The Impact Mechanism of ESG Performance on the Financial Performance of Listed New Energy Companies under the Dual-Carbon Goals

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Abstract. This study examines how ESG performance affects the financial performance of listed new energy firms in China under the "dual-carbon" goals. While the sector benefits from policy support and growing demand, it also faces cost volatility and fast technological change, making financial performance a key indicator of sustainability. Using a framework that links market forces, internal governance, and reputation, and drawing on cases such as CATL, BYD, and LONGi, the study shows that stronger ESG performance improves financial outcomes mainly by lowering financing costs, raising operating efficiency, and enhancing brand value. The findings provide practical guidance for firms and decision support for investors and policymakers.

Keywords: new energy industry, ESG, financial performance.

1. Introduction

1.1. Background and Significance

1.1.1. Background

The global energy system is shifting rapidly. China's "carbon peaking and carbon neutrality" goals have become a national strategy and are reshaping corporate development. Meanwhile, ESG has emerged as a core framework for sustainability. In high-emission sectors, ESG performance is increasingly treated as a signal of long-term competitiveness. Understanding how ESG affects financial performance can help firms refine strategy and support sustainable growth.

The dual-carbon agenda creates opportunities for new energy firms, supported by policies and green finance, rising global demand, and China's strengths in photovoltaics and EV batteries. Technological progress in PV, wind, storage, and hydrogen is reducing costs and improving efficiency. New business models (e.g., virtual power plants and integrated energy services) and overseas cooperation also expand growth space.

However, the sector faces clear challenges. PV firms such as LONGi are exposed to upstream price volatility, which weakens earnings stability. Wind firms such as Goldwind face delays from land approval and grid connection constraints. EV leaders such as BYD still face pressure from high battery costs, potential overcapacity in some segments, and faster technology cycles. In this context, scale expansion alone is not enough; financial performance remains a key metric for evaluating sustainable development in the new energy industry.

1.1.2. Research Significance (simplified)

This study examines how ESG performance affects the financial performance of listed new energy firms under China's dual-carbon policy, with a focus on industry heterogeneity.

Theoretically, prior work often emphasizes single drivers (e.g., subsidies or technological innovation) and pays less attention to policy changes (such as carbon quota adjustments) and regional differences in policy intensity. By documenting financial-performance patterns across new energy sub-sectors, this study adds industry-specific evidence to research in industrial economics and financial management.

Practically, the study helps firms set ESG priorities and governance actions, balance short-term costs with long-term returns, and supports investors and financial institutions in screening firms and

designing green financing. It also provides evidence for improving policy tools such as ESG disclosure rules and green finance, aiming to raise efficiency and reduce risk.

Overall, the study contributes in three ways. First, it addresses industry heterogeneity by comparing sub-sectors such as photovoltaics, wind power, and new-energy vehicles, which face different cost and technology dynamics. Second, it moves beyond aggregate ESG scores by analyzing key indicators within the E, S, and G dimensions and testing mechanisms (e.g., green innovation and financing costs) as well as moderators (e.g., policy intensity and competition). Third, it evaluates policy–ESG synergy by quantifying how policy tools (carbon trading, green credit, environmental subsidies) shape the ESG–performance link and how effects differ across regions with different policy implementation strength.

1.1.3. Research Questions

Building on the above discussion, this study focuses on three key questions.

First, what is the current financial performance of China's new energy industry? We describe recent changes in overall profitability and solvency. For example, in the automotive sector, BYD has achieved strong revenue growth, but its net profit growth has lagged behind revenue growth, suggesting that price competition has compressed margins. Solvency has also become more polarized across firms, with leverage indicators (especially the debt–asset ratio) playing a central role. We further compare performance across sub-sectors, including photovoltaics, wind power, new-energy vehicles, and energy storage, where financial outcomes differ substantially.

Second, what are the main drivers of financial performance in new energy firms? We examine internal factors such as R&D investment, cost control capability, and firm size, as well as external conditions such as policy subsidies, raw-material price

2. Literature Review

2.1. ESG and Corporate Financial Performance: International and Domestic Evidence

2.1.1. International Literature

Research on the relationship between ESG and corporate financial performance began relatively early in international scholarship and has produced extensive findings. However, conclusions regarding the direction of this relationship are not fully consistent. Busch and Friede (2018), based on a second-order meta-analysis combining 25 meta-studies and 1,214 empirical papers with more than one million observations, document a strong and robust bidirectional positive relationship between firms' environmental and social performance and financial performance. The association is particularly pronounced for operating-based financial indicators, with corporate reputation acting as a key mediating channel, although short-term resource allocation pressures from ESG investment are not excluded.

