

A Study on the Development of a Carbon Accounting Disclosure Framework for the Coal Industry Under the TCFD

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Abstract: Against the backdrop of the ongoing advancement of the “dual carbon” goals and the continuous refinement of international sustainable disclosure standards, the coal industry—as a typical high-carbon sector—is facing multiple challenges, including emission reduction constraints, pressure to transition, and revaluation by capital markets. Carbon accounting disclosure is no longer merely an expression of environmental responsibility but is gradually becoming a critical information mechanism linking corporate governance, strategic decision-making, risk management, and the identification of financial impacts. The TCFD framework, centered on the four pillars of governance, strategy, risk management, and metrics and targets, provides a relatively mature international paradigm for corporate climate-related financial disclosure. However, its application in the coal industry still faces issues such as fragmented disclosure content, insufficient quantification, inadequate disclosure of financial impacts, weak connectivity between reports, and insufficient assurance support. Given the coal industry’s characteristics of high emissions, high sunk costs, and long-term investment cycles, this paper, based on a review of relevant research and practical realities, proposes that the carbon accounting disclosure system for the coal industry should be structured around seven key areas: governance mechanisms, strategic responses, risk management, metrics and targets, financial impacts, connectivity, and assurance support. Furthermore, it outlines an implementation pathway that combines phased implementation with data governance and external oversight. The study argues that carbon disclosure in the coal industry should shift from “compliance-oriented disclosure” to “decision-useful disclosure.” By enhancing disclosure quality through standardization, quantification, forward-looking perspectives, and verifiability, this approach will support corporate low-carbon transitions and regulatory governance.

Keywords: Carbon Accounting Disclosure; Coal Industry; TCFD; Financial Impacts; Connectivity; Assurance Support

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1. Introduction

Since the introduction of the “dual carbon” goals, climate governance has ceased to be merely an issue within the ecological and environmental sector and has gradually become a critical financial topic influencing corporate strategy, investment, financing, and risk management. For the coal industry, while it continues to play a vital role in ensuring energy supply and security in the short term, stricter carbon constraints, the expansion of green finance, and the deepening of ESG investing are placing coal enterprises under increasing pressure to transform in the medium to long term. Coal enterprises must not only address traditional operational challenges such as costs, efficiency, and market competition but also meet low-carbon

requirements from policymakers, capital markets, and the public. Under these circumstances, whether a company can clearly disclose its carbon emissions, emission reduction targets, transition pathways, and their impact on financial results is no longer merely a technical issue of information disclosure; rather, it is a critical institutional arrangement that determines whether the company can successfully complete its transition.

In reality, while coal companies have begun disclosing some carbon-related information, the overall disclosure remains fragmented, with inconsistent formats, insufficient depth, and incomplete logical frameworks^[1]. Some companies include relevant content in their annual reports, others in their ESG reports, and still others merely use general language to describe “continuing to advance green transformation” or “strengthening energy conservation and emissions reduction.” However, there is little content that truly reflects financial impacts, risk transmission, and future planning. This indicates that carbon information disclosure in the coal industry currently remains at the stage of “disclosure for the sake of disclosure,” with a significant gap remaining before reaching “useful disclosure.”

The TCFD framework offers a highly instructive approach. It does not view climate-related information merely as a statement of environmental responsibility, but rather integrates it into the overall structure of corporate governance, strategic planning, risk management, and performance evaluation. For the coal industry, this approach is particularly important, as carbon-related issues for coal enterprises often involve asset revaluation, impairment risks, financing constraints, restructuring of capital expenditures, and adjustments to long-term business models. Only by integrating carbon information with financial information can disclosures truly provide decision-making value. Based on this, this paper attempts to answer three questions: First, what are the main shortcomings in carbon accounting disclosures in the coal industry? Second, how can a disclosure system suitable for the coal industry be constructed based on the TCFD framework? Third, how can this system be implemented in corporate governance and external regulation?

2. Literature Review and Theoretical Foundation

2.1 Review of Relevant Research

Existing research has demonstrated that carbon accounting disclosure is not merely an environmental information issue, but rather a critical mechanism closely linked to corporate value, financing costs, green innovation, and risk management^[2]. Current studies primarily focus on three areas: disclosure quality assessment, influencing factors, and economic consequences^[3]. On the one hand, researchers are increasingly recognizing that the quality of carbon disclosure should not be judged solely by whether disclosure occurs, but also by whether the disclosed content is comprehensive, the data is quantified, and the information is comparable and forward-looking; On the other hand, factors such as firm size, governance structure, political connections, external regulatory pressure, and media attention also influence the level of corporate carbon disclosure. Overall, domestic research has laid the groundwork for improving carbon disclosure systems and enhancing disclosure quality, but most studies focus on general listed companies or the macro-institutional level, and targeted research on the coal industry—a typical high-carbon sector—remains insufficient.

