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A Study on the Accounting Treatment and Countermeasures for Carbon Emission Allowances of Key Emitting Enterprises in Light of Information Disclosure Requirements

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Abstract: Against the backdrop of the "Dual Carbon" goals and the ongoing refinement of the national carbon emissions trading market, carbon emission allowances have gradually become a resource of significant economic value in the production and operations of major emitting enterprises. This paper analyzes the current status of accounting treatment and disclosure of carbon emission allowances for major emitting enterprises by reviewing the *Interim Provisions on Accounting Treatment for Carbon Emission Trading* and using Huaneng International Power Co., Ltd. as a case study. The study finds that current regulations still have shortcomings in areas such as the initial recognition of carbon emission allowances and carbon information disclosure, which may affect the reliability and completeness of financial information. In response, this paper proposes recommendations for improvement in the areas of recognition, measurement, and disclosure of carbon emission allowances to help the carbon emission quota system achieve its full potential.

1. Introduction and Significance of the Study

After the *Kyoto Protocol* officially entered into force in 2005, China, as a developing country, participated in the international carbon market through the Clean Development Mechanism (CDM). During this period, by collaborating with developed countries on energy-saving and emissions-reduction projects, China gained experience in areas such as carbon emissions accounting and project development. In 2011, China began establishing a carbon emissions trading market, launching pilot programs in seven provinces and municipalities—including Beijing, Shanghai, and Guangdong—and gradually developed local carbon markets with Chinese characteristics.

A healthy market environment and sound operation rely on an effective institutional system. To address the accounting issues arising in transactions, the Ministry of Finance of China issued the *Interim Provisions on the Accounting Treatment of Carbon Emissions Trading* [1] in December 2019 (hereinafter referred to as the *Interim Provisions*), which clarifies accounting matters related to carbon emissions rights and provides specific guidelines for relevant enterprises. Since China's research and policy formulation on carbon trading accounting started relatively late, the *Interim Provisions* mainly focus on the accounting treatment of carbon emission allowances for key emission enterprises.

Though imperfect, its provisions are relatively detailed. Nevertheless, the clauses concerning carbon information disclosure are brief; only a statement of changes in carbon emission allowances is stipulated. This statement merely reflects changes in enterprises' carbon emission allowances for the current period from a quantitative perspective and can only provide limited useful information. Therefore, this paper intends to supplement and improve the *Interim Provisions* on the basis of existing rules and practical problems encountered in implementation. It further refines the content of corporate carbon information disclosure, aiming to positively promote the theoretical development of carbon accounting.

Practically speaking, since the signing of the *Paris Agreement*, the low-carbon economic and social transition and green development have reached a consensus. Against this backdrop, sustainable development has become a priority in the capital market, and information users have an increasing demand for ESG information. Therefore, in the course of operation, enterprises should not only strive for sound business performance, create value for stakeholders and ensure their sustainable development, but also pay attention to the two-way impacts between enterprises and the environment and society. Under the standards for sustainability reporting, the impacts exerted by enterprises on the environment and society are referred to as impact materiality. In contrast, the impacts of the environment and society on enterprises are defined as financial materiality. For key emission enterprises, carbon accounting is gaining growing importance in corporate economic development and accounting practices. During production and operation, enterprises shall maximize the utilization of limited resources for green development and reduce environmental pollution through technological upgrades. Meanwhile, in addition to disclosing corporate financial information to the public, it is more critical to disclose non-financial information such as climate and carbon emissions as well as green governance, contributing to balancing economic benefits and social benefits.

2. Literature Review

(1) Accounting Recognition and Measurement of Carbon Emission Rights

Carbon emission rights fall under the theory of emission trading, which originated from the sulfur dioxide emission trading scheme stipulated in the *Clean Air Act* enacted by the United States in 1977. Since then, many developed countries have introduced similar policies for environmental protection, sparking scholarly research on the accounting recognition of emission rights. Internationally, there are three main viewpoints regarding the accounting attribute of carbon emission rights: intangible assets, financial assets and inventory. With the launch of China's national carbon trading market, Chinese scholars have gradually realized that it is inappropriate for pilot enterprises in previous regional carbon markets to recognize carbon emission allowances as inventory, intangible assets or financial assets. Jia Jianjun and Sun Zheng[2]argued that carbon emission rights represent a special property right under government regulation. On this basis, they proposed establishing a separate asset account titled "carbon emission rights", with subsidiary accounts for self-use carbon emission right assets, trading carbon emission right assets and available-for-sale carbon emission right assets. This design prevents enterprises from conducting earnings management through account reclassification.

