neutral bond named "21 Datang Power Generation GN001". When selecting the research date, the event window period of this paper is set as (-5, 5) with reference to the studies of scholars Luo Aihui[6] and Liang Si 'an et al[7]. From 6 days to 126 days before the event date, a total of 120 days is the estimate window, i.e. (-6, -125).

Calculation of normal and abnormal rates of return.
In order to evaluate the impact of the occurrence of an event on the value of the company, it is necessary to calculate normal income and extraordinary income. Referring to the research of scholars Li Mengyu and Ye Mengfei[8], formula (1) is used to estimate parameters αi and βi in the market model by using the actual return rate of sample companies and the return rate of corresponding market segments in the estimation window (-6, -125). Secondly, formula (2) is used to predict the normal rate of return of the sample company in the event window (-5, 5).
The calculation formula is as follows:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \tag{1}$$

$$R'_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} . \tag{2}$$

Where, R_{it} is the actual return rate of stock i on day t; R_{mt} is the market return rate; R'_{it} is the normal return of stock i on day t; αi and βi are regression coefficients; ε_{it} is a random disturbance term.
The excess rate of return (AR) is used to estimate the impact of an event, that is, the difference between the actual rate of return and the normal rate of return within the event window (-5, 5). The cumulative excess return (CAR) is the sum of the excess return of a stock in the event window (-5, 5). The calculation formula is as follows:

$$AR_{it} = R_{it} - R'_{it} \tag{3}$$

$$CAR_{(-5,5)} = \sum_{-5}^{5} AR_{it} \tag{4}$$

Where, AR_{it} is the excess return of stock i on day t, $CAR_{(-5,5)}$ is the cumulative excess return of stock i in the event window (-5, 5).

Hypothesis testing.
Statistical t test was performed on CAR values to determine whether the results were significant.

2.1.2 The Impact of Issuing Carbon Neutral bonds on Datang International Market Value.

According to the above steps. the excess rate of return (AR) and cumulative excess rate of return (CAR) for 5 days before and after the event can be calculated.

Table 1. Daily AR and CAR in the short-term event window (-5, 5) on the event day.

Event day	Excess rate of return	Cumulative excess return	Event day	Excess rate of return	Cumulative excess return
t=-5	-0.005441215	-0.005441215	t=1	-0.012409585	0.046121024
t=-4	-0.000130541	-0.005571756	t=2	0.036576849	0.082697873
t=-3	0.011758125	0.006186369	t=3	0.00345523	0.086153103
t=-2	0.017908703	0.024095072	t=4	0.015569534	0.101722637
t=-1	-0.005081294	0.019013778	t=5	-0.00650611	0.095216527
t=0	0.039516831	0.058530609			

The data in Table 1 show that in the short-term event window (-5, 5), the cumulative excess return rate is greater than 0 from the third day before the event date, showing a gradual upward trend, and the rise is larger on the day after the event and the second day after the event, indicating that the company is sensitive to the issue of carbon neutral bonds. The announcement of issuing carbon neutral bonds has a significant positive impact on the stock price of listed companies.

Calculate the Excess Return and Cumulative Excess Return of the Control Group.
The control group selected in this paper is Guodian Electric Power, which has the following selection criteria: First, both companies are listed in the Shanghai Stock Exchange of power enterprises; Second, the difference in total assets between the two is small, and the scale is similar. Third, during the event window period, Guodian Power did not issue carbon neutral bonds, and there was no event affecting its stock price. Fourth, both companies' main power generation methods are thermal power generation.

Guodian Electric Power was selected as the control group and the results of the above steps were re-performed as shown in the following table:

Table 2. Daily AR and CAR in Guodian's short-term event window (-5, 5).

