Research on Performance Evaluation Indicator System of Iron and Steel Enterprises in the Context of "Dual Carbon"

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Abstract. The iron and steel industry, a cornerstone of the economy and a major carbon emitter, faces urgent green transformation under "dual carbon" goals. Traditional financial-focused performance evaluations fall short in measuring low-carbon progress due to unbalanced indicators and inadequate policy alignment. This paper constructs a three-dimensional performance evaluation system integrating financial, low-carbon environmental, and social performance metrics. It retains core financial indicators while introducing new ones for carbon reduction, energy efficiency, and pollution control, along with social indicators like internal synergy and industry chain empowerment. The system aims to comprehensively assess green transformation effectiveness, providing theoretical and practical support for enhancing green competitiveness in the steel sector amid "dual carbon" targets.

Keywords: "dual carbon" target, iron and steel enterprises, performance evaluation, indicator system, low-carbon transition, sustainable development

1 Introduction

The iron and steel industry, as a cornerstone of the national economy, is also a major contributor to energy consumption and carbon dioxide emissions[1]. According to the China Iron and Steel Association, the industry accounts for approximately 15% of China's total carbon emissions, ranking highest among industrial sectors[2]. Faced with stringent "dual carbon" targets, the steel industry is under pressure to transform technologically and reduce costs, while also confronting dual pressures from government regulations and international markets. In 2024, the National Development and Reform Commission and other departments issued the "Special Action Plan for Energy Conservation and Carbon Reduction in the Iron and Steel Industry," setting clear targets: by 2025, comprehensive energy consumption per ton of steel should decrease by more than 2% from 2023 levels, with strict production capacity controls and enhanced energy efficiency benchmarks.

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Therefore, this paper aims to construct a comprehensive performance evaluation index system that meets "dual carbon" goals and is tailored to the iron and steel industry. By breaking away from a single finance-centric evaluation model, we propose a multi-dimensional system that integrates financial performance, low-carbon environmental performance, and social performance[3]. This system addresses key pain points in current evaluations, such as imbalanced indicator dimensions, disconnection from "dual carbon" policies, and lack of international identifiability. By providing enterprises with a scientific and operational measurement tool, we hope to support the sound and sustainable operation of the iron and steel industry, promote green, low-carbon, and high-quality development, and offer solid support for achieving national "dual carbon" goals.

2 Current Situation and Problem Analysis of Performance Evaluation of Steel Enterprises in the Context of "Dual Carbon"

2.1 Current Situation of Performance Evaluation of Iron and Steel Enterprises

Currently, the performance evaluation systems adopted by China's iron and steel enterprises predominantly feature a financial performance-oriented core framework and indicator composition. This characteristic is closely tied to the industry's historical focus on scale expansion and output growth. Although non-financial dimensions such as safety production and environmental protection have been incorporated into the assessment scope with the evolution of management concepts and the strengthening of corporate social responsibility, in practical application, financial indicators still dominate in terms of weight allocation, result utilization, and strategic orientation. Non-financial indicators merely serve as supplementary elements to meet government regulatory requirements and mitigate operational risks, lacking inclusion in the core evaluation framework and sufficient weighting to effectively drive long-term strategic transformation and upgrades for enterprises.

2.2 Adaptability of the Existing Evaluation System under the Background of "Dual Carbon"

Under the new environment where the "dual carbon" target has become a rigid constraint for the industry, coupled with dual pressures from domestic and foreign policies, the existing financial-centric evaluation system has revealed multiple structural deficiencies. The current system not only fails to meet the needs of enterprise transformation but also, to some extent, hinders the low-carbon development process, primarily due to three major issues[4]: imbalanced evaluation weights, policy adaptation disconnection, and incomplete stakeholder coverage.

Come a core issue that combines theoretical necessity with practical urgency.

3 Construction of Performance Evaluation Indicator System for Iron and Steel Enterprises in the Context of "Dual Carbon"

3.1 Design of Financial Performance Evaluation Dimension Indicators

Profitability.

Table 1. Design of Financial Performance Evaluation Dimension Indicators.

