Journal of Carcinogenesis
Covering Genesis to Therapeutics

Journal of Carcinogenesis, ISSN: 1477-3163
2025; Vol 24: Issue 8s, https://carcinogenesis.com/

Analysis of motivation and performance of green transformation of steel enterprises under the "Dual Carbon" target: A case study of Shougang Steel

Shao Huimin [1], Liu Kexin[2], Mcxin Tee [3], Hu Mei [4], Zhao Zhong [5]

[1]College of Management, Yunnan Nrmal University, Kunming , China，

Email ID : 170045@ynnu.edu.cn , ORCID iD：0009-0006-1798-4722

[2]College of Management, Yunnan Nrmal University, Kunming , China，
Email ID：15117213565@163.com

[3]Faculty of Business and Communications, INTI International University, Nilai, Malaysia，

Email Id: mcxin.tee@newinti.edu.my, ORCID iD：0000-0001-7990-8377

[4]School of Business, Yinchuan University of Energy, Ningxia, China，

Email ID : amyhu19872023@gmail.com, OCRID: 0009-0009-9808-257X

[5]Faculty of Education Shinawatra University,

Email ID : 18602519205@163.com, OCRID: 0009-0009-9808-257X

Corresponding Author

Email ID :15117213565@163.com

ABSTRACT

With the intensification of global climate change and the rapid growth of China's energy consumption, adjusting the energy consumption structure and promoting green and low-carbon development have become important directions for China's energy policy, echoing the United Nations Sustainable Development Goals such as Affordable and Clean Energy, Industry, Innovation and Infrastructure. As a major carbon emitter, the steel industry faces an imperative need for green transformation. This paper takes Shougang Steel Co., Ltd. as the research subject, conducting a systematic analysis of its internal and external drivers, transformation pathways, and performance in green transition. A performance indicator system is constructed from four dimensions: market, finance, innovation, and environment, with quantitative evaluations using the entropy method and fuzzy comprehensive evaluation. The study reveals that Shougang Steel's green transition momentum stems from international trade policy incentives, regulatory support, industry challenges, and its own developmental needs. Its transformation pathways encompass environmental management system construction, energy conservation and consumption reduction, water resource recycling, and other aspects. Comprehensive performance evaluations demonstrate that green transition has a significant positive impact on corporate long-term financial performance, innovation performance, and environmental performance. This paper provides valuable references for green transitions in high-carbon industries under the "dual carbon" context..

Keywords: *Dual Carbon"; steel enterprises; green transformation; motivation; performance*

How to Cite: Shao Huimin , Liu Kexin, Mcxin Tee , Hu Mei , Zhao Zhong , (2025) Analysis of motivation and performance of green transformation of steel enterprises under the "Dual Carbon" target: A case study of Shougang Steel, *Journal of Carcinogenesis*, *Vol.24, No.8s*, 228-238

1. INTRODUCTION

As global ecological conditions continue to deteriorate, climate change has become a critical challenge affecting sustainable development. To achieve the dual goals of climate governance and economic transformation, most countries worldwide have established carbon peaking and carbon neutrality targets. China explicitly proposed in 2020 to strive for achieving carbon peaking by 2030 and carbon neutrality by 2060, while establishing a "1+N" policy framework as the top-level design for realizing these "dual carbon" goals. The steel industry, a crucial pillar of China's manufacturing sector, remains one of the highest carbon emission contributors. The rapid development of emerging economies and growing domestic and international demand for steel have further intensified the industry's carbon pressure. This has driven the steel sector toward higher-end, intelligent, and green new productive forces, actively promoting the establishment of a unified national carbon

market system that aligns with China's realities and international standards.

As China's leading steel industry enterprise, Shougang Steel Group has achieved remarkable progress in green transformation in recent years. Through implementing full-process ultra-low emission upgrades, developing eco-friendly products, and enhancing environmental disclosure, the company has successfully transitioned from traditional manufacturing to sustainable production. As China's first steel producer to achieve comprehensive ultra-low emissions across its entire production chain, Shougang Steel's green transformation practices serve as a representative model with significant reference value for the industry.

Current research on corporate green transition performance predominantly focuses on macro-level policies or industry-wide frameworks, lacking systematic analysis from the micro-perspective of individual enterprises. This study examines Shougang Steel Corporation's green transformation process to analyze its driving forces, implementation pathways, and performance metrics. By establishing a green transition performance evaluation system, we quantify the effectiveness of the transformation efforts, providing actionable insights for corporate implementation while offering theoretical foundations for government policymakers to formulate targeted transition strategies.