Event day	Excess rate of return	Cumulative excess return	Event day	Excess rate of return	Cumulative excess return
t=-5	0.00837556	0.00837556	t=1	0.008079566	0.027094584
t=-4	-0.005785419	0.002590141	t=2	0.013469747	0.040564331
t=-3	0.000716926	0.003307067	t=3	-0.000401246	0.040163085
t=-2	-0.007052352	-0.003745285	t=4	0.00246167	0.042624755
t=-1	-0.00546883	-0.009214115	t=5	-0.009947797	0.032676958
t=0	0.028229133	0.019015018			
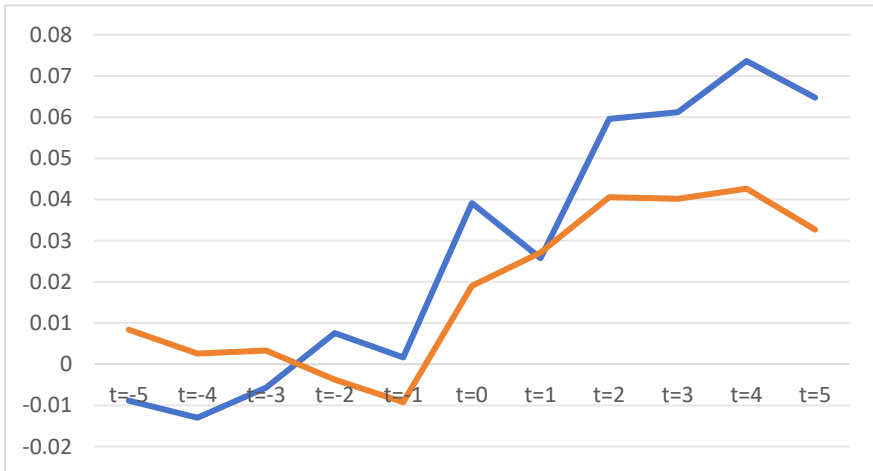
Fig. 1. Cumulative excess rate of return of Datang International and control group.

The data in Table 2 show that in the short-term event window (-5, 5), the cumulative excess return rate of Guodian Power was less than 0 on the second and first days before the event date, and was greater than 0 after the event date and showed a gradual upward trend. As shown in Figure 1, by comparing the trend of cumulative excess rate of return of Datang International Power, it is found that the trend of Datang International Power and Guodian Power is basically the same.This indicates that the stock changes of Datang International are not necessarily due to the issuance of carbon neutral bonds, and the issuance of carbon neutral bonds did not produce big fluctuations on the company, but only had a short negative impact on the company's stock price three days before the event occurred. This indicates that before the announcement of carbon neutral offering, Datang International conducted bond rating and applied for issuance permission, and the information of bond issuance was leaked. It's reflected in stock information in advance.

Significance Test.

t test[2] is carried out on the cumulative excess return of Datang International, and the results are as follows:

Table 3. Results of cumulative excess return T-test.

Window period	Mean	t	p-value	Upper limit of 95% confidence interval	Lower limit of 95% confidence interval
(-3, 3)	0.0370778	5.9265	0.0010	0.0217694	0.0523863
(-5, 5)	0.0277811	2.7849	0.0193	0.0055544	0.0500079

Through t test of single sample data on cumulative excess return and 0, it is tested whether the accumulated excess return is significant. It can be seen from Table 3 that when the window period is (-5, 5), the p value of the cumulative excess return is only 0.0193. Therefore, the cumulative excess return brought by the issuance of carbon neutral bonds in Datang International is significant. Then, when the window period is changed to (-3, 3), the t test of CAR value is carried out, and the P-value is only 0.0010. The result is more significant. The closer the event date is, the more significant the impact is. To sum up, the carbon neutral bond issued by Datang International has an obvious effect on the company's stock price. Different from the effect of ordinary bonds issued by enterprises, it has an obvious positive effect on the stock price.

2.2   Financial Effect

2.2.1 Profitability Analysis.

When evaluating the profitability of enterprises, it is crucial to pay attention to the net profit rate of total assets and the gross operating margin.

Table 4. Net profit rate (%) on total Assets, 2019-2023.