At the same time, recent sustainability disclosure frameworks such as the TCFD, IFRS S1/S2, and TNFD indicate that international disclosure standards are shifting from “whether to disclose” to “what to disclose, how to disclose, and how to demonstrate the credibility of disclosures”^[4]. This indicates that future carbon disclosure is not merely a matter of quantity, but also one of structure, logic, and verification. For the coal industry, simply disclosing emissions data is no longer sufficient; it must also disclose climate risks, transition strategies, and financial impacts. In other words, the shift in carbon disclosure from “describing environmental matters” to “expressing financial consequences” has become a clear trend^[5].

2.2 Theoretical Foundation

This paper primarily draws upon stakeholder theory, information transmission theory, and legitimacy theory^[6].

First, stakeholder theory posits that enterprises should respond to the information needs of diverse stakeholders, including governments, investors, creditors, employees, and the general public. If coal enterprises can systematically disclose carbon accounting information, this will not only help meet regulatory requirements but also enhance external trust. For high-carbon industries, stakeholders are particularly concerned with whether enterprises genuinely recognize the pressure of low-carbon transition, have adopted practical emission reduction measures, and have incorporated relevant risks into their business

decisions.

Second, the information transmission theory emphasizes that high-quality disclosure can alleviate information asymmetry. The coal industry faces significant uncertainty regarding climate risks; if companies do not proactively disclose relevant information, external stakeholders can only speculate about their actual risks based on limited data, which in turn affects valuation and financing. Conversely, if companies can reduce uncertainty through standardized, consistent, and comparable disclosures, they can to some extent mitigate the overestimation of their risks by capital markets.

Third, the legitimacy theory posits that companies in high-carbon industries need to seek external recognition by disclosing their emission reduction practices, governance mechanisms, and transition pathways. Coal enterprises often face intense social scrutiny during the low-carbon transition; carbon disclosure is not merely about transparency but also serves as a means to restore legitimacy and reshape corporate value. Particularly in the context of green transition, the more transparent the disclosure, the clearer the pathway, and the more verifiable the actions, the easier it is for companies to gain understanding from society and the market.

3. Practical Challenges in Carbon Accounting Disclosure in the Coal Industry

3.1 Dispersed Disclosure Content and Lack of a Unified Framework

Currently, carbon-related information from coal enterprises is scattered across various platforms such as annual reports, ESG reports, and corporate social responsibility reports, lacking a unified framework to integrate them. There is often no intrinsic linkage between governance, strategy, risk management, and performance metrics, resulting in disclosures that appear voluminous but lack logical coherence and clear structure. Some enterprises list energy-saving and emission-reduction measures but fail to explain how these measures relate to their long-term strategies; others disclose emission data without specifying the corresponding accounting boundaries or management criteria. Consequently, external users find it difficult to form a comprehensive assessment^[7].

3.2 Overemphasis on Qualitative over Quantitative Information, with Insufficient Disclosure of Financial Impacts

Most companies state that they are “actively promoting green transformation” or “continuously strengthening energy conservation and emissions reduction,” but rarely provide further details on total emissions, emissions intensity, carbon costs, the achievement rate of emission reduction targets, or the impact of climate-related matters on asset impairment, cash flow, and capital expenditures. As a result, while carbon disclosures exist, their informational value is limited, making it difficult for them to influence financial decision-making. For investors, creditors, and regulators, what truly matters is not whether a company has made such declarations, but whether these climate-related matters have already impacted the company’s future profitability, asset security, and financing stability.

3.3 Weak Connectivity Between Reports

Annual reports, ESG reports, and notes to financial statements often speak at cross-purposes: management discussions address transformation, ESG reports focus on emissions reductions, yet the notes to financial statements fail to reflect the corresponding financial impacts. Disclosures lacking such connectivity make it difficult for external readers to assess whether a company’s commitments are genuine, its strategies are being implemented, and its costs are under control. A direct consequence of this lack of connectivity is that a company’s low-carbon narrative cannot be translated into verifiable financial logic, thereby undermining the credibility of the disclosures.

3.4 Insufficient Assurance Support and Weak Data Foundation

Carbon data in the coal industry is highly technical and involves complex metrics. Without third-party verification, selective disclosure and “greenwashing” are likely to occur. At the same time, many companies have not established unified mechanisms for collecting, calculating, and aggregating carbon data internally, resulting in fragmented data sources, inconsistent metrics, and insufficient comparability. In other words, the challenges of carbon disclosure in the coal industry extend beyond “what to report” to encompass “how to calculate, who verifies, and how to ensure consistency.” Without a solid data foundation, even the best disclosure frameworks will struggle to be effectively implemented.