2. LITERATURE REVIEW

2.1 Research on the Motivations of Green Transition

Research indicates that corporate green transformation is driven by multiple factors. Domestically, scholars emphasize the core role of national environmental policies. Environmental taxes incentivize corporate green transition through increased tax burdens (Yu Lianchao et al., 2019); green credit policies significantly boost corporate innovation and transformation, though with limited effectiveness for heavily polluting enterprises (Xie Qiaoxin et al., 2021); tax incentives like accelerated depreciation of fixed assets have been proven to drive green transformation, achieving dual improvements in emission reduction and performance (Wu Fei et al., 2022). Internationally, developing countries face challenges from globalization and need green transformation to break free from low-end industrial chain constraints (Shi Dan, 2018), while economies like the EU are compelled to accelerate transition under external pressure (Chen Xiaojing, 2024). Green trade barriers further highlight the urgency of this shift (Xiang Jingwei et al., 2024). Socially, strong public opinion pressures drive corporate adaptation to market competition (Li Dayuan et al., 2018), while growing green market demand (Sun Lan, 2022) and demand-side low-carbon reforms (Huang Yunhui et al., 2023) serve as key forces propelling production transformation. Technological innovation is also recognized as a crucial pillar supporting this transition (Tavoni et al., 2012). From the perspective of enterprises themselves, internal governance structures such as a higher proportion of independent directors can positively influence green technology innovation (Wang Fengzheng et al., 2018). The enterprise-specific "gray" dynamic capabilities help coordinate contradictions in green innovation (Guo Pibin et al., 2021), while the value orientation of managers directly determines the company's green innovation strategy (Guo Yineng, 2022).

2.2 Research on Green Transition Performance

Regarding the connotation of green transition, scholars define it as a comprehensive transformation encompassing development philosophies, strategies, and methodologies aimed at achieving synergistic benefits across economic, social, and environmental dimensions (Sun Liwen et al., 2020; Gazi et al., 2025). Its core lies in the effective and rational utilization of resources to ensure sustainable development (Cheba et al., 2022). In performance evaluation frameworks, three primary objectives are widely emphasized: environmental performance, the most visible outcome reflecting corporate achievements in pollution control (Li Jinchang et al., 2023); economic performance, the cornerstone of corporate sustainability, where studies show that green patents (Zhang et al., 2019) and sound environmental management can enhance profits while achieving dual benefits of emission reduction and economic gains (Antoine et al., 2019); and green innovation performance, the key technological indicator. The successful implementation of green transition is considered achieved when these three elements synergize (Li Jinchang et al., 2023). Performance evaluation methodologies vary significantly, ranging from single-indicator approaches like EVA assessments incorporating green metrics (Fan Chen, 2020) to comprehensive systems such as the modified TOPSIS model combining BSC and entropy weighting (Chen Yijun et al., 2020). Additionally, factors influencing corporate green transition performance are complex, including industry competition dynamics and digital technology applications affecting low-carbon performance disparities (Wang Chen et al., 2023; Doğan et al., 2025), as well as the need for enterprises to address challenges from both external environments and internal management systems (He Ling, 2024).

3. ANALYSIS OF THE MOTIVATION AND PATH OF GREEN TRANSFORMATION OF SHOUGANG STEEL

3.1 Case Enterprise Introduction

Beijing Shougang Steel Co., Ltd. is one of the largest steel production enterprises in China, with main products including

high-end electrical steel, automotive steel, tinned sheets, pipeline steel, and household appliance steel. It has established a nationwide marketing service system covering Northeast, East China, South China, North China, Central China, and Southwest China, demonstrating massive scale. As the leading enterprise in China's steel industry, Shougang Steel achieved a total profit of 900.3 million yuan in 2023. In 2023, it was awarded the titles of AAA-rated ESG enterprise in China's steel industry and a benchmark enterprise for green development in the steel sector.

3.2 Motivations for green transition

3.2.1 International trade policy drivers

With the increasingly severe global climate change, countries around the world have proposed international green trade policies, including green tariff policies, green product standards and certifications, green trade barriers, green trade agreements, and negotiations. To protect their domestic environment and ecological resources, some Western countries have adopted a series of green trade barrier measures, including anti-dumping and countervailing duties. In April 2022, the UK issued a final transitional review ruling on iron and non-alloy materials originating from China, with Shougang Steel Qian 'an Company and Shougang Steel Jingtang Company both facing countervailing duties of 31.5%. In January 2024, the U.S. Department of Commerce announced a final countervailing ruling on tin-plated steel sheets imported from China, determining that Shougang Steel Jingtang Company's tax rate would be 331.88%. In recent years, the EU Carbon Border Adjustment Mechanism (CBAM) law has officially taken effect, requiring domestic steel product exporters to provide carbon emission-related data and levy taxes based on carbon emissions. This indicates that carbon behavior has become a key focus in international trade, imposing stricter standards for Chinese product exports.