Primary Indicator	Secondary Indicator	Calculation Formula	Nature of the indicator
Profitability	Return on Equity (ROE)	Net Profit÷Average Net Worth	Positive Quantitative
	Gross Profit Margin	(Operating Income-Operating Costs)÷Operating Income	Positive Quantitative
	Net profit per tonne of steel	Net profit÷total crude steel production	Positive Quantitative
	Return on Investment (ROI) of Low Carbon Projects	Net Profit of Low Carbon Project÷Total Investment of Low Carbon Project	Positive Quantitative
	Green Capacity Profit Contribution Ratio	Green Process Net Profit÷Total Enterprise Net Profit	Positive Quantitative
Operating capacity	Low-carbon inventory turnover	Low-carbon related operating costs÷Average low-carbon inventory balance	Positive Quantitative
	Low Carbon Fixed Assets Turnover	Low Carbon Related Operating Income÷Average Low Carbon Net Fixed Assets	Positive Quantitative
	Green accounts receivable turnover	Low-carbon related operating income÷average green accounts receivable balance	Positive Quantitative
	Green supply chain capital turnover	Green supply chain related operating income÷average green supply chain capital utilisation	Positive Quantitative
Solvency	Green gearing ratio	Green total project-related liabilities÷total corporate assets	Reverse Quantitative
	Current Ratio	Current Assets÷Current Liabilities	Positive Quantitative
	Quick ratio	Quick assets÷current liabilities	Positive Quantitative
	Transitional Interest Coverage Multiple	(Total Profit+ Interest Expense)÷Interest Expense	Positive Quantitative
Growth capacity	Year-on-year growth rate of low-carbon operating income	(current period low-carbon related operating income-previous period low-carbon related operating income)÷previous period low-carbon related operating income	Positive Quantitative
	Year-on-year growth rate of green net profit	(net profit realised by green technology in the current period-net profit realised by green technology in the previous period)÷net profit realised by green technology in the previous period	Positive Quantitative
	Low-carbon technology R&D investment growth rate	(current low-carbon technology R&D investment-previous low-carbon technology R&D investment)÷previous low-carbon technology R&D investment	Positive Quantitative

In the profitability dimension, we select three improved indicators: Return on Equity (ROE), Gross Profit Margin, and Net Profit per Ton of Steel, and introduce two new indicators: Return on Investment (ROI) of Low-Carbon Projects and Green Capacity Profit Contribution Ratio. ROE, as a fundamental financial indica-tor, remains a core data focus for enterprises and a primary measure of green profitability. In the highly homogenized steel industry, Gross Profit Margin directly reflects cost control capabilities for bulk raw materials like iron ore and scrap. In the "dual-carbon" context, green power procurement and low-carbon technology investments impact cost structures, making this indicator also reflect the "carbon reduction-profitability" balance—a key industry benchmarking basis. Net Profit per Ton of Steel aligns with the steel industry's "ton of steel" production core unit, eliminating production method capacity scale differences during low-carbon transitions from long to short processes, aiding accurate unit product profitability comparisons.

The specific constructs for the design of the financial performance evaluation dimension indicators are shown in **Table 1**.

3.2 Design of Indicators for Evaluating Low-carbon Environmental Performance Dimensions

Carbon Emission Reduction Core Indicators.

In the carbon emission reduction dimension, we focus on the actual effective-ness of carbon reduction under the "dual-carbon" target, adopting two key non-financial indicators: Carbon Emission Intensity per Unit of Crude Steel (CEI-CS) and Carbon Emission Reduction Target Achievement Rate (CER-Rate). CEI-CS, as a foundational indicator, uses "ton of steel," a common accounting unit in the steel industry, as a benchmark to directly quantify the carbon emission level per unit of product. This accurately reflects the carbon reduction effectiveness achieved by enterprises through metallurgical process upgrades, efficient scrap resource utilization, and other low-carbon measures, serving as a core metric for measuring carbon emission reduction effectiveness in steel enterprises. CER-Rate closely aligns with the milestone targets set in the State Council's "Carbon Peak Action Programme by 2030," quantifying the extent to which actual enterprise emission reductions match national low-carbon goals.

Energy Efficiency Core Indicators.

Combining national energy-saving priorities, we adopt two key indicators in the energy efficiency dimension: Comprehensive Energy Consumption per Ton of Steel (CEC-TS) and Proportion of Renewable Energy Use (PREU). CEC-TS precisely adapts to the energy-intensive nature of the steel industry, directly quantifying energy consumption per unit of product and reflecting the real effectiveness of enterprise energy-saving reforms. Through process upgrades, waste heat and energy recovery, and other measures, energy consumption space can be continuously compressed, promoting industry energy efficiency towards international advanced levels. PREU focuses on energy structure low-carbon transformation, quantifying the proportion of clean energy sources like wind and photovoltaic in total energy consumption. This indicator not only keeps pace with the times but also urges enterprises to replace fossil fuels with clean energy, reducing carbon emissions from the source and ensuring synergistic energy security and carbon reduction goal achievement.

Pollution Management Core Indicators.