Table 1: Major Issues and Practical Manifestations of Carbon Accounting Disclosure in the Coal Industry

Issues	Specific Manifestations	Impact
Fragmented Disclosure	Annual reports, ESG reports, and social responsibility reports operate independently	Information is fragmented and lacks a cohesive narrative
Insufficient quantitative information	Primarily consists of general statements, lacking data on emission intensity, carbon costs, etc.	Difficulty in evaluating emissions reduction performance
Weak disclosure of financial impacts	Insufficient disclosure regarding the impact on asset impairment, cash flow, and capital expenditures	Cannot support investment decisions
Poor report connectivity	Lack of consistency and alignment between different reports	Reduced credibility of information
Insufficient assurance support	Lack of third-party verification and standardized accounting criteria	Increased risk of greenwashing

4. Establishing a Carbon Accounting Disclosure System for the Coal Industry Under the TCFD Framework

4.1 Development Approach

The carbon accounting disclosure system for the coal industry should not simply replicate international frameworks but should be localized to reflect industry-specific characteristics^[8]. This paper argues that the system should adhere to five principles: First, relevance—disclosure content must be relevant to the actual carbon risks and transition pressures faced by coal enterprises; Second, industry suitability—it must reflect the characteristics of high emissions, high sunk costs, and long-term investment cycles; third, forward-looking perspective—disclosures should not be limited to historical emissions but should also include future strategies and scenario analyses; fourth, comparability—accounting boundaries, metric definitions, and disclosure formats should be standardized as much as possible; and fifth, verifiability—disclosed information must be verifiable by third parties to avoid vague statements.

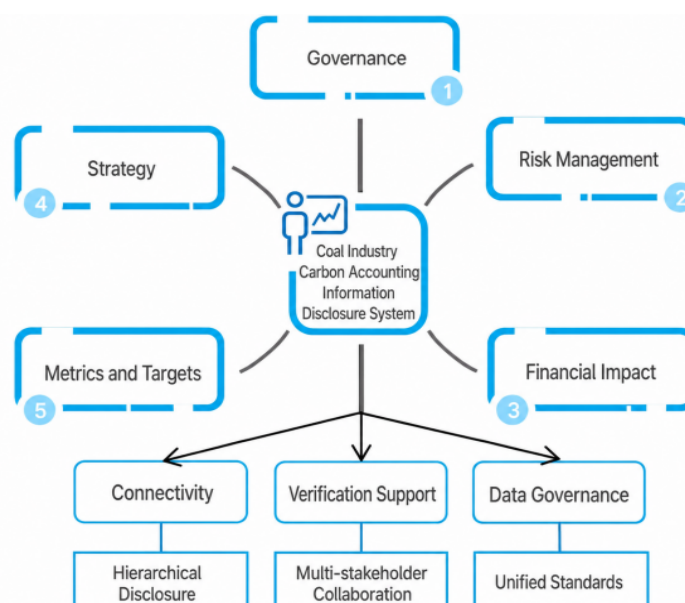
From a framework perspective, the four pillars proposed by the TCFD—“Governance, Strategy, Risk Management, and Metrics and Targets”—actually provide a relatively comprehensive pathway for carbon disclosure in the coal industry. Governance addresses “who is responsible,” strategy addresses “how to transition,” risk management addresses “how to respond,” and metrics and targets address “how to measure effectiveness.” If these four levels are linked together, carbon disclosure by coal enterprises will no longer be a mere accumulation of scattered information, but rather a systematic framework with inherent logic.

4.2 Application of the Four Pillars to the Coal Industry

In the governance dimension, coal enterprises should disclose the division of responsibilities between the board of directors and management regarding climate matters, whether a dedicated committee has been established, and whether climate issues are incorporated into performance evaluations. The core of governance information lies not in “whether it is written down,” but in “whether it is truly integrated into the decision-making system.” If climate matters remain merely at the level of statements without being embedded in the organizational structure and chain of responsibility, then such disclosures will struggle to hold substantive meaning.

From a strategic perspective, companies should focus on disclosing the impact of carbon constraints on business models, capital expenditures, asset values, and revenue structures—particularly regarding coal mine closures, clean production upgrades, new energy deployment, scenario analysis, and stranded asset risks. For coal enterprises, strategic disclosures must address a critical question: how will the company maintain long-term profitability during the low-carbon transition? In other words, strategic disclosures should not merely articulate a “transition vision,” but must also outline the “transition pathway” and the “logic of resource allocation.”