Regarding the measurement of carbon emission rights, IFRIC 3 *Emission Rights* issued in 2004 required enterprises to recognize acquired carbon emission allowances as intangible assets at fair value, with the difference between consideration and fair value recorded in deferred income. This accounting treatment resulted in an accounting mismatch in the subsequent measurement of related assets and liabilities, so the interpretation was withdrawn after only six months. Nevertheless, this interpretation stimulated scholars to investigate the "asset-liability mismatch problem". Allan Cook[3] proposed that carbon emission allowances should be subsequently measured at fair value, recognizing "carbon emission allowance assets" alongside "carbon emission allowance liabilities". Wang

Aiguo[4]argued that given the imperfect institutional mechanism of China's carbon trading market, carbon emission rights should be measured at historical cost. Jia Jianjun and Sun Zheng[1] suggested adopting corresponding measurement models based on enterprises' purposes of holding carbon emission allowances. First, allowances held for settlement obligations, namely for corporate production and operation, shall be measured at historical cost. Second, allowances held for arbitrage transactions shall be measured at fair value by reference to the accounting rules for financial assets. Third, for allowances with mixed holding purposes or where holding intent changes during operation, the accounting standard for investment property shall be applied.

(2) Regarding the Content of Carbon Disclosure

Carbon information disclosure constitutes an important component of carbon accounting treatment. Bebbington et al.[5]argued that with the establishment and improvement of carbon trading markets, carbon accounting has expanded from simple accounting recognition to cover financial accounting for carbon emission allowances, reporting on responses to global warming risks, carbon assurance and other elements. Since 2011, the National Development and Reform Commission has constructed China's pilot carbon emission trading markets at the institutional level, and domestic scholars have launched research on corporate carbon emission trading information. From the perspective of decision usefulness, Wang Aiguo [4]proposed that carbon accounting information disclosure should consist of macro, meso and micro dimensions, and corporate carbon information should be disclosed from the perspectives of financial accounting, risk management accounting, cost accounting and auditing. Referring to the carbon information disclosure framework defined by five major international organizations and combining the policy orientation of China's low-carbon economy, Chen Hua et al.[6] further held that corporate carbon information disclosure in China should mainly include risks, opportunities and corresponding strategies and policies related to corporate carbon emissions; corporate carbon emission volumes; carbon reduction measures and their performance implemented by enterprises; corporate carbon trading; and carbon information audit and assurance.

Nevertheless, using the combination weighting-TOPSIS method and introducing external evaluation indicators, Teng Xu and Xie Yu[7]evaluated the carbon information disclosure quality of high-carbon emission enterprises. They found that although the disclosure quality of high-emission enterprises has steadily improved compared with previous periods, problems still persist, including uneven disclosure quality, serious greenwashing, low decision-making value and insufficient reliability. These problems stem from China's current voluntary disclosure regime for corporate carbon information. Accordingly, Yao Sheng and Peng Yan[8]suggested establishing a mandatory carbon information disclosure system with both qualitative and quantitative disclosure requirements. Qualitative information covers governance, strategy and risk management; quantitative information includes indicators and targets, representing current data and forward-looking information respectively, so as to enhance data comparability.

(3) Impacts of Carbon Information Disclosure on Enterprises

Carbon information disclosure reflects the concept of corporate accountability. Effective carbon information disclosure can mitigate information asymmetry. While providing information to external parties, it also generates positive feedback for enterprises and strengthens supervision over their green operations. Zhang Daohan and Zhang Xuandong[9]conducted research from the perspective of corporate governance and found that when the CEO serves as the legal representative of an enterprise, emphasis on carbon information disclosure enables the CEO to fully understand the firm's carbon emission level, allocate resources accordingly and advance corporate green transformation. When state-owned equity holds seats on the shareholder board, enterprises can more keenly perceive policies concerning environmental protection and green development, guiding them to formulate strategies more consistent with prevailing policies based on disclosed information and ultimately promoting corporate green innovation.