Subject Year	2019	2020	2021	2022	2023
Datang Power	1.06	1.90	-4.02	-0.29	0.99
Guodian Electric Power	1.35	2.16	-0.86	1.67	2.61
Electric power industry	2.73	3.16	0.50	1.95	3.13

Data source: Guotai 'an

According to Table 4, it can be seen that Datang Power Generation's net profit margin on total assets is low, but it has increased in 2019 and 2020, but the net profit margin on total assets has dropped significantly to -4.02% in 2021.Guodian Power and the power industry as a whole have shown a trend of growth from 2019 to 2023. In summary, although Datang Power generation encountered some difficulties in 2021 and 2022, in the context of the entire power industry, the net profit margin of total assets of the enterprise industry in 2023 has recovered. The performance of Guodian power is relatively stable during this period of time, showing a trend of continuous growth.

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[2] Through the software stata16 implementation

Table 5. Gross operating margin of enterprises in 2019-2023.

Subject Year	2019	2020	2021	2022	2023
Datang Power	0.17	0.18	-0.01	0.07	0.12
Guodian Electric Power	0.18	0.21	0.07	0.13	0.15
Electric power industry	0.22	0.24	0.11	0.16	0.21

Data source: Guotai 'an

According to Table 5, Datang Power Generation's gross profit margin on sales increased from 2019 to 2020, however, there was a significant decline in gross profit margin between 2020 and 2021, which means that the operating costs for the year exceeded the operating income, possibly due to rising costs or declining revenue. Overall, the gross profit margin of Datang power generation is lower than that of Guodian Power in all years. This indicates that Guodian Power may have better profitability or cost control ability in the same industry.

2.2.2 Operational Capacity Analysis.

When analyzing the operation capacity of an enterprise, the receivables turnover rate and total assets turnover rate are selected as key indicators by referring to the research of scholars Wang Yibing[9] and He Xuejing[10].

Table 6. Industry receivables turnover rate of enterprises from 2019 to 2023.

Subject Year	2019	2020	2021	2022	2023
Datang Power	6.46	6.31	5.63	6.47	6.24
Guodian Electric Power	8.54	8.55	8.23	9.19	8.21
Electric power industry	7.37	6.51	5.82	5.47	4.74

Data source: Guotai 'an

According to Table 6, from 2019 to 2021, the accounts receivable turnover rate of Datang Power Generation shows a downward trend, from 6.46 to 5.63. During the construction of wind power and photovoltaic power generation projects, Datang Power Generation may face a tight cash flow situation, because a large amount of funds are invested in long-term assets. In the short term, it may not be able to generate enough operating income to cover accounts receivable, which may lead to a decline in accounts receivable turnover. Although the turnover rate of accounts receivable of Datang Power generation and Guodian Power has fluctuated, it has maintained a relatively stable level on the whole, while the turnover rate of the power industry as a whole has shown a downward trend. This may mean that companies in the industry face greater challenges in collection and need to pay attention to the management of receivables and cash flow situation.

Table 7. Total asset turnover of enterprises in the industry from 2019 to 2023.

Subject Year	2019	2020	2021	2022	2023
Datang Power	0.34	0.34	0.35	0.38	0.40
Guodian Electric Power	0.32	0.33	0.42	0.47	0.40
Electric power industry	0.29	0.28	0.31	0.32	0.29

Data source: Guotai 'an

According to Table 7, Datang Power's total asset turnover has fluctuated between 0.34 and 0.40 over the past five years. This shows that Datang Power generation has effectively increased its total asset turnover through investment in wind power and photovoltaic power generation projects, combined with effective capital management and cost control, and has a certain degree of growth trend in the past few years. In summary, Datang Power generation and Guodian Power in the past few years, although the volatility is large, but on the whole have shown a trend of asset turnover growth. Compared with this, the asset turnover ratio of the entire power industry is low, but it also maintains a relatively stable level.

2.2.3 Solvency Analysis.

When analyzing the solvency of enterprises, the current ratio and asset-liability ratio are selected as key indicators by referring to the research of scholars Chen Xiaohong[11] and Zhu Yan[12].

Table 8. Business sector flow ratios 2019-2023.