3.2.2 Domestic policy and regulatory support and influence

China's current environmental policies are categorized into regulatory and incentive-based approaches. Regulatory policies serve as crucial external drivers for corporate green transformation. The 14th Five-Year Plan and the 2035 Long-Range Objectives explicitly outline government guidance in environmental governance, employing measures such as environmental regulations, pollution discharge fees, eco-taxes, and cleaner production standards to regulate economic activities and ensure compliance with environmental protection initiatives. This compels enterprises to proactively shift their development strategies toward green transition, achieving coordinated progress in economic, environmental, and social dimensions. Meanwhile, incentive-based policies incentivize voluntary corporate transformation through government subsidies, tax incentives, and green finance mechanisms, serving as vital instruments for promoting environmental protection and sustainable development (Kanchanawongpaisan & Yan, 2025）.

3.2.3 Challenges in the development of steel industry

With the steel industry's inclusion in China's national carbon market, environmental authorities have imposed stricter requirements on annual carbon emission reporting and verification. Steel enterprises now face increasingly stringent emission standards and higher quality benchmarks for steel products, resulting in mounting environmental pressures. These developments have triggered shifts in demand among downstream supply chain partners. Industries such as automotive, wind power, and photovoltaics are raising quality standards, while the steel sector grapples with domestic economic restructuring and sluggish demand from other industries. The current situation features oversupply relative to demand and intense competition in low-end product markets, compelling steel companies to innovate and produce high-quality products. For Shougang Steel Group Co., Ltd. to retain customers and stabilize market share, it must adapt to evolving consumer needs and domestic market dynamics. Furthermore, the industry's fragmented landscape with low concentration and scattered production bases leads to disorderly competition and ineffective market regulation mechanisms, presenting significant operational challenges for steel enterprises.

3.2.4 Enterprise's own development needs

With continuous economic and social progress, production costs for enterprises have been steadily increasing. China's iron ore resources, predominantly imported, face significant price volatility abroad, substantially impacting domestic steel industry profits. Rising labor and environmental costs have also created substantial financial pressures. Amid declining performance, Shougang Steel Group executives conducted in-depth analysis of industry trends and national policies, actively pursuing green transformation to achieve environmental performance. This transition has not only reduced environmental penalties but also secured relevant subsidies for environmental protection and technological innovation, providing strong support for achieving the "dual carbon" goals. To enhance market competitiveness through green transformation, Shougang Steel has developed multiple low-carbon technologies and eco-friendly products tailored to its development needs. These innovations have created new economic growth drivers, made positive contributions to social energy conservation and emission reduction efforts, while elevating the company's social image and brand value.

3.3 Green transition path analysis

3.3.1 Establish a complete environmental management system

Shougang Steel Corporation strictly complies with national environmental regulations and has established a comprehensive environmental management system. The company continuously increases investment in eco-friendly infrastructure to ensure compliance with the highest environmental standards. Its intelligent environmental management system integrates organized emission monitoring and unorganized emission control platforms, significantly enhancing operational efficiency. Shougang Steel actively conducts environmental training programs and promotes eco-awareness initiatives. In pollution control, the group actively participates in regional ecological civilization development by implementing comprehensive management of industrial, domestic, and agricultural waste. For logistics operations, Shougang Steel has optimized transportation planning and implemented sustainable practices including waste transfer, storage, distribution, and information processing to accelerate the adoption of clean energy. Regarding packaging materials, the corporation advocates eco-friendly solutions, improves material utilization efficiency, expands recycling categories and volumes, and enhances material reuse rates.

3.3.2 Carry out special campaigns to save energy and reduce consumption

Shougang Steel Corporation has implemented mature and advanced energy-saving technologies to launch special initiatives for optimizing energy consumption in key production processes, effectively reducing pollutant emission intensity. By adopting clean energy and environmental technologies, the company has made continuous breakthroughs in solid waste processing and top-of-furnace recycling processes, significantly enhancing energy recycling efficiency. Jingtang Company has intensified R&D efforts on deep recovery and comprehensive utilization of process residual energy, promoting efficient multi-stage energy utilization. Shougang Steel Corporation continues to upgrade intelligent and digital management systems for energy control, advancing comprehensive precision energy management. The company also actively collaborates with universities and enterprises to drive technological innovation, fostering energy efficiency and carbon reduction.

3.3.3 Promoting the protection of water sources

Qiansteel Company has achieved near-zero wastewater discharge through comprehensive water resource management. By improving water utilization efficiency, it has eliminated the discharge of high-salinity wastewater. The implementation of zero-discharge technology for coking wastewater has brought nearly zero wastewater discharge to fruition. Through developing hydropower symbiotic renewable energy technologies, the company effectively addressed water scarcity issues while maintaining zero wastewater discharge. In terms of wastewater management, Shougang Steel Group pursues ultra-low discharge standards. Qiansteel Company has established integrated sewage treatment plants and reclaimed water processing facilities to recycle production wastewater. Jingtang Company built a comprehensive sewage treatment station that enables wastewater resource utilization, with actual discharge volumes significantly below permitted limits.