In the pollution management dimension, we design two key indicators: Main Air Pollutant Emission Compliance Rate (MAPECR)[5] and Comprehensive Utilization Rate of Industrial Solid Waste (CUR-ISW)[6]. MAPECR, combined with nation-al steel industry air pollutant emission standards, is subdivided into sulfur dioxide (SO2), nitrogen oxides (NOx), and particulate matter (PM) emission compliance rates, quantifying the extent to which enterprise emissions align with national ultra-low emission standards and directly reflecting the targeting of cleaner pro-duction process transformations. These sub-indicators comprehensively cover key steel industry air pollution factors, building a solid foundation for continuous industry environmental quality improvement. CUR-ISW quantifies the recycling level of bulk industrial solid wastes like steel slag and iron-containing dust and sludge, embodying the "dual-carbon" resource recycling orientation and undertaking targets from the "Industrial Sector Peak Carbon Implementation Plan" to promote efficient solid waste utilization in production cycles or cross-industry ex-changes, achieving pollution control and resource conservation co-development and supporting steel industry green and low-carbon transformation.

The specific construction of the design of the low-carbon environmental performance evaluation dimension indicators is shown in **Table 2**.

Table 2. Design of indicators for evaluating low-carbon environmental performance dimensions.

Primary Indicator	Secondary Indicator	Calculation Formula	Nature of the indicator
Degree of carbon emission reduction	Carbon emission intensity per unit of crude steel	Total carbon dioxide emissions÷total crude steel production	Reverse Quantitative
	Carbon emission reduction targets completion rate	Actual carbon emission reduction÷planned carbon emission reduction	Positive Quantitative
	Percentage of hydrogen metallurgy technology application	Hydrogen metallurgy related production capacity÷total enterprise blast furnace ironmaking capacity	Positive Quantitative
	Scrap utilisation rate	Scrap usage÷total raw material usage for EF steelmaking	Positive Quantitative
Energy efficiency	Comprehensive energy consumption per tonne of steel	Total energy consumption (tonnes of standard coal)÷total crude steel output	Reverse Quantitative
	Percentage of renewable energy use	Renewable energy consumption÷total energy consumption	Positive Quantitative
	Energy Efficiency of Blast Furnace Ironmaking Processes Meeting the Standard Rate	Actual Energy Efficiency of Blast Furnace Ironmaking Processes÷Energy Efficiency Benchmarking Level	Positive Quantitative
	Percentage of green electricity use in electric furnace	Green electricity consumption in electric furnace production÷total electricity consumption in electric furnace production	Positive Quantitative
Completion of pollution control	Achievement rate of major air pollutant emissions	(sulphur dioxide emissions+nitrogen oxides emissions+particulate matter emissions)÷(total sulphur dioxide emissions+total nitrogen oxides emissions+total particulate matter emissions)	Positive Quantitative
	Comprehensive utilisation rate of industrial solid waste	Comprehensive utilisation of industrial solid waste÷total amount of industrial solid waste generated	Positive Quantitative

3.3 Design of Social Performance Evaluation Dimension Indicators

Driven by national ESG policies, social dimension evaluation indicators must con-sider multiple stakeholders demands[7]. Therefore, we design indicators from two core perspectives: internal operation synergy and external industry chain empowerment, fitting industry realities and accurately echoing social value creation goals.

The Low-Carbon Process Operation and Process Synergy Rate (LC-OPSCR) focuses on enterprise internal operations, closely related to long-process production characteristics and "dual-carbon" transformation technological demands in the steel industry. It comprehensively covers core production link low-carbon process implementation and cross-process synergy, using exclusive steel industry low-carbon processes like hydrogen-based shaft furnace reduction operations and hydrogen-rich carbon cycle smelting as core evaluation carriers.

The specific constructs of the indicator design for the social performance evaluation dimension are shown in **Table 3**.

Table 3. Design of Social Performance Evaluation Dimension Indicators.

Primary Indicator	Secondary Indicator	Calculation Formula	Nature of the indicator
Degree of internal operation synergy	Low-carbon process operation and process synergy attainment rate	number of passes in core low-carbon process operation÷total number of core low-carbon process operations×50% +number of completed cross-process carbon reduction synergy tasks÷total number of cross-process carbon reduction synergy tasks×50%	Positive Quantitative
Degree of external industry chain empowerment	Low-carbon supply chain synergy	Low-carbon procurement ratio×25% +Supplier carbon footprint report coverage rate×25% +Downstream customer carbon footprint synergy service completion rate×25% +Scrap recycling synergy recovery volume compliance rate×25%	Positive Quantitative

4 Conclusion

Under the “dual carbon” targets, the existing finance-focused performance evaluation system for iron and steel enterprises has proven inadequate, suffering from imbalanced indicator weights, policy disconnect, and incomplete stakeholder coverage. To address these deficiencies, this paper constructs a three-dimensional performance evaluation indicator system integrating financial, low-carbon environmental, and social performance. By introducing novel metrics, such as low-carbon project ROI, carbon emission intensity per unit of crude steel, comprehensive energy consumption per tonne of steel, and process synergy rates, the proposed framework enables a holistic assessment of enterprises’ low-carbon transition effectiveness. This system not only aligns with national policy milestones but also provides a practical tool for enhancing green competitiveness in the steel industry, thereby supporting the achievement of China’s carbon neutrality goals.

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