Figure 1: Framework for Building a Carbon Accounting Disclosure System for the Coal Industry Under the TCFD



In the risk management dimension, in addition to traditional physical risks, greater attention must be paid to transition risks, including rising carbon prices, tightening policies, technological substitution, declining demand, and reputational pressures. Coal enterprises should explain how these risks are identified, assessed, and incorporated into the overall risk management framework. Particularly for capital-intensive industries like coal, transition risks often entail asset impairments, extended payback periods, and business model restructuring, which must be fully reflected in disclosures.

In terms of metrics and targets, companies should begin with indicators such as total emissions, emissions intensity, carbon costs, carbon allowances, low-carbon investments, and emission reduction target achievement rates, and gradually expand to Scope 1, Scope 2, and even Scope 3 emissions. The key to metric disclosure lies not in simply compiling data, but in using data to demonstrate the effectiveness of the transition. If a company only discloses static data without explaining its targets, pathways, and progress toward achieving them, the metrics lose their managerial significance.

4.3 Three Dimensions of Enhancement

4.3.1 Financial Impact: Translating Climate Information into Financial Language

Carbon disclosure in the coal industry must not remain confined to environmental descriptions; it should be reflected as much as possible in financial statements and notes. For example: Do changes in climate policy affect asset impairment tests? Does rising carbon cost impact future cash flows? Does the transition alter judgments regarding the useful life and residual value of fixed assets? These are questions coal enterprises must address head-on. Only by translating climate-related matters into financial impacts can disclosure truly hold decision-making value. The significance of disclosing financial impacts lies in its ability to transform climate risks from “external environmental changes” into “consequences for business operations,” thereby making them easier for capital markets to understand and price.

4.3.2 Coherence: Ensuring Different Reports Tell the Same Story

Connectivity is not mere repetition, but rather the establishment of logical consistency across different reports. Annual reports outline strategy, ESG reports detail actions, and notes to the financial statements explain financial consequences—these three levels must corroborate one another. Only then can external readers connect “transition commitments” with “accounting figures” and truly understand the company’s low-carbon path. The key to building connectivity lies in shifting from “disclosure across separate reports” to “disclosure under a unified logic,” using the same set of underlying facts to support multiple reporting formats, thereby enhancing information integration and readability.

4.3.3 Assurance Support: Ensuring Disclosures Are Credible, Verifiable, and Traceable

Carbon disclosures without verification often have limited credibility. Coal enterprises should gradually establish third-party verification mechanisms to validate key carbon emission data, emission reduction targets, carbon costs, and scenario analyses.

For listed companies, incorporating climate-related matters into key audit matters can also be considered, thereby linking assurance support with audit oversight. The significance of verification mechanisms lies not merely in proving “whether there is fraud,” but more importantly in compelling enterprises to improve data management standards and driving the transformation of carbon information from “management language” into “public language.”

Table 2: Specific Content of the TCFD’s Four Pillars in Carbon Accounting Disclosures for the Coal Industry

TCFD Pillar	Key Disclosure Areas for the Coal Industry	Example Content
Governance	Board oversight, management responsibilities, and performance evaluation mechanisms	Whether a dedicated carbon management unit has been established
Strategy	Transition Pathways, Scenario Analysis, and Risks of Stranded Assets	Coal Mine Phase-Out Plans, New Energy Deployment
Risk Management	Identification, Assessment, and Mitigation of Physical and Transition Risks	Impact of rising carbon prices and tightening policies
Indicators and Targets	Total Emissions, Emission Intensity, Carbon Costs, and Emission Reduction Progress	Scope 1 and Scope 2 Emissions

5. Implementation Pathways for Carbon Accounting Disclosure in the Coal Industry

5.1 Strengthening the Foundation of Data Governance

Coal enterprises must first establish a unified mechanism for carbon data collection, calculation, verification, and aggregation, integrating environmental protection, production, and financial systems to avoid data fragmentation and inconsistent definitions. Without a unified data foundation, disclosure will remain merely a slogan. Data governance is not only a technical issue but also a management issue. Only by incorporating carbon data into daily operational management processes can enterprises ensure that disclosures are consistent, accurate, and traceable^[9].