3.3.4 Carry out energy conservation and carbon reduction

Since the launch of China's "Dual Carbon" goals, Shougang Steel Group has proactively identified climate change risks and opportunities while leveraging its strengths and industry-specific characteristics to deepen its green transition. In July 2023, the company unveiled a Low-Carbon Action Plan outlining clear targets and implementation strategies to ensure effective execution and continuous optimization of its sustainability efforts. To drive this initiative, Shougang Steel established a Green Manufacturing Committee focused on sustainable supply chain development. The company innovates product design with eco-conscious approaches and operates dedicated low-carbon product lines. Concurrently, it has significantly increased R&D investments in low-carbon technologies, accelerated energy structure upgrades, and achieved efficient utilization of clean energy. Through these initiatives, Shougang Steel has enhanced its market competitiveness, contributed to sustainable development, and played a vital role in advancing society's green transformation and ecological sustainability.

3.3.5 Develop green and low-carbon products

Shougang Steel Corporation has been actively implementing green development concepts, intensifying R&D efforts on eco-friendly products featuring high strength, lightweight construction, corrosion resistance, and extended durability. The company maintains a commitment to producing premium, energy-efficient, and environmentally sustainable products, having established a cluster of high-performance, low-consumption offerings. Furthermore, Beijing Shougang Steel Co., Ltd. strictly complies with national and local regulations. During project design phases, the company conducts biodiversity conservation and land use assessments in accordance with requirements. Throughout operations, it continuously monitors surrounding ecosystems while actively protecting biodiversity, effectively minimizing environmental impacts from production and operational activities.

4. GREEN TRANSFORMATION PERFORMANCE ANALYSIS OF SHOUGANG STEEL CO., LTD

4.1 Market performance

This study employs event analysis to evaluate short-term market responses to corporate green transformation. The research period was defined by the public disclosure date of Qian 'an Iron & Steel Company's full-process ultra-low emission assessment acceptance, with reasonable demarcation of the event period and estimation period. Figure 1 indicates a significant cumulative return increase 10 days prior to the incident, peaking on the event date followed by gradual stabilization. Shougang Steel Group Co., Ltd. demonstrated simultaneous peaks in abnormal trading patterns and cumulative returns during the event period, with sustained growth preceding the event – suggesting some participants may have obtained insider information and made optimistic investment decisions. Although subsequent market fluctuations declined within 3% after the incident, overall positive data reflects cautious market sentiment toward corporate green transformation initiatives.

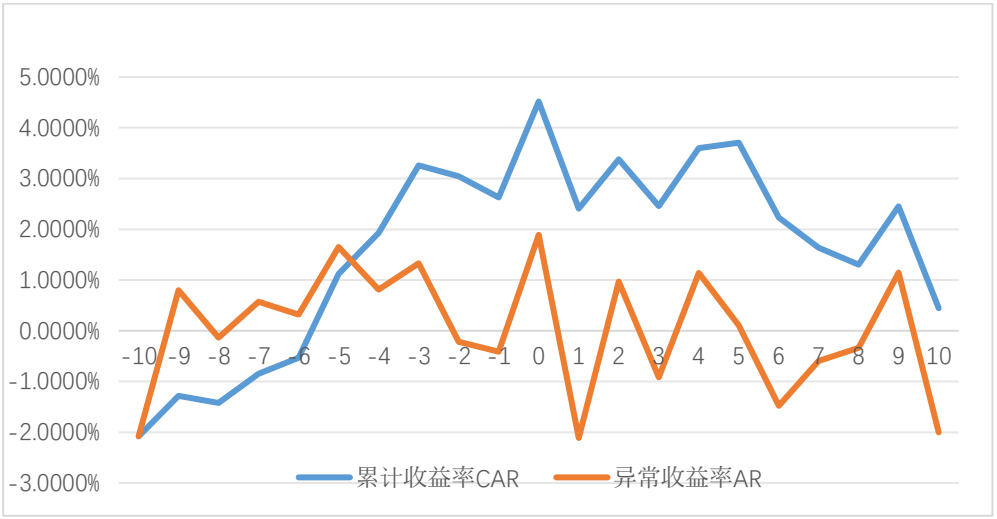

Figure 1Line chart of return rate of Shougang Steel Co., Ltd. during the time window

Through comparative analysis of Tobin's Q values before and after Shougang Steel's green transformation, this study examines the impact of environmental transition on corporate long-term market value. As shown in Figure 2, since entering its green development phase in 2018, Shougang Steel's Tobin's Q value has fluctuated around 0.9 – indicating that market valuation remains below asset replacement costs, reflecting investors 'cautious stance toward its investment value. From 2019 to 2021, the company achieved significant progress in green transformation, with the Tobin's Q value showing an upward trend, demonstrating positive market expectations. However, data since 2021 reveals a gradual decline in stock prices. Affected by market supply-demand dynamics and the ongoing profit compression in the steel industry, Shougang Steel's development faces challenges, suggesting room for further improvement.

