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Article

Research on the Practical Pathways of Transition Finance in the Context of Carbon Peaking

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Abstract: Transition finance has emerged as a crucial policy and market mechanism for aligning carbon-intensive sectors with long-term climate goals while maintaining economic stability. Under the carbon peaking agenda, the primary challenge extends beyond expanding green finance; it requires constructing financing arrangements that support credible, phased, and sector-specific decarbonization for industries unable to transform immediately. This paper examines the practical pathways of transition finance to facilitate carbon peaking. It clarifies the conceptual distinction between green and transition finance and reviews the institutional conditions necessary for effective capital allocation. Subsequently, the study develops an analytical framework centered on standards, incentives, information, and governance. The practical advancement of transition finance relies on mutually reinforcing pathways: establishing taxonomy-based classification standards, designing differentiated financial products for hard-to-abate sectors, improving carbon data disclosure and verification, and creating coordinated policy-finance risk-sharing mechanisms. Furthermore, the paper addresses current constraints, including ambiguous eligibility boundaries, weak enterprise transition planning, insufficient performance assessment tools, and fragmented coordination between financial institutions and industrial regulators. By integrating policy analysis and institutional interpretation, this research provides a structured account of how transition finance can realistically support carbon peaking. The findings indicate that transition finance must be embedded within a broader governance architecture linking climate targets, industrial upgrading, financial innovation, and accountability mechanisms, thereby translating general financial logic into concrete implementation pathways.

Keywords: transition finance; carbon peaking; sustainable finance; climate governance; decarbonization

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1. Introduction

Carbon peaking has become a critical intermediate objective in the broader global response to climate change. For countries undergoing rapid industrial transformation, the pathway toward peaking carbon emissions is shaped not only by environmental regulation but also by the capacity of the financial system to channel capital toward orderly structural adjustment. In this context, transition finance has emerged as a policy-relevant concept because it addresses a problem that conventional green finance cannot fully resolve. Many sectors with high emissions remain central to industrial production, employment, and energy security [1]. These sectors may not qualify as green in the strict sense, yet their decarbonization is indispensable to any credible carbon peaking strