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Climate-Related Information Disclosure in China's Manufacturing Sector: A Case Study of Rainbow Appliance

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Abstract: With the continuous strengthening of global climate governance, corporate climate-related information disclosure has become an important indicator for measuring sustainable development capabilities. This study takes Chengdu Rainbow Appliance as a case to explore the climate information disclosure practice of listed manufacturing companies in the background of the "dual carbon" policy. The study adopts a case study method and uses the data from the company's publicly disclosed reports to conduct a comparative analysis of the changes from 2019 to 2024. The results show that, driven by the national "dual carbon" strategy and green manufacturing policies, Rainbow Appliance has continuously optimized its production processes, significantly reducing unit product energy consumption and greenhouse gas emissions. From 2019 to 2023, the unit product energy consumption decreased from 8.5 kWh to 6.2 kWh, carbon emission reduction increased from 200 tons to 450 tons, and the coverage rate of energy-saving equipment rose from 40% to 90%. In 2024, it is further predicted that the unit energy consumption will be reduced by 27% compared with 2019, the carbon emission reduction will reach 500 tons, and the coverage rate of energy-saving equipment will reach 95%. These achievements indicate that the green transformation of enterprises driven by the synergy of policy and technological innovation has achieved remarkable results, which helps to enhance market competitiveness. The results of this study provide practical reference for manufacturing enterprises to improve their climate information disclosure mechanisms, and also provide a reference basis for policy formulation and enterprise disclosure improvement.

Keywords: Climate information disclosure; Low carbon transformation; ESG performance

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1. Introduction

Climate change has become a pressing global issue, prompting international cooperation through agreements such as the Paris Agreement and accelerating national climate policies. These developments have driven the continuous refinement of corporate climate-related disclosure frameworks. The latest international standards now mandate

that companies disclose climate-related risks and opportunities that are material to investors' decision-making. In fiscal year 2023, 82% of listed companies reported at least one climate-related disclosure aligned with the TCFD framework, indicating the growing global adoption of such international guidelines [1].

Research has consistently shown that carbon disclosure significantly enhances corporate ESG performance, with particularly strong effects in the manufacturing sector [2]. In China, the government's explicit goals of "carbon peaking" by 2030 and "carbon neutrality" by 2060 have further incentivized enterprises to report greenhouse gas emissions and implement emissions reduction strategies [3]. As a major contributor to energy use and carbon emissions, the manufacturing industry is under increasing pressure to demonstrate its climate risk management capabilities and sustainability commitments through systematic and transparent climate-related disclosures [4].

This study adopts a case-based approach, focusing on Chengdu Rainbow Electric (Group) Co., Ltd. — a typical listed manufacturing enterprise — to comprehensively examine its practices and outcomes in climate-related information disclosure. Drawing upon international and domestic disclosure frameworks and the evolving ESG landscape within manufacturing, the study investigates Rainbow Electric's energy conservation measures, emissions reduction efforts, and the comprehensiveness and transparency of its carbon disclosures. Through quantitative analysis of key performance indicators disclosed from 2019 to 2024 — including energy consumption per unit of output, carbon emissions reductions, and energy-efficient equipment adoption rates — this research assesses the company's progress in green transformation and its impact on disclosure quality and sustainability performance.

2. Data and research methods

This study centers on Chengdu Rainbow Electric (Group) Co., Ltd. as a representative case. Publicly available materials — including annual reports, corporate social responsibility reports, and carbon reduction disclosures from 2019 to 2024 — are collected and analyzed to extract climate-related disclosures and relevant quantitative data. The focus is on core indicators such as greenhouse gas emissions, usage of energy-saving technologies, and production-related energy consumption, along with the company's stated strategies and goals for addressing climate change.

To evaluate performance trends, the study conducts year-by-year comparisons of these indicators and assesses the evolution of disclosure quality and environmental outcomes. The study further contextualizes these results through reference to relevant policy frameworks and academic literature. For analytical clarity, key historical data and forward-looking targets are presented in **Table 1**.

Table 1. Core energy conservation and emission reduction indicators of Rainbow Electric (2019–2024)

Year	Energy Consumption per Unit Product (kWh)	Carbon Emission Reduction (t/CO_2)	Energy-Saving Equipment Coverage Rate (%)
2019	8.5	200	40
2023	6.2	450	90
2024	6.2	500	95

3. Results and discussion

3.1. Operational sensitivity to climate variability

Rainbow Electric, a leading manufacturer of flexible household heating appliances, exhibits high operational

sensitivity to winter temperatures. In 2022, an El Niño-driven warm winter led to a sequential decline in quarterly net profits — a downturn that the company attributed in its annual report to "persistently warm climatic conditions." **Figure 1** illustrates a clear inverse relationship between average winter temperatures and heating product sales from 2019 to 2024. Warmer winters consistently correlated with decreased demand for heating appliances, exposing the company's vulnerability to climate fluctuations.