Elamer and Boulhaga (2024), using a large panel of firm-year observations, show that the negative impact of ESG controversy events on firm performance varies with governance quality. Firms with weaker governance structures experience stronger adverse effects, whereas effective governance mechanisms significantly mitigate the negative impact of ESG controversies. In firms with high governance quality, the performance penalties associated with ESG controversies are substantially reduced.

2.1.2. Domestic Literature

Chinese studies are closely aligned with national policies and the institutional features of China's capital market, with a primary focus on the impact of ESG on financial performance and its transmission mechanisms. Ming Junren et al. (2023) find that green patent output partially mediates the relationship between ESG performance and financial performance, and that this mediating effect is stronger for firms operating under stricter environmental regulation. Their results suggest that ESG improves financial performance indirectly by promoting green innovation.

Domestic research also emphasizes industry heterogeneity. Using data on A-share listed firms, Fang Xianming and Hu Ding (2023) show that strong ESG performance significantly enhances corporate innovation output, but the magnitude of this effect varies across industries. In the pharmaceutical manufacturing sector, the positive ESG–innovation link is notably weaker than the manufacturing average, largely due to tighter financing constraints and more severe agency problems that limit the conversion of ESG resources into innovation outcomes. Similarly, Wang Zhi and Peng Baichuan (2024) find that ESG performance promotes innovation through both resource channels (such as government subsidies and credit access) and reputation effects, with stronger effects observed in non-state-owned enterprises than in state-owned firms.

2.2. Financial Performance in the New Energy Industry

Existing studies on the financial performance of new energy firms tend to focus on single drivers, with limited attention to multi-factor interactions. From a policy perspective, substantial research examines the role of government subsidies. Yue Zhonggang et al. (2025) argue that effective subsidy schemes are not simple financial transfers but part of a broader system that alleviates financing constraints and encourages strategic risk-taking, thereby fostering sustainable innovation capacity. This innovation-oriented objective differs fundamentally from short-term goals such as improving profitability or solvency. Nie Huihua et al. (2022) further clarify the logic of subsidy withdrawal, showing that although firms may experience short-term profit declines after subsidies are reduced, this pressure forces them to increase R&D investment and improve management, ultimately leading to longer-term performance gains.

However, these studies largely examine policy effects in isolation and do not integrate environmental, social, and governance dimensions. Evidence from Mao Qilin et al. (2023) shows that strong ESG performance enhances firm growth by expanding production scale, easing financing constraints, and improving talent attraction. In the new energy sector, ESG practices help firms build responsible brand images to expand markets while improving internal governance to reduce costs, jointly supporting financial performance. Their findings also highlight policy–ESG complementarity, as stricter environmental regulation amplifies the advantages of ESG-leading firms in financing, markets, and human capital. Nevertheless, how ESG and industry-specific policies jointly shape financial performance in the new energy sector remains insufficiently explored.

From the perspective of technology and costs, prior research mainly examines R&D investment and cost control. For example, profitability in photovoltaic firms is highly sensitive to silicon price fluctuations, while wind power firms often face project delays due to land approval and grid connection constraints. These factors directly affect financial outcomes. Yet, the moderating role of ESG in technology development and cost control has received limited attention. Fan Dingxiang (2024) provides evidence that ESG positively affects technological innovation, with financing constraints acting as a partial mediator, suggesting that ESG operates partly by easing financial frictions. However, whether ESG also moderates the effects of other factors—such as market competition or managerial characteristics—remains unexplored.

From an environmental perspective, stricter standards may raise short-term costs but encourage green innovation and improve long-term efficiency. Lin Juanjuan (2025) shows that strong ESG performance significantly promotes green technological innovation and helps firms reduce costs through technological progress. From the social dimension, employee protection and talent attraction may enhance R&D efficiency, while from the governance dimension, sound governance structures can improve R&D decision-making and resource allocation.