Subject Year	2019	2020	2021	2022	2023
Datang Power	0.42	0.43	0.48	0.42	0.44
Guodian Electric Power	0.39	0.37	0.42	0.49	0.41
Electric power industry	0.53	0.52	0.57	0.63	0.58

Data source: Guotai 'an

As shown in Table 8, from 2019 to 2023, Datang Power Generation's current ratio fluctuated between 0.42 and 0.48, which was generally stable, indicating that it had certain solvency, but a relatively low value appeared in 2022, which was related to the issuance of more bonds in that year. Like 22 Datang power generation SCP001, 22 Datang power generation SCP002, a total of 20 bonds. The current ratio of Guodian power fluctuates between 0.37 and 0.49, and the fluctuation is relatively large, especially between 2020 and 2021, there is a large increase. On the whole, the current ratio of the power industry fluctuates between 0.52 and 0.63, showing an upward trend year by year, indicating that the solvency of the entire industry is gradually improving.

Table 9. Industrial asset-liability ratio of enterprises in 2019-2023.

Subject Year	2019	2020	2021	2022	2023
Datang Power	0.71	0.67	0.74	0.75	0.71
Guodian Electric Power	0.68	0.67	0.72	0.73	0.74
Electric power industry	0.64	0.62	0.65	0.64	0.65

Data source: Guotai 'an

As shown in Table 9, the asset-liability ratio of the entire power industry is relatively stable, while the asset-liability ratio of Datang Power and Guodian Power fluctuates greatly, showing a certain trend of instability and inconsistency. In 2020, the as-

set-liability ratio of Datang Power is at a low level, but it rises to 0.74 in 2021. The reason is that Datang Power Generation issued its first carbon-neutral bond and a total of 12 other bonds in 2021, raising funds to increase the company's debt, resulting in an increase in its asset-liability ratio and a weakening of its long-term debt repayment ability.

2.3   Environmental Effects

For reference to the CO_2 emission reduction calculation formula obtained by United Equator[3] combined with the "2019 Annual Emission Reduction Project China Regional Power Grid Baseline Emission Factors" published by the Ministry of Ecology and Environment and the energy-saving emission reduction calculation guidelines of green credit projects in the Green Financing Statistical System (2020 edition) of the China Banking and Insurance Regulatory Commission, The details are as follows:

$$CO_2 = \omega_g \times \alpha_i \tag{5}$$

Where: CO_2 : CO_2 emission reduction in the current year, unit: CO_2 / year;

ω_g : Project annual electricity supply, unit: megawatt-hour;

α_i : Co_2 base line emission factor of the regional power grid in the region where the renewable energy generation project is located, in tonnes of CO_2/MWH; According to the UNFCCC Power System Emission Factor Calculation Tool (Version 5.0), for wind power and photovoltaic projects α_i : 75%*EFgrid, OM, y+25%*EFgrid, BM, y).

The current investment projects are wind power generation and photovoltaic power generation projects, the construction of the projects are located in Hebei Province, belonging to the North China regional power grid. The corresponding marginal emission factor (OM) for electricity and marginal emission factor (BM) for capacity are 0.9419tCO2/MWh, 0.4819tCO2/MWh, and the combined marginal emission factor (CM) is 0.8269tCO2/MWh.

In 2022, Datang International Power Generation Co., Ltd. will have a total of 1,459,971MWh of wind power and photovoltaic power generation, and the clean energy power generation projects involved in the raised funds will reduce carbon dioxide emissions by 1.2073 million tons compared with the same thermal power generation; In 2023, the annual online capacity of wind power and photovoltaic power generation will total 1,810,873MWh, and the emission reduction will be 1.4974 million tons of carbon dioxide. The photovoltaic power generation and wind power generation projects invested in the current carbon neutral bond fund do not produce air pollutants in the power generation process compared with thermal power, reduce the emission of pollutants such as SO2, NOx and soot, and save coal resources.

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[3] United Equator Environmental Assessment Co., LTD.]

3   Conclusions

3.1   Advantages of Carbon-Neutral Bonds

From a market effect perspective, carbon neutral bonds offer investors a new investment option that allows them to participate in projects that support environmental and climate change action. At the same time, issuing carbon neutral bonds can enhance the image of enterprises in the field of social responsibility and environmental protection, and attract more attention and support from investors and consumers.