To mitigate such risks, Rainbow Electric has diversified its product portfolio by accelerating R&D and promoting year-round offerings, such as electric mosquito repellents and hand warmers. Nonetheless, the company continues to rely primarily on experiential judgment and lacks advanced scenario analysis and climate forecasting tools. Given the increasing frequency and unpredictability of extreme weather events, it is imperative that enterprises enhance climate scenario-based risk assessments, integrate climate variables into annual business planning, and strengthen operational resilience.

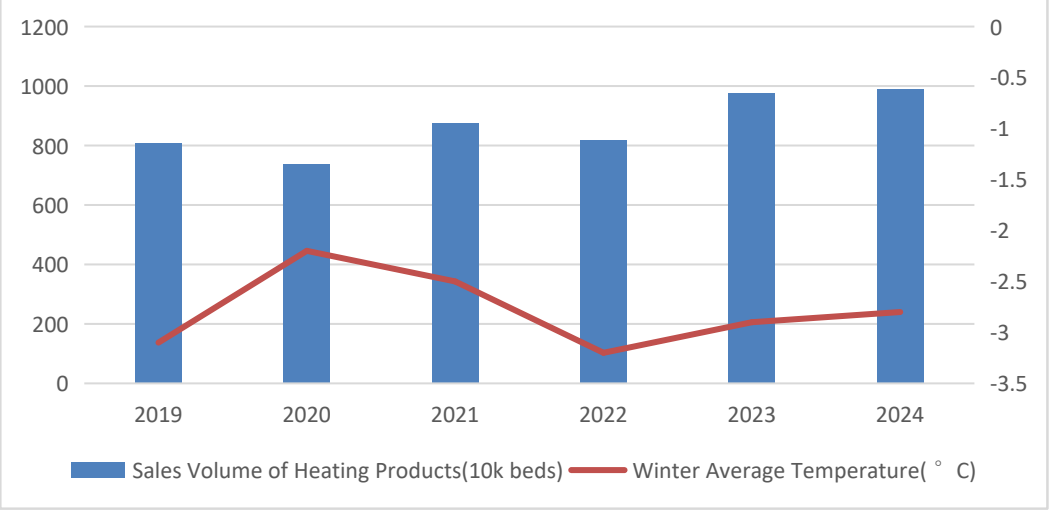

Figure 1. Comparison of winter average temperature and sales volume of Rainbow Electric's heating products (2019–2024)

3.2. Policy-driven adaptation and strategic transformation

On the compliance side, Rainbow Electric strictly adheres to environmental regulations. Through targeted upgrades such as energy-efficient retrofitting of production lines and optimization of operational processes, the company has significantly reduced energy consumption and enhanced resource efficiency. As a result of these measures — and under the guidance of national policies — energy-saving equipment coverage increased from 40% in 2019 to 90% in 2023, with a projected rise to 95% in 2024. The company also achieved ISO 14001 environmental management certification in 2021, signaling maturation in its environmental governance systems. Nevertheless, there remains a need to integrate greenhouse gas management more fully with traditional environmental performance indicators.

In parallel, the company has proactively responded to green manufacturing and sustainable development directives by advancing green supply chain initiatives and reconfiguring its product structure to emphasize low-carbon solutions. These efforts include introducing products with environmentally friendly materials and higher energy efficiency, such as graphene-based electric blankets and smart thermostatic systems, which align with national industrial transformation goals.

As depicted in **Table 1** and **Figure 2**, Rainbow Electric has made notable progress across several key dimensions between 2019 and 2024. Energy consumption per unit of production has declined substantially, while

total carbon emissions reductions have steadily increased. The coverage of energy-saving equipment has expanded rapidly, underscoring the company's sustained investment in energy and emissions management. These outcomes have not only curtailed operational costs but also bolstered the firm's competitive position in an increasingly regulated environmental landscape.