Regarding market and competition factors, prior studies mainly focus on market share and competitive strategies. Wang Shuangjin (2022) finds that firms' competitive strategies—such as cost leadership or differentiation—significantly moderate the relationship between ESG responsibility and financial performance, underscoring the role of strategic positioning. However, systematic evidence on financial performance differentiation across sub-sectors and the heterogeneity of its core drivers remains limited.

2.3. Literature on "Dual-Carbon" Policy and Green Governance

Domestic studies generally argue that the dual-carbon policy shapes corporate decisions through both incentives and constraints. Existing work mainly focuses on how carbon pricing affects firms' emission costs and supply-chain arrangements. To avoid carbon taxes, firms may optimize production processes and increase investment in low-carbon technologies, which then affects financial performance. For example, Liu Changnian (2025) shows that carbon pricing raises emission-related costs and pushes firms to adjust strategies by improving production efficiency and strengthening low-carbon R&D, with material consequences for financial outcomes.

Research also highlights the role of green finance and carbon quota policies in guiding financing costs and investment direction. Zhang Hongxia (2022) notes that although China's new energy industry has grown rapidly, it still faces major constraints such as delays in key technological breakthroughs. The study finds that green finance policies can reduce financing costs and support project implementation, but also points out that much of the literature remains macro-oriented and does not fully capture the sector's specific features, including technology pathways and policy dependence.

Studies on green governance and firm value, often centered on ESG, examine how environmental management (e.g., carbon intensity and environmental equipment investment), social responsibility (e.g., employee protection and community relations), and governance structure (e.g., environmental performance incentives and ownership structure) affect firm value. Huang Huixing and co-authors argue that new energy firms, as part of a "green industry," can enhance brand image and reduce environmental risk through green governance practices such as low-carbon production and community engagement. However, the specific transmission channels through which green governance affects financial performance under the dual-carbon policy framework remain unclear. Quantitative evidence on how policy intensity moderates the ESG–financial performance link is also limited.

Cai Wenxia et al. (2023) find that stronger ESG performance significantly improves financial performance, and that government regulation, industry competition, and media supervision each strengthen this relationship. They also identify technological innovation as an important internal channel through which ESG translates into better financial outcomes. In addition, Wen Chenyan (2025), using a nonlinear dynamic model, reports a significant U-shaped relationship between ESG performance and financial performance, with policy intensity, regional marketization, and firm digitalization moderating this U-shape. From the perspective of green financial management, firms can reduce energy use and waste-treatment costs through measures such as adopting energy-saving equipment and improving production processes. These actions also lower hidden environmental-risk costs, strengthen brand value, and improve financial stability. Moreover, strong ESG performance sends positive signals to the market, facilitating external financing, government subsidies, and tax incentives, and may reduce labor-related costs, all of which can support financial performance.

2.4. Research Gaps

The existing literature has four main limitations. First, most studies take an economy-wide perspective and do not focus on the specific features of the new energy industry under the dual-carbon agenda; its ESG–performance logic differs substantially from that of high-pollution industries, and targeted evidence remains fragmented. Second, many studies rely on aggregate ESG scores, with limited attention to the heterogeneous effects of ESG sub-indicators in the new energy sector, and insufficient tests of mediating and moderating mechanisms. Third, prior work does not clearly identify how dual-carbon policies shape financial performance through firms' ESG practices, nor does it adequately examine regional variation in policy intensity. Fourth, the literature often emphasizes short-term effects while underestimating the long-term impacts of ESG investment, and it provides limited evidence on heterogeneity across new energy sub-sectors, firm sizes, and regions.

3. Theoretical Framework

3.1. Mechanism Analysis of ESG

3.1.1. External market mechanism: repricing in capital markets

The effect of ESG on firm value is not a simple one-step causal link. It operates through a multi-channel and dynamic transmission process. In financial markets with information asymmetry, ESG performance functions as a credible signal that improves capital allocation and directly affects financing costs and valuation.