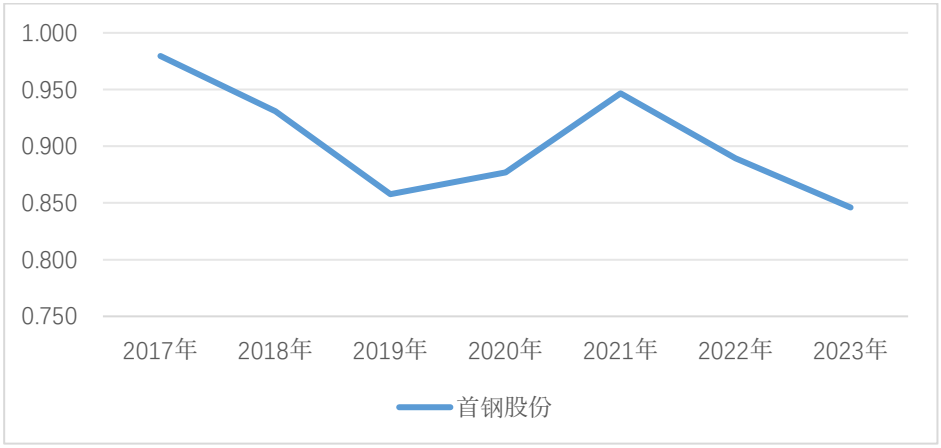

Figure 2 Line chart of Tobin's Q value of Shougang Steel Co., LTD. from 2017 to 2023

4.2 Financial performance

From a financial performance perspective, as shown in Table 1, Shougang Steel Co., Ltd. has demonstrated improved debt repayment capabilities. Its debt-to-asset ratio decreased from 73% in 2017 to 60% in 2023, while both current and quick ratios showed upward trends. Although short-term debt repayment remains below industry averages, long-term solvency has been steadily strengthening during the mid-to-late stages of green transformation. Profitability-wise, the company experienced fluctuations in return on equity (ROE), gross margin, and return on total assets (ROTA) between 2017 and 2023 due to high upfront capital investments in early green transition phases and subsequent market volatility in the steel industry. A peak in profitability was achieved in 2021 through increased sales of premium products, though subsequent declines were offset by sustained support from eco-friendly products like electrical steel. Operational efficiency showed continuous improvement, with total asset turnover approaching industry benchmarks, inventory turnover responding to market demand fluctuations, and accounts receivable turnover rate showing overall growth. The company's asset utilization efficiency has progressively improved through green transformation. Regarding growth momentum, while total asset growth, net profit growth, and revenue growth followed industry trends—with 2021's outstanding performance driven by product restructuring and market expansion followed by temporary declines due to external factors—the innovation and market recognition from green transformation have laid a solid foundation for the company's long-term development.

Table 1 Financial performance indicators of Shougang Steel

Indicators	2017	2018	2019	2020	2021	2022	2023
Current Ratio	0.34	0.318	0.355	0.389	0.461	0.452	0.505
Quick Ratio	0.257	0.242	0.242	0.252	0.308	0.296	0.316
Asset-Liability Ratio	0.73	0.73	0.73	0.73	0.67	0.65	0.60
Return on equity (weighted)	8.70	9.18	4.52	6.66	19.42	2.42	1.35
Gross Profit Rate	13.16	12.97	10.26	8.60	11.72	5.99	4.67
Return On Total Assets (Weighted)	2.38	2.47	1.20	1.66	5.73	1.03	0.54
Total Asset Turnover (Times)	0.461	0.489	0.488	0.549	0.905	0.807	0.811
Inventory Turnover Ratio (Times)	9.563	11.22	8.838	7.538	10.2	9.109	8.986
Average Accounts Receivable Turnover Ratio	9.772	7.733	9.109	11.49	16.57	14.19	16.9
Total Asset Growth Rate	0.055	0.007	0.046	-0.017	0.020	-0.042	-0.040
Net Profit Growth Rate	5.589	0.072	-0.473	0.375	2.453	-0.819	-0.501
Increase Rate Of Business Revenue	0.440	0.092	0.051	0.156	0.676	-0.119	-0.037

4.3 Innovation performance

In R&D development, Shougang Steel Group has consistently prioritized innovation-driven strategies and allocated resources accordingly as shown in Table 2. During its green transformation period from 2017 to 2018, the company experienced a sharp increase in R&D personnel, followed by a brief dip before returning to steady growth. The proportion of R&D staff aligned with the workforce expansion trend, though their overall representation remained relatively small due to the unique nature of steel manufacturing. Shougang Steel also strategically optimized patent portfolios for key production lines, accelerating the acquisition of critical patents that steadily increased during the green transition, providing technological support. Meanwhile, Shougang Steel Group saw significant growth in R&D investment both in 2017 and its proportion of revenue, with minimal fluctuations in the ratio to operating income, demonstrating active compliance with

innovation policies. Given that Shougang Steel's technological innovations remain in the early stages of commercialization, it will take time for its full innovation potential to materialize.