In addition, diverse groups with demands for carbon information lead to varied impacts of disclosure on enterprises. From the stakeholder theory perspective, corporate social image and reputation exert influences on different stakeholders. Taking reputation as the mediating variable, Xu Lifei et al.[10]discovered that actively disclosing carbon information helps enterprises build a good reputation. Positive reputation further comprehensively improves enterprises' overall competitiveness, eases financing constraints and thereby raises corporate performance.

(4) Research on the Relationship between Accounting Treatment of Carbon Emission Rights and Carbon Information Disclosure

With the development of the national carbon trading market, scholars have gradually realized that the accounting treatment of carbon emission rights and carbon information disclosure are not two independent research fields, but share strong internal connections. A sound theoretical framework for carbon emission right accounting forms the basis of corporate carbon accounting information. Accordingly, the standardization of accounting treatment directly affects the completeness and reliability of carbon information disclosure. Xie Maohua et al.[11]pointed out that the lack of theoretical support for current carbon accounting calculation methods makes it difficult for corporate managers to provide guidance for corporate governance based on definite standards, which further results in enterprises' inactive carbon information disclosure and low disclosure quality. Based on the *Interim Provisions*, Zhang Yan and Yang Xin[12]investigated the current situation of carbon emission right accounting treatment in China and argued that the current provisions still have certain deficiencies in both theory and practice. Further improvement of carbon information disclosure needs to be linked with accounting recognition and measurement.

In summary, scholars at home and abroad have carried out studies on the accounting treatment of carbon emission rights, carbon information disclosure and their economic consequences. The research scope has expanded from the initial accounting measurement to corporate operation and management, and scholars advocate mandatory carbon information disclosure combining qualitative and quantitative approaches. Nevertheless, when considered alongside the development of China's carbon market and the real conditions of key emission enterprises, certain deficiencies remain in existing research. First, existing studies, to some extent, separate carbon emission right accounting from carbon information disclosure. Discussions on disclosure issues mainly focus on disclosure content and forms, while few studies examine defects in current accounting treatment from the perspective of information demand. Second, there is inadequate connection between current accounting practices and high-quality carbon information disclosure; room for improvement remains in the presentation accounts for carbon emission rights and the information disclosed in notes to financial statements. Third, most improvement measures proposed in prior literature focus merely on accounting rules themselves and ignore the industrial characteristics and actual business conditions of key emission enterprises. Therefore, this paper takes key emission enterprises as research objects. On the basis of sorting out the relevant regulations on carbon emission right accounting treatment and carbon information disclosure, it starts from enterprises' actual disclosure practices to analyze the current status of carbon information disclosure among key emission enterprises. Targeted optimization suggestions are put forward from two dimensions: improving carbon accounting methods and raising the quality of carbon information disclosure.

3. Current Status of Accounting Treatment for Carbon Emission Rights of Key Emission Enterprises

The current carbon emission trading mechanisms can be divided into two types: the baseline-and-credit model and the cap-and-trade model[13]. China adopts an allowance allocation system for corporate carbon emission rights, in which free allocation plays the primary role and paid allocation

serves as a supplement. Governments allocate carbon emission allowances free of charge to key emission entities based on factors such as industrial carbon emission benchmarks and enterprises' actual output. Enterprises can use the allowances to cover their own emissions or trade allowances on the national carbon emission trading market to achieve optimal allocation of allowances.

Key emission enterprises refer to enterprises or other economic organizations within the industries covered by the national carbon emission trading market whose annual greenhouse gas emissions reach 26,000 tonnes of carbon dioxide equivalent. At present, four major industries are covered: power generation, iron and steel, cement, and aluminum smelting. Huaneng Power International, Inc. (hereinafter referred to as "Huaneng Power International"), selected in this paper, is one of the representatives of large comprehensive energy enterprises in China. Its main business is dominated by thermal power generation, featuring extremely high carbon emission intensity. It was included in the first batch of industries covered by the national carbon emission trading market in 2021 and serves as one of the key emission entities in the national carbon market, possessing strong research representativeness[14].