First, stronger ESG performance can reduce the cost of debt. Banks and other lenders often interpret high environmental and governance quality as evidence of lower long-term operating risk, which lowers the risk premium demanded by creditors. Second, ESG can generate a valuation premium. Equity investors increasingly incorporate ESG into valuation frameworks (e.g., discounted cash flow) and expect ESG-leading firms to face lower regulatory risk and better capture opportunities from green transition, leading to more stable future cash flows and higher valuation multiples. Third, ESG effects can be reinforced by policy. Under the dual-carbon agenda, green finance tools (e.g., green bond guidelines and carbon-reduction support instruments) open lower-cost funding channels for eligible firms. For example, LONGi Green Energy has issued green bonds at relatively low rates. This advantage reflects not only its market position, but also the strong alignment between its business and carbon-neutrality goals and its forward-looking in technology choices and zero-carbon factories, which reduces perceived climate-policy risk and lowers its weighted average cost of capital. Similarly, Goldwind is an active issuer in China's green bond market. Its funded projects (e.g., wind farm construction) deliver clear and measurable carbon-reduction benefits, meet strict green finance criteria, and can therefore obtain long-term capital at rates below ordinary loans, improving project returns.

3.1.2. Internal governance mechanism: higher operating efficiency and innovation resilience

This mechanism treats ESG not as an external burden, but as a source of operational improvement once embedded into strategy and management routines. ESG practices can reduce operating costs and strengthen risk control. Attention to energy efficiency and water management directly lowers operating expenses. Strict audits on supply-chain responsibility and business ethics can reduce disruption risk and compliance risk.

ESG also guides targeted innovation. Goals such as low-carbon products and circular economy requirements push firms toward focused R&D that builds new markets and technology barriers. In addition, ESG can raise the productivity of human capital. A responsible employer brand helps attract and retain skilled talent and increases employee engagement, which supports both productivity and innovation.

In the new-energy vehicle sector, CATL faces strict requirements under the EU Battery Regulation on carbon footprint and recycling rates, which forces lifecycle carbon management across its supply chain. This external pressure is internalized into stronger supply-chain capabilities and drives upstream green-energy and investment in battery recycling. Beyond compliance, these actions help stabilize input costs through innovation and vertical integration, improving cost control and supply security and supporting long-term margins. As another example, Tongwei, a major upstream polysilicon producer with high energy intensity, places environmental management at the center of governance. Through continuous technical upgrading, it reduces electricity use per unit of output and shifts capacity toward regions rich in clean energy. This is not only a response to energy-control policies, but also a strategic move to reduce future financial risk from carbon cost internalization.

3.1.3. Reputation and social responsibility mechanism: making intangible assets visible

This mechanism emphasizes how stakeholder-based intangible assets (reputation capital) accumulate over time and can be converted into competitive advantage and financial returns when it matters.

First, firms with stronger ESG performance are more likely to obtain policy and regulatory support, including subsidies, tax incentives, and project approvals. Second, ESG can strengthen consumer trust and brand premiums as customers increasingly reward responsible brands. Third, ESG helps firms maintain a "social license to operate." Good relationships with communities and the public can reduce resistance and social risk during project development.

For example, BYD rapidly shifted production to masks during the early stage of COVID-19 and donated them globally. This high-profile social responsibility action reinforced a positive brand narrative and strengthened trust among consumers. Such reputation capital is hard to measure, but it can lower market-entry costs and improve acceptance during international expansion. For wind and solar developers, large projects often hinge on community relations. Hiring local workers, investing in local infrastructure, and protecting local ecosystems may raise upfront costs, but they help secure social acceptance, reduce delays or shutdown risks, and avoid major financial losses. This is a typical "risk-avoidance return."

These three mechanisms interact rather than operate independently. Financing advantages from capital markets support internal upgrades such as R&D and energy-efficiency investment. Better operations and products then improve ESG outcomes, which strengthens reputation and stakeholder support. Stronger reputation feeds back into capital markets, further lowering financing costs and reinforcing the cycle. In this sense, ESG integrates financial and non-financial performance into a self-reinforcing loop and helps build a more resilient foundation for long-term competitiveness.

3.2. Refined Analysis of Sector-wide Financial Characteristics

3.2.1. Profitability

Profitability in the new energy sector shows strong divergence between leading firms and second- or third-tier firms, and stability differs across sub-sectors. In photovoltaic manufacturing, average ROE is often driven by top firms, while smaller firms remain weak. Using 2022 as an example, industry-average ROE was 8.3%. LONGi achieved 12.5% due to scale and technology advantages, while some smaller firms were around 3%. By contrast, wind power operators tend to have more stable profitability, with ROE often staying in a 10–12% range. For instance, Longyuan Power maintained ROE above 11% for three consecutive years. Leading firms also show improving margins through scale economies and faster technology cycles, with higher gross margins and lower expense ratios.