5.2 Promoting Tiered Disclosure

Given the varying scales, governance capabilities, and data foundations of coal enterprises, a tiered implementation approach is recommended. Basic-level enterprises should first disclose total emissions, governance structures, and key emission reduction actions; intermediate-level enterprises should add emission intensity, carbon costs, carbon allowances, and emission reduction targets; while advanced-level enterprises should further disclose scenario analysis, Scope 3 emissions, and third-party verification results. A tiered approach not only reduces implementation costs but also better aligns with industry realities. For large and medium-sized listed coal companies, disclosure efforts can begin with indicators that are more strictly mandated and highly quantifiable, and then gradually expand to more complex forward-looking disclosures.

Table 3: Tiered Implementation Pathway for Carbon Accounting Disclosure in the Coal Industry

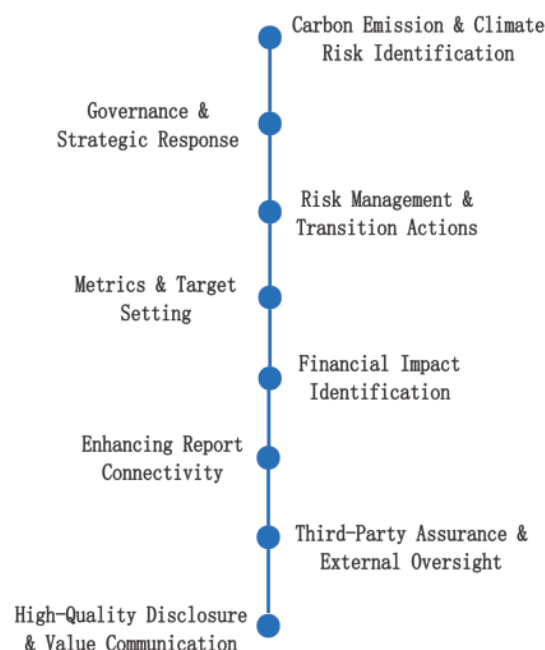
Tier	Disclosure Content	Applicable Companies	Objective
Basic Level	Total emissions, governance structure, emission reduction actions	Companies with a weak data foundation	Basic Disclosure
Advanced	Emissions intensity, carbon costs, carbon allowances, target achievement rate	Most listed coal companies	Enhance comparability and quantification
Advanced Level	Scenario analysis, Scope 3 emissions, third-party verification	Companies with robust governance	Achieve high-quality, forward-looking disclosures

5.3 Strengthening Connectivity

Companies should integrate climate-related risks and opportunities into a unified framework across annual reports, ESG reports, and notes to financial statements. Management discussions should explain strategy, financial notes should reflect financial impacts, ESG reports should disclose progress on actions, and sustainability reports should supplement scenario

analysis. This approach not only enhances the completeness of information but also improves readability for external stakeholders. The goal of building connectivity is not to increase the length of reports, but to establish a consistent narrative structure across them, enabling external users to clearly see the full picture of the transition by following the company's strategy, actions, and financial consequences.

Figure 2: The Logical Chain of Carbon Accounting Disclosure in the Coal Industry



5.4 Establishing a Multi-Stakeholder Collaboration Mechanism

Improving the quality of carbon accounting disclosures in the coal industry is not solely the responsibility of individual companies; it requires joint efforts from regulatory authorities, audit firms, financial institutions, and industry associations. Regulatory authorities must establish minimum disclosure requirements; audit firms must enhance their verification capabilities; financial institutions can incorporate disclosure quality into credit assessments; and industry associations can promote the development of standardized templates. Only through multi-stakeholder collaboration can the coal industry's carbon accounting disclosure system be effectively implemented. Particularly for high-carbon industries, the clearer the external constraints, the stronger the internal motivation for corporate reform.

6. Conclusion and Outlook

Based on the realities of the coal industry and in light of the new accounting requirements under the TCFD framework and the “dual carbon” goals, this paper has restructured the carbon accounting disclosure system for the coal industry. The study argues that carbon disclosure in the coal industry should shift from simple environmental statements to decision-useful disclosures oriented toward financial impacts. Building upon the four pillars of governance, strategy, risk management, and metrics and targets, it should further strengthen financial impact, connectivity, and assurance support. At the same time, disclosure quality and verifiability should be enhanced through a unified data foundation, a tiered implementation mechanism, and multi-stakeholder collaborative governance.

Overall, the future direction of carbon accounting disclosure in the coal industry lies not in adding more vague descriptions, but in making disclosures more authentic, comparable, and reflective of the pressures of transition and financial consequences. Only in this way can carbon disclosure truly serve corporate low-carbon transition and better serve capital markets and regulatory governance. Future research could further examine a sample of listed companies in the coal industry to assess the impact of different disclosure dimensions on corporate financing costs, investment efficiency, and market value, thereby providing stronger empirical support for this regulatory framework.

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Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

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