From the perspective of overall accounting treatment, the *Interim Provisions* require key emission enterprises to recognize purchased carbon emission allowances as "carbon emission right assets" on the purchase date, measured at historical cost for initial and subsequent measurement. When allowances are used, enterprises debit non-operating expenses. When allowances are sold, the difference between the sales proceeds and the book balance is recorded in non-operating income or non-operating expenses. For carbon emission allowances obtained free of charge, no accounting entries are made upon acquisition or surrender. In terms of financial statement presentation and disclosure, the debit balance of the "carbon emission right asset" account shall be presented under "other current assets" on the balance sheet. Meanwhile, enterprises shall disclose information related to carbon emission trading, specific sources of carbon emission allowances, and changes in allowance holdings.

(1) Initial Recognition of Carbon Emission Rights

For the accounting treatment of production-related carbon emission rights, the *Interim Provisions* require that acquired carbon emission allowances be recognized as carbon emission right assets on the purchase date. The actually paid or payable consideration (including transaction fees and other relevant taxes) is recorded in the "carbon emission right asset" account. The year-end debit balance is presented under the item "other current assets" on the balance sheet.

As disclosed in Huaneng Power International's 2025 ESG report, the company had fully completed allowance settlement and compliance obligations through internal coordination and external purchases by the end of 2025. Taking the Beijing region as an example, grassroots subsidiaries of Huaneng purchased and used 14,164 tonnes of carbon credits in 2025, including 7,089 tonnes from purchased allowances and 7,075 tonnes of carbon inclusive emission reductions. Nevertheless, according to the company's annual report for the same period, neither a separate line item of "carbon emission right asset" nor its presentation within "other current assets" in accordance with the *Interim Provisions* can be found in the balance sheet and relevant notes (see Table 1). Hence, it cannot be verified how Huaneng Power International recognizes carbon emission right assets. Given the ongoing debate over the dual attributes of carbon emission rights for production compliance and market trading, Huaneng Power International faces problems such as inadequate asset recognition and opaque statement presentation in its practical accounting practices.

Table 1 Details of Other Current Assets in Huaneng Power International's 2025 Annual Report
(Unit: Yuan)

Item	Ending balance	Beginning balance
Deductible VAT	4599937848	4593354416
Prepaid income tax	182305221	149538763
Others	585934367	491606789
Total	5368177436	5234499868
Less: Allowance for bad debts	171428451	167096022
Total	5196748985	5067403846

Source: Huaneng Power International 2025 Annual Report

(2) Carbon Emission Right Information Disclosure

Corporate carbon information disclosure aims to provide stakeholders with additional operational and managerial information to facilitate supervision by governments, investors and the general public. The *Interim Provisions* specify a framework and template for the disclosure of carbon emission allowance information, requiring enterprises to present allowance changes in financial reports in tabular form, including the opening balance, additions during the period, reductions during the period and closing balance of carbon emission allowances in both the current year and the prior year, in terms of quantity and amount. Nevertheless, Huaneng Power International has not made such disclosures in its annual reports over the past five years.

In addition, there are two major international standards for carbon information disclosure[4]. The first is the Carbon Disclosure Project (CDP), which requires enterprises to disclose climate-related information covering low-carbon strategies, carbon emission reduction accounting, carbon reduction management and global climate governance, so as to demonstrate the lasting relationship between shareholder value and corporate operations arising from climate change. The second is the Greenhouse Gas (GHG) Protocol. It defines corporate reporting boundaries (direct emissions, indirect emissions from purchased electricity, and other indirect emissions), corporate value chains, product life cycles and other reporting contents, and mandates that carbon information satisfy the requirements of relevance, completeness, consistency, transparency and accuracy. Such information is mostly released separately on corporate official websites via ESG reports.

Drawing on the content and standards of carbon information disclosure, this paper constructs evaluation indicators for the completeness of carbon information disclosure in Huaneng Power International's ESG reports. First, risks related to emission reductions and countermeasures refer to operational risks and financial impacts brought by climate change. Second, carbon trading information reflects the enterprise's participation in the national carbon emission trading market, including the compliance settlement of allowances in the current period and purchased and used national greenhouse gas emission reductions. Third, carbon emission reduction management refers to specific descriptions of technological upgrades invested for carbon reduction, pollution charges, fines and other relevant items. On this basis, this paper reads and analyzes relevant sections in Huaneng Power International's ESG reports from 2021 to 2025 and conducts statistics (see Table 2).