Table 2 Innovation performance indicators of Shougang Steel

Year	2017	2018	2019	2020	2021	2022	2023
Number of R& D Personnel	1239	2559	2464	2454	2295	2342	2481
The Proportion of R&D Personnel (%)	7.7	15.89	13.87	13.51	12.86	12.59	13.61
Authorized Patents	219	312	328	424	450	654	685
R& D Investment Amount (ten thousand)	14485.24	232673.6	285632.34	327119.3	532148.7	538607.1	502212.2
R&d Investment as A Percentage of Operating Revenue (%)	0.24%	3.54%	4.13%	4.09%	3.97%	4.56%	4.41%

4.4 Environmental performance

Environmental performance evaluation exhibits distinct industry-specific characteristics, requiring indicator design that aligns with both sectoral features and corporate operational realities. When assessing Shougang Steel Group's green transition initiatives, this study systematically categorizes environmental performance metrics into external and internal components, as detailed in Table 3.

Table 3 Environmental performance indicators of Shougang Steel

Class	Specific indicators	Indicator note
Outside	Wind ESG Score	Excerpt from Wind ESG
	Status of Awards	Excerpt from the Sustainable Development Report
	Environmental Management Disclosure	Summarize the data of Guotai An
Interior	Pollutant Discharge	Excerpt from environmental responsibility report
	Green House Gas Emission	Excerpt from environmental responsibility report
	Water Reuse Rate	Excerpt from environmental responsibility report
	Synchronized Operation Rate of Environmental Protection Facilities	Excerpt from the Sustainable Development Report
	Proportion of Clean Transport	Excerpt from environmental responsibility report

The research findings indicate that externally, Shougang Steel Group ranks among the industry leaders in social and governance scores within Wind ESG ratings, though its environmental performance requires improvement. However, the company has earned multiple honors including "Green Factory" and "Steel Green Development Benchmark Enterprise" through achievements like full-process ultra-low emission retrofitting. Its environmental management disclosures have

been continuously expanding alongside green transformation progress, with environmental transparency steadily increasing. Internally, Shougang Steel Group has vigorously advanced green transition by innovating production processes, achieving remarkable pollutant reduction outcomes. The company has effectively controlled greenhouse gas emissions, significantly improved water resource utilization efficiency, enhanced clean transportation practices, maintained stable operation of environmental facilities with full compliance of pollutant discharge standards, and established a highly efficient and mature internal environmental management system.

4.5 Comprehensive performance evaluation

This study employs the entropy method to quantify evaluation indicators, constructing a green transition performance assessment system by selecting key metrics from market, financial, innovation, and environmental dimensions. The analysis results were validated and optimized using the fuzzy comprehensive evaluation method. The weight values of Shougang Steel Group's indicators determined through the entropy method were adopted as the fuzzy evaluation factor set and weighting parameters. A five-level evaluation system was implemented, with independent assessments conducted through questionnaires from 14 experts and the company's public reports, as shown in Table 4.

Table 4 Selection of indicators in the comprehensive performance evaluation system of Shougang Steel Co., LTD

Primary Indicator	Secondary Indicators	Indicator Properties
Market Performance	Tobin Q value	forward pointer
Debt Paying Ability	Current ratio	forward pointer
	Quick ratio	forward pointer
	Asset-liability ratio	Indicators of need
Profitability	Return on equity (weighted)	forward pointer
	Gross profit rate	forward pointer
	Return on total assets (weighted)	forward pointer
Operation Capacity	Turnover of total capital	forward pointer
	Inventory turnover ratio	forward pointer
	Average accounts receivable turnover ratio	forward pointer
Capacity for Development	Total asset growth rate	forward pointer
	Net profit growth rate	forward pointer
Capacity for Development	Increase rate of business revenue	forward pointer
Innovation Performance	The proportion of r&d personnel (%)	forward pointer
	R&d investment as a percentage of operating revenue (%)	forward pointer
	Authorized patents	forward pointer
Environmental Performance	Emission of smoke and dust per ton of steel	Indicators of need
	Sulfur dioxide emission per ton of steel	Indicators of need
	Nitrogen oxide emissions per ton of steel	Indicators of need