From the perspective of financial effect, carbon neutral bonds provide enterprises with diversified financing channels, reduce financing costs, and reduce the dependence on traditional financing methods. The issuance of carbon neutral bonds provides enterprises with a long-term and stable source of funding, which helps to realize the implementation of sustainable development strategies and projects.

From the perspective of environmental effects, the issuance of carbon neutral bonds will directly use funds to support emission reduction and environmental protection projects, which will help promote the increase of corporate and social investment in environmental protection. Through the issuance of carbon neutral bonds, enterprises can achieve emission reduction targets, reduce the negative impact on the environment, and promote ecological environmental protection and sustainable development.

3.2   Disadvantages of Carbon-Neutral Bonds

In order to achieve the goal of carbon neutrality, enterprises may need to carry out expensive technology upgrades or transformations, which will bring technical risks, affect the normal operation of enterprises, but also increase the cost pressure of enterprises, and these additional expenditures will have an adverse impact on the profitability of enterprises. The construction of wind power and photovoltaic power generation projects by enterprises is a long-term investment, which affects the daily operating capital flow of enterprises, and takes a considerable time to achieve the expected environmental benefits, which also affects the short-term profitability of enterprises. In addition, issuing carbon-neutral bonds means that companies need to take on additional debt, increasing the debt level of enterprises, affecting the solvency and credit rating.

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Reference

1. Jin Zhijun, Zhang Chuan, Wang Xiaofeng, Li Xiang. Thinking on the realization path of carbon neutrality and energy transition in China [J]. Oil & Gas Geology, 2024, 45 (03): 593-599.
2. Nouman Muhammad,Ahmad Ijaz,Siddiqi Muhammad Fahad,Khan Farman Ullah,Fayaz Mohammad,Shah Idrees Ali.Debt maturity structure and firm investment in the financially constrained environment[J].International Journal of Emerging Markets, 2023, 18 (10): 4613-4630.
3. Xiong Chengcheng, Liao Yuan, ZHAO Jiajia. Current situation, problems and Suggestions on the construction of local climate investment and financing policy system under the goal of carbon peaking and carbon neutrality [J]. Environmental Protection, 2019,50(06):26-29.
4. Mustafa Tevfik Kartal,Ugur Korkut Pata,Cosimo Magazzino.Effectiveness of green bonds on carbon neutrality and clean electricity generation: Comprehensive evidence from the leading emitting country by disaggregated level analysis[J].Energy Strategy Reviews,2024,53101374-.
5. Li Xudong, TAN Qingbo, ZHAO Haochen, QIAO Ning, LIU Liwei, TAN Caixia, TAN Zhongfu. Carbon emission factors and decoupling effect of China's power industry under the background of carbon peaking [J]. Power China, 2024, 57 (05): 88-98.
6. Luo Aihui. "21 Huaneng GN001" Carbon neutral Debt Financing Case study [D]. Zhongnan University of Economics and Law,2022.
7. Liang Si-an, Ping Zhong-Qi, Li Shan-min, Duan Jun-shan. Effect of announcement on downward revision of convertible bond conversion price of Listed companies: An empirical study based on China's A-share market [J]. Southern Finance,2022,(12):76-86.
8. Li Mengyu, Ye Mengfei. Research on the effect of market manipulation on stock return deviation: Based on the perspective of event study [J]. Financial Theory and Practice, 2022, (10):81-91.
9. Wang Y B. Study on the effect of carbon neutral debt issued by enterprises [D]. Northeast Agricultural University,2023.
10. He Xuejing, XU Xiaoli, KONG Kejing. Construction of company operation ability level index: Based on empirical research of listed companies in Xinjiang [J]. Journal of Xinjiang University (Philosophy and Social Sciences Edition), 2019,50(06):15-22.
11. Chen Xiaohong. Analysis on the solvency of enterprises [J]. Zhejiang Finance, 2012, (11): 47-48.
12. Zhu Yan. Thoughts on improving the analysis index of corporate solvency [J]. Journal of Finance and Accounting,2010,(26):121-122.