Table 2 Details and Locations of Carbon Information Disclosure in Huaneng Power International's ESG Reports

Disclosure Content	2021	2022	2023	2024	2025
Risks related to emission reduction and countermeasures	×	×	×	5.3.6 Addressing Climate Change (only types and factors of risks disclosed)	5.3.6 Addressing Climate Change (including risk types, impacts on business models, impacts on strategic decisions, current and expected financial impacts)
Carbon trading information	5.3.4.2 GHG Management – "Participation in the national carbon emission trading market" (text description only: the company actively participated in the national carbon market in the current year and completed allowance settlement and compliance on schedule)			5.3.4.2 GHG Management – "Participation in the national carbon emission trading market" (first disclosure that its subsidiaries purchased 170,000 tonnes of emission reductions via the trading platform for allowance settlement and compliance in 2023)	5.3.6.4 Indicators and Targets – "Participation in the national carbon emission trading market"
Carbon emission reduction management (technologies and related expenses)	×	×	×	×	×

Source: Huaneng Power International ESG Reports

Overall, Huaneng Power International's carbon information disclosure shows a trend of gradual improvement and comprehensiveness. Nevertheless, its disclosures are still dominated by qualitative descriptions and macro-level information, while quantitative information remains relatively insufficient. Specifically, regarding the disclosure of emission-reduction-related risks and countermeasures, Huaneng Power International only described climate change risks and contributing factors in 2024. It was not until the following year that the company supplemented the impacts of climate change on operation and management as well as current financial expenditures caused by climate change. As for the disclosure of "countermeasures" and "carbon emission reduction management", the enterprise only provided energy-saving measures concerning "management, structure, institutional standard development and project construction". It merely emphasized that it would "actively comply with relevant national policies", with minimal disclosure of technological upgrades and expense outlays. This makes it difficult for stakeholders to fully evaluate the enterprise's actual emission reduction performance. In terms of carbon trading information, although Huaneng Power International has started to disclose the total amount of carbon emission allowances purchased by its grassroots subsidiaries in the current period, detailed information on allowance

allocation is still undisclosed. In summary, although Huaneng Power International's ESG report has established a basic carbon information disclosure framework, several shortcomings persist: insufficiently detailed disclosure content, inadequate quantitative information, and a lack of continuity and comparability for part of the disclosed information.

To sum up, from the perspective of financial report disclosure, as a key emission enterprise in the national carbon market, Huaneng Power International's production and operation activities are strongly correlated with carbon emission rights. However, the "carbon emission right asset" item is not separately presented in its financial statements, nor is there a clear explanation of whether such assets are included in "other current assets". This prevents information users from judging the enterprise's actual recognition and measurement of carbon emission allowances. It indicates that the ambiguity in the current initial recognition rules for carbon emission rights prevents enterprises from fully disclosing allowance-related information. In addition, the statement of changes in carbon emission allowances required by the *Interim Provisions* has not been disclosed in the annual reports for the past five years, impairing the transparency and completeness of accounting information related to carbon emission rights. In its ESG reports, Huaneng Power International devotes a large proportion of disclosure to environmental performance such as the characteristics of the enterprise's participation in emission reduction mechanisms and carbon emission strategies. However, the quantification level of items such as "specific sources of allowances" and "investment in energy conservation and emission reduction" still needs to be improved. It can be seen that carbon information disclosed in financial reports and ESG reports is somewhat fragmented with different disclosure priorities. Consequently, stakeholders cannot comprehensively understand the economic value of carbon emission rights, compliance status and carbon emission reduction outcomes of Huaneng Power International from both financial and non-financial dimensions, which reduces the decision usefulness of corporate carbon information disclosure to a certain extent.

The case of Huaneng Power International reveals that accounting issues of carbon emission rights for key emission enterprises are not merely confined to account setting or bookkeeping practices. Such issues will further undermine the completeness of carbon information disclosure. Therefore, it is necessary to further improve the information disclosure mechanism for carbon emission rights of key emission enterprises and promote information coordination and connection between financial reports and ESG reports.