Under the entropy value method, the comprehensive performance score clearly demonstrates that Shougang Steel's overall performance is closely tied to its green transformation, as shown in Table 5. From 2018 to 2020, Shougang Steel's comprehensive performance showed a relatively sluggish trend with limited early-stage achievements in green transition. However, following the successful ultra-low emission retrofit in 2020 and 2021, the company's performance saw significant

improvement. Subsequently, despite declining steel market demand and falling steel prices, Shougang Steel's overall performance declined. Nevertheless, driven by China's "Dual Carbon" strategy and the company's environmental initiatives, its performance still outperformed pre-transition levels, indicating that green transformation positively impacts overall performance. Under the fuzzy comprehensive evaluation method, the dual-credit method scored 0.212, while the total score method reached 84.8 points. This demonstrates experts 'positive assessment of Shougang Steel's green transition effectiveness, reflecting the company's strong commitment to environmental protection.

Table 5 Comprehensive performance scores of Shougang Steel Co., LTD. from 2017 to 2023

	2017	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Score	0.4063	0.2645	0.2697	0.3000	0.7853	0.4648	0.5460

5. CONCLUSIONS AND IMPLICATIONS

This study examines Shougang Steel Corporation as a case to explore the drivers and pathways of its green transformation, while analyzing its performance metrics across market, financial, innovation, and environmental dimensions. The research reveals that Shougang Steel's green transition is propelled by dual forces: externally, driven by international trade policies, domestic regulatory support, and industry competition; internally, fueled by corporate developmental needs. The transformation mechanism demonstrates comprehensive advancement through phased implementation, encompassing establishing a complete environmental management system, implementing energy conservation and water source protection measures, advancing carbon reduction initiatives, and developing eco-friendly products. Through this transformation, the company achieves synergistic improvements in economic, environmental, and market benefits. This approach not only increases revenue and reduces operational costs but also enhances growth potential and market competitiveness, with pollutant emissions declining year by year and social reputation significantly elevated.

Research findings indicate that steel enterprises should advance their green transformation through five key dimensions: First, continuously strengthen green technology innovation by increasing investments in clean energy and environmental protection technologies, while deepening technical collaborations with domestic and international partners. Second, optimize business structures by maintaining core steel production capabilities while actively extending industrial chains through diversified services in upstream and downstream markets to mitigate transition risks. Third, enhance environmental information disclosure management by establishing robust reporting systems to foster transparent information environments. Fourth, reinforce social responsibility awareness by integrating green development goals into strategic planning. Fifth, implement comprehensive incentive mechanisms that align individual employee interests with corporate environmental objectives, using reward-punishment systems to reduce environmental incidents and improve corporate environmental performance and public image

REFERENCES

[1] Antoine, D., Tomasz, K., Tobias, K., et al. (2019). Do environmental and economic performance go together? A review of micro-level empirical evidence from the past decade or so. International Review of Environmental and Resource Economics, 13(1–2), 1–118. http://eprints.lse.ac.uk/id/eprint/100900

[2] Cheba, K., Bąk, I., Szopik-Depczyńska, K., & Ioppolo, G. (2022). Directions of green transformation of the European Union countries. Ecological Indicators, 136, 108601. https://doi.org/10.1016/j.ecolind.2022.108601

[3] Chen, X. (2024). The new phase of EU green transition: Drivers, impacts, and policy recommendations. Yujian Journal, 16(02), 63–79, 172–173. https://doi.org/10.13878/j.cnki.yjxk.20240223.001

[4] Chen, Y., Hu, W., & Wu, Z. (2020). Performance evaluation indicator system construction and assessment method for Baijiu enterprises: An improved TOPSIS model based on BSC and entropy weight. Journal of Sichuan University of Science and Engineering (Social Sciences Edition), 35(05), 68–87. https://doi.org/10.11965/xbew20200505

[5] Doğan, B., Tiwari, S., Bergougui, B., Ghosh, S., & Balsalobre-Lorente, D. (2025). Green innovation and fiscal spending: Decoding the path to sustainable development. Sustainable Development. https://doi.org/10.1002/sd.3464

[6] Fan, C. (2020). Research on EVA performance evaluation method based on green transformation and development [Doctoral dissertation, Tianjin University of Finance and Economics].