3.2.2. Solvency

Solvency in the sector is shaped by generally high leverage, while strong firms show better short-term repayment capacity and cash-flow strength. The sector is asset-heavy, and leverage is therefore elevated. Photovoltaic manufacturers have an average debt–asset ratio around 65%, while wind operators can be around 70%, which raises demands on capital management. High-quality firms improve short-term solvency by optimizing asset structure. For example, Goldwind's current ratio rose from 1.2 (2020) to 1.5 (2023), and its quick ratio improved from 0.8 to 1.1, indicating lower short-term liquidity risk. Cash-flow coverage has become a key "safety line." The ability of operating cash flow to cover interest-bearing debt helps distinguish solvency quality. Strong firms often exceed 0.3 (e.g., Tongwei reached 0.45 in 2022), while some new entrants show negative values due to heavy upfront investment and weak cash flows.

3.2.3. Operating efficiency

Operational efficiency tends to be stronger among leading firms, especially in inventory and receivables management. Top firms often outperform the industry average in inventory turnover due to better supply-chain planning. For example, CATL reduced inventory days from 78 (2020) to 65 (2023), far below the industry average of about 85, lowering the cost of tied-up capital. Some firms also lead in receivables turnover by optimizing customer structure and collection policies. Trina Solar, for instance, keeps receivables days around 75, compared with an industry average near 90, indicating stronger working-capital liquidity.

3.3. Mechanism Analysis of Key Drivers

Firms in the new energy sector are jointly shaped by policy, cost and technology, and market structure. These forces interact through linked transmission channels and together determine strategic choices and operating performance.

3.3.1. Policy factors

Policy effects do not operate as simple commands. They work through financial incentives and market signals that reshape decision environments. A typical chain is: national dual-carbon targets → green credit guidelines by financial regulators → banks adjust credit structures → firms incorporate green credit into internal assessment, obtain certifications → firms access lower-cost funding.

Green credit can reduce financing costs by about 1–1.5 percentage points, improving cash flows and profitability, especially for asset-heavy firms with large capital expenditure. For example, China Three Gorges Renewables issued a green bond in 2022 with a spread of only 80 basis points over government bonds, notably below comparable conventional credit bonds. This reflects not only firm credit quality, but also policy mechanisms that lower perceived risk and required returns, which reduces issuance costs and supports large-scale project development.

3.3.2. Cost structure factors

Cost structure is dynamic and reflects the joint effects of technology upgrading and scaling. In photovoltaics, the share of polysilicon cost in module cost fell from about 45% (2020) to about 30% (2023) as capacity expanded and processes improved (e.g., thinner wafers and higher yields). At the same time, new technologies can increase auxiliary material costs. The industry is shifting from P-type to higher-efficiency N-type cells. N-type cells require higher conductivity, increasing both the amount and quality requirements of silver paste, with paste costs roughly 30% higher than in P-type cells. This creates an early-stage cost pressure and pushes firms to develop low-silver materials (e.g., copper-based pastes) or adopt new electrode structures (e.g., copper plating).

3.3.3. Market structure factors

Changes in competition directly shape profit space and market power. In photovoltaic manufacturing, scale is a key path to lower unit costs. Integrated firms with capacity above 10 GW often have unit costs more than 15% lower than firms below 5 GW, driven by stronger procurement bargaining power, greater dilution of fixed costs (depreciation, management, R&D), and more standardized and automated production with higher yields. In power batteries, leading firms have expanded capacity, locked in major customers, and strengthened technological leadership, raising concentration. The combined market share of the top three firms rose from about 65% (2020) to about 75% (2023).

Overall, firm performance can be viewed as a dynamic triangle of policy, costs, and markets. Policy shifts capital costs and guides resources; technology reshapes cost structure with both main-material savings and auxiliary cost pressures; and competition selects winners through scale and concentration, giving them stronger pricing power and long-term resilience. Understanding these interactions is critical for assessing future trajectories.