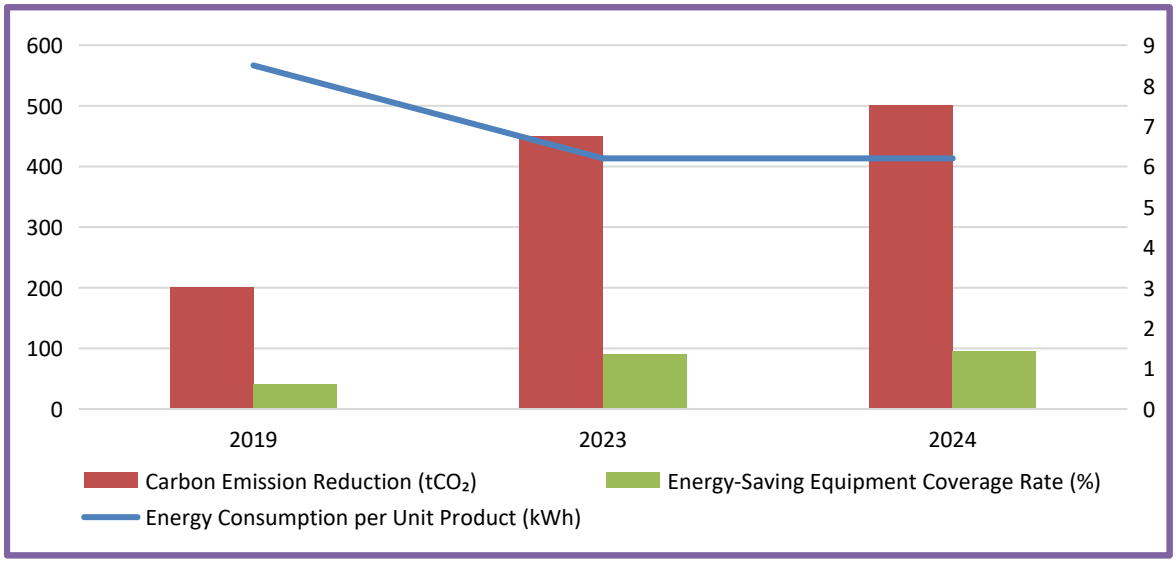

Figure 2. Energy conservation and emission reduction effects of Rainbow Electric: energy consumption per unit product, carbon emission reduction, and energy-saving equipment coverage rate (2019–2024)

In addition to technical improvements, Rainbow Electric has begun embedding a climate strategy into its corporate governance structure. A dedicated addressing climate change task group has been established to oversee sustainability planning, track progress on emissions targets, and ensure that climate-related risks are included in enterprise-wide risk assessments. At the board level, climate performance metrics are being linked to executive evaluation and incentive mechanisms, reflecting a shift from compliance-based to performance-oriented sustainability management.

Moreover, the company has actively participated in local government green pilot programs and industry alliances to gain early insights into regulatory trends and best practices. These engagements have enabled Rainbow Electric to align its disclosure format with emerging standards such as IFRS S2 and to benchmark its climate disclosures against leading domestic peers. This policy-driven transformation, grounded in both internal capacity building and external cooperation, provides a replicable model for other manufacturing enterprises navigating low-carbon transitions.

4. Conclusion

This paper takes Chengdu Rainbow Electrical Appliances as a case study to analyze the practices of manufacturing listed companies in climate-related disclosure and low-carbon transition. Findings show that, driven by dual goals of "carbon peak and carbon neutrality" and environmental policies, Rainbow Electrical has significantly improved energy efficiency and reduced carbon emissions through energy-saving upgrades and green innovation. Specifically, unit product energy consumption decreased by approximately 27% from 2019 to 2024, while carbon reduction volume increased by 150%, and energy-saving equipment coverage reached over 90%. Moreover, the

company has begun integrating climate risk management into its long-term strategy, continuously improving internal governance and disclosure channels. These improvements align with existing research suggesting that climate disclosure enhances corporate ESG performance, indicating that robust disclosure practices can guide green investment and strengthen sustainability image.

Despite these achievements, Rainbow Electric's climate disclosure remains incomplete, such as lacking comprehensive reporting on Scope 1, 2, and 3 emissions and not setting clear carbon reduction targets. To address this, enterprises should refer to international standards (e.g., IFRS S2/TCFD) to refine disclosure frameworks, quantify more climate-related data, and integrate climate factors into business decisions via scenario analysis and forward-looking planning. Regulators should promote unified industry disclosure standards to enhance transparency and comparability, thereby strengthening market discipline. Overall, this case demonstrates significant potential for manufacturing firms in the low-carbon transition and climate disclosure under effective policy guidance and proactive corporate responses. Future research could expand to more industries and samples to test the generalizability of disclosure practices and explore methods to further improve disclosure quality.

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Disclosure statement

The authors declare no conflict of interest.

Author contributions

Yifan Jia, Junxi Tang, and Siyu Tang drafted the manuscript and designed the implementation methodology. Guochao Wan conceived the idea of the study and supervised the overall writing.

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