4. Improvement Suggestions and Reflections

Based on the above research on carbon information disclosure of Huaneng Power International, it can be found that key emission enterprises currently have problems including inadequate, discontinuous and untimely carbon information disclosure. These issues arise because carbon accounting methods and carbon information disclosure lack effective support from carbon accounting theories. First, with regard to carbon accounting methods. Although the *Interim Provisions* provide references and approaches for carbon accounting implementation, they essentially simplify accounting treatment. With the development of the national carbon market, more industries besides key emission enterprises have gradually participated in it[14], such as carbon asset management companies and financial institutions. Therefore, recognizing carbon emission allowances as "carbon emission right assets" under the historical cost method cannot sufficiently reflect the authenticity of their market value. Second, the lack of a unified carbon information disclosure system results in uneven quality of carbon information disclosure. Meanwhile, enterprises inevitably take social impacts and national supervision into account when disclosing information. To some extent, the investment in carbon emission reduction cannot bring corresponding returns. To avoid possible administrative penalties and attract investment, enterprises selectively disclose carbon accounting

information so as to build a sound corporate brand image.

Considering the above analysis, the following suggestions are put forward to improve the accounting treatment of carbon emission rights for key emission enterprises:

(1) Strengthen Theoretical Research on Carbon Accounting Methods

The absence of unified carbon accounting methods leads to inconsistent carbon information disclosure and impairs information comparability. Therefore, it is necessary to strengthen theoretical research on carbon accounting measurement based on current practical conditions. Given the dual attributes of carbon emission allowances for compliance performance and market trading, as well as the reliable availability of fair value in the operational national carbon trading market, a dual measurement mechanism similar to that for investment real estate can be established[16]. Key emission enterprises may choose either historical cost measurement or fair value measurement for carbon emission allowances. Once the measurement model is determined, it shall be applied consistently to all carbon allowances and shall not be changed arbitrarily. Under the fair value model, asset values are adjusted according to market fluctuations and recognized through fair value gain or loss. Under the historical cost model, asset impairment provisions are accrued to objectively reflect the year-end value of carbon emission right assets.

(2) Standardize the Carbon Information Disclosure System

In accordance with China's institutional context, a phased mandatory carbon information disclosure system should be implemented to enhance corporate social responsibility and information transparency[8]. First, laws and regulations should explicitly require listed enterprises participating in carbon trading, especially key emission enterprises, to disclose current-period carbon information publicly on unified disclosure platforms within standardized time limits, formats and scopes[15]. Second, current corporate carbon disclosures focus excessively on qualitative descriptions of strategy and risk management[17]. To enable information users to better evaluate actual emission reduction outcomes, mandatory disclosure requirements should mandate quantitative disclosure of expected future emission reductions and corresponding cost inputs, thereby improving the completeness and understandability of carbon information.

(3) Improve the Supervision Mechanism for Carbon Information Disclosure

To accelerate the achievement of the "dual carbon" goals and promote corporate green transformation, environmental authorities should conduct regular on-site inspections of key emission enterprises to ensure the authenticity of carbon information disclosure. Specialized carbon audit departments should be established to verify carbon accounting treatments and carbon trading information, so as to mitigate information omission and selective disclosure behavior. Furthermore, regulatory evaluation results should be incorporated into corporate performance assessment. Enterprises with high-quality carbon disclosure may be rewarded with preferential taxation policies, investment incentives and financial subsidies for energy conservation and emission reduction, so as to improve disclosure initiative. In contrast, enterprises with poor disclosure quality should face administrative penalties, public warnings and other restrictive measures to constrain non-compliant disclosure behavior from both economic and social perspectives.

5. Conclusion

Taking the accounting treatment of carbon emission allowances as the starting point, this paper adopts the cap-and-trade carbon emission trading mechanism and the relevant accounting requirements stipulated in the *Interim Provisions*. Combined with the case study of Huaneng Power International, it systematically analyzes the current status of carbon information disclosure among key emission enterprises and puts forward targeted optimization suggestions based on practical implementation conditions. The main conclusions of this paper are as follows: (1) Regarding carbon

emission right accounting treatment, existing deficiencies in the *Interim Provisions* should be summarized in accordance with current practical conditions, so as to clarify the specific financial statement items for carbon emission right presentation. (2) In terms of carbon information disclosure, mandatory disclosure mechanisms should be implemented to require enterprises to disclose more quantitative information concerning emission reduction achievements and corresponding financial impacts. (3) Under the background of the low-carbon economy, relevant regulatory authorities shall strengthen the supervision and governance of corporate carbon emissions. A clear reward and punishment mechanism should be established to effectively motivate enterprises to improve their awareness and initiative of carbon information disclosure.

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