4. Financial Strategy Analysis of Representative Cases

4.1. Corporate Financial Strategies

4.1.1. CATL: integrating ESG into cost control

CATL embeds ESG practices into its cost-control strategy. To reduce exposure to raw-material price volatility, the company strengthens its lithium supply chain and, through investment and partnerships, improves self-supply and recycling capacity for key resources. In sourcing, CATL pursues cost discipline while tightening process compliance, including responsible procurement of critical materials such as cobalt through qualified suppliers. Through its battery recycling system, the

company recovers cobalt at a high rate, reducing reliance on primary mining and supporting a circular-economy approach. On the production side, CATL improves efficiency through smart manufacturing and advanced process optimization, which helps contain manufacturing costs. Part of the savings is reinvested in green manufacturing. For example, CATL has invested about RMB 8 billion in a zero-carbon industrial park in Dongying, Shandong, aiming to produce batteries using 100% renewable electricity and substantially reduce emissions. These actions improve compliance with low-carbon market-access requirements overseas and are associated with a gross margin of about 24.4% in 2024, indicating a reinforcing cycle linking cost control, environmental performance, and profitability.

4.1.2. BYD: stabilizing financial performance through full value-chain ESG integration

BYD leverages vertical integration to align financial strategy with ESG goals. By integrating the full chain from batteries to vehicles, building unified production platforms, and expanding scale, BYD keeps battery-pack and vehicle costs below the industry average. In 2024, it invested RMB 54.2 billion in R&D, enabling progress in key technologies such as hybrid systems. Its fifth-generation DM hybrid system reportedly reached a thermal efficiency of 46.06%, supporting sales and profit growth. Technological upgrading also supports lower-carbon products; the company reports that its new-energy vehicle fleet reduced carbon emissions by 8.4 million tonnes in the year, equivalent to planting 504 million trees. BYD's financial position remains strong, with cash reserves of RMB 154.9 billion at year-end and interest-bearing liabilities accounting for only 4.9%. This liquidity supports ESG actions, including RMB 1.41 billion spent on waste treatment to ensure full compliance with discharge standards. BYD also shortened supplier payment cycles to 127 days to ease liquidity pressure in the supply chain, established a RMB 3 billion education philanthropy fund, linked ESG performance to executive compensation with a 10% weight, and became among the first firms certified under ISO ESG standards. These practices strengthen investor confidence and further reinforce financial stability.

4.1.3. LONGi: building competitive advantage through R&D-driven ESG

LONGi uses R&D investment as a link between financial growth and ESG performance. Evidence suggests that each RMB 1 invested in R&D is associated with roughly RMB 1.5 in gross profit growth, while supporting continuous progress in green technologies. By developing high-efficiency photovoltaic products, LONGi increased the revenue share of new products from 25% in 2020 to 40% in 2023 and reduced the levelized cost of electricity to about RMB 0.20 per kWh, strengthening cost competitiveness in clean energy and aligning with environmental objectives. In ESG practice, the firm promotes sustainability awareness through initiatives such as "Sustainable Development Week," and its ESG cases have been recognized as Forbes "inspiring" examples, enhancing brand credibility. As overseas markets tighten low-carbon requirements, LONGi's low-carbon product profile supports stronger performance in green power tenders and international orders, forming a reinforcing loop from R&D to ESG advantage, to market competitiveness, and to profit growth. This loop both improves the return to innovation and strengthens the firm's competitive moat.

5. Outlook on Financial Trends in the Industry

5.1. Costs and profitability

The new energy sector is showing encouraging changes in costs and profitability. In some regions, the levelized cost of electricity has fallen to around RMB 0.20/kWh for photovoltaics and RMB 0.23/kWh for wind power, while storage costs are declining by about 10% per year. As capacity consolidation continues, profit pressure is expected to ease and gross margins may gradually recover. This pattern is already visible among leading firms. For example, Goldwind has reduced unit manufacturing costs by developing larger-capacity turbines, supporting a steady improvement in wind-related profitability. Falling storage costs also benefit the sector. CATL, through technology

upgrading and supply-chain integration, has lowered storage product costs over time and maintained competitiveness during industry consolidation, with margins becoming more stable.

5.2. Revenue and compliance

Revenue models and compliance requirements are changing rapidly. As subsidies phase out, the linkage between green electricity trading and carbon markets is creating new income opportunities. By purchasing green electricity and using green certificates, firms can offset carbon allowance needs, monetize environmental value, and reduce the carbon-related costs faced by exported products. Technologies such as energy storage also enable additional revenue through participation in power markets, including peak–valley arbitrage.