[7] Gazi, M. A. I., Hossain, M. M., Islam, S., et al. (2025). Effect of corporate social responsibility on sustainable environmental performance: Mediating effects of green capability and green transformational leadership; moderating effects of top management environmental concern and perceived organizational support. Environment, Development and Sustainability. Advance online publication. https://doi.org/10.1007/s10668-025-06082-x

[8] Guo, P., & Zhang, A. (2021). Responsible innovation, dynamic capabilities, and corporate green transformation and upgrading. Research Management, 42(07), 31–39. https://doi.org/10.19571/j.cnki.1000-2995.2021.07.004

[9] Guo, Y., Fan, L., & Yuan, X. (2022). Market competition, financialization, and green innovation: Evidence from China's manufacturing industries. Frontiers in Environmental Science, 2022. https://doi.org/10.3389/fenvs.2022.836019

[10] He, L. (2024). Research on factors influencing company performance in the e-commerce industry: A case study of JD.com. Modern Commerce, 2024(09), 98–101. https://doi.org/10.14097/j.cnki.5392/2024.09.010

[11] Huang, Y., & Yang, L. (2023). Green consumption transition under the "dual carbon" context: Drivers, challenges, and pathways. Journal of Jianghai Studies, 2023(04), 79–85, 255.

[12] Kanchanawongpaisan, S., & Yan, T. (2025). Sustainable Construction Practices in Bangkok: Reducing Carbon Emissions in Urban Infrastructure Projects. Journal of Lifestyle and SDGs Review, 5(1), e04718. https://doi.org/10.47172/2965-730X.SDGsReview.v5.n01.pe04718

[13] Li, D., Song, J., Chen, L., et al. (2018). Can public opinion pressure promote corporate green innovation? Research and Development Management, 30(06), 23–33. https://doi.org/10.13581/j.cnki.rdm.2018.06.003

[14] Li, J., Lian, G., & Xu, A. (2023). Breaking the deadlock of corporate green transformation under the "dual carbon" vision: An empirical study on digital-driven green development. Quantitative & Technical Economics Research, 40(09), 27–49. https://doi.org/10.13653/j.cnki.jqte.20230725.009

[15] Li, J., Lian, G., & Xu, A. (2023). Breaking the deadlock of corporate green transformation under the "dual carbon" vision: An empirical study on digital-driven green development. Quantitative & Technical Economics Research, 40(09), 27–49. https://doi.org/10.13653/j.cnki.jqte.20230725.009

[16] Stan. (2018). Green development and a new stage of global industrialization: China's progress and comparison. China Industrial Economics, 2018(10), 5–18. https://doi.org/10.19581/j.cnki.ciejournal.2018.10.001

[17] Sun, L. (2022). Enterprise green technology transformation: Demand, competition, and policy based on a multi-stage game theory model. Science and Technology Management Research, 42(12), 179–187. https://doi.org/10.3969/j.issn.1000-7695.2022.12.023

[18] Sun, L., & Ren, X. (2020). Research on driving factors and mechanisms of enterprise green transformation: Integrated analysis framework for cross-stratum interaction factors. Management Modernization, 40(02), 67–70. https://doi.org/10.19634/j.cnki.11-1403/c.2020.02.016

[19] Tavoni, M., Cian, E., Luderer, G., et al. (2012). The value of technology and of its evolution towards a low carbon economy. Climatic Change, 114(1), 39–57. https://doi.org/10.1007/s10584-011-0294-3

[20] Wang, C., Zhao, L., & Zhang, M. (2023). Research on low-carbon performance evaluation of manufacturing enterprises in the context of green transformation. Management & Operations, 2023(Online), 1–13. https://doi.org/10.16517/j.cnki.cn12-1034/f.20231213.012

[21] Wang, F., & Chen, F. (2018). Board governance, environmental regulation, and green technology innovation: An empirical study of listed companies in China's heavy-pollution industries. Science of Science, 36(02), 361–369. https://doi.org/10.16192/j.cnki.1003-2053.2018.02.019

[22] Wu, F., & Li, W. (2022). Tax incentives and corporate green transformation: Empirical evidence based on annual report text recognition of listed companies. Journal of Fiscal Studies, 2022(04), 100–118. https://doi.org/10.19477/j.cnki.11-1077/f.2022.04.006

[23] Xiang, J., & Liu, X. (2024). Research on the green transformation of international agricultural trade under the background of carbon neutrality. China Business Review, 2024(05), 54–58. https://doi.org/10.19699/j.cnki.issn2096-0298.2024.05.054

[24] Xie, Q., & Zhang, Y. (2021). Green credit policy, supportive measures, and enterprise innovation transformation. Research Management, 42(01), 124–134. https://doi.org/10.19571/j.cnki.1000-2995.2021.01.012

[25] Yu, L., Zhang, W., & Bi, Q. (2019). Research on the incentive effect of environmental taxes on corporate green transformation. China Population, Resources and Environment, 29(07), 112–120. https://doi.org/10.12062/cpre.20190108

[26] Zhang, D., Rong, Z., & Ji, Q. (2019). Green innovation and firm performance: Evidence from listed companies in China. Resources, Conservation and Recycling, 144, 48–55. https://doi.org/10.1016/j.resconrec.2019.01.023.