These opportunities come with rising compliance burdens. Tighter green finance standards and higher ESG disclosure requirements at home and abroad are increasing compliance costs. Firms must invest in ESG management systems, information infrastructure, and third-party assurance, which have become rigid operating expenses. For example, LONGi reported environmental spending of about RMB 50,000 in 2023, up 38% year-on-year. In 2022, its green electricity use exceeded 4.279 billion kWh, with green power accounting for 47.18%, and its greenhouse gas emissions per unit of revenue fell by 38.8% relative to 2021. LONGi also plans to change its audit firm, with an estimated audit fee of RMB 3.45 million for the 2024 annual report. The industry as a whole faced pressure in 2024. LONGi reported revenue of RMB 82.582 billion in 2024, down 36.23% year-on-year, and recorded a net loss attributable to shareholders, largely due to supply–demand mismatch and aggressive low-price competition. Overall, the sector is shifting from a subsidy-driven model toward market-based competition, where managing environmental assets and controlling compliance risks are central to building competitiveness.

5.3. Investment and risk

On investment and risk, technologies such as perovskite photovoltaics and solid-state batteries are approaching scale-up, creating new investment opportunities and supporting growth for technology-leading firms. At the same time, rapid technology cycles and potential overcapacity may intensify industry divergence, and lagging capacity faces losses and exit risk. In response to these opportunities, firms such as JA Solar and CNBM New Energy have begun deploying perovskite production lines to capture next-generation PV markets. CATL has partnered with BMW to build a solid-state battery mass-production line, with production expected in 2026; although near-term investment is large, the long-term payoff could be substantial. Risk responses also differ across firms. The lithium iron phosphate segment is already showing clear differentiation: leading firms such as Hunan Yuneng and Wanrun New Energy have strengthened their positions through technology and scale, while many smaller producers face low utilization or shutdowns due to weak competitiveness. Traditional battery firms that failed to adapt to new technologies are seeing weaker sales and rising losses, and some are at risk of being pushed out of the market.

6. Conclusion

6.1. ESG enhances financial performance through three reinforcing mechanisms

Through the external market mechanism, ESG performance acts as a credible signal that lowers financing costs and generates valuation premiums, with green finance policies further amplifying these effects. Within the internal governance mechanism, ESG is embedded into corporate strategy, improving cost efficiency, guiding targeted innovation, and strengthening human capital, thereby enhancing core competitiveness. Through the reputation and social responsibility mechanism, accumulated reputation capital is converted into policy support, brand premiums, and social license, helping firms avoid latent risks. Together, these mechanisms interact dynamically to form a virtuous cycle of capital support–operational optimization–reputation building–capital attraction.

6.2. The new energy sector shows strong financial divergence and a clear advantage for leading firms

In terms of profitability, leading firms achieve higher returns on equity through technological leadership and scale advantages, while wind power operations exhibit more stable profitability than photovoltaic manufacturing. Regarding solvency, the sector as a whole remains highly leveraged, but high-quality firms strengthen short-term repayment capacity and cash-flow coverage through asset structure optimization. In operating efficiency, industry leaders significantly outperform peers in inventory and receivables turnover, indicating more efficient capital use.

6.3. Policy, costs, and markets form a core triangular set of drivers

Dual-carbon policies reduce financing costs through green finance tools and direct resources toward high-ESG firms. Cost structures display a dynamic balance, with declining costs of core materials alongside rising auxiliary costs, driven by technological upgrading. In market structure, scale economies and rising concentration enable leading firms to reduce costs and gain pricing power, further widening industry differentiation.

6.4. Industry trends point to coordination and transformation

On the cost side, declining levelized electricity costs and capacity consolidation are expected to ease profit pressure. On the revenue and compliance side, green power trading and carbon-market integration create new income channels, while stricter ESG disclosure and regulation raise compliance costs. On the investment side, emerging technologies such as perovskite photovoltaics and solid-state batteries offer growth opportunities, but rapid technology cycles and overcapacity risks are accelerating industry reshuffling.

Overall, ESG practice has become a core strategy for new energy firms to navigate industry cycles and build sustainable competitive advantages. Firms should integrate ESG deeply into strategic planning, focus on key indicators within specific segments, and balance short-term costs with long-term returns through policy support and technological innovation. Investors and financial institutions can use ESG performance to identify high-quality assets and improve capital allocation, while policymakers should further strengthen coordination between green finance and ESG regulation to support high-quality and sustainable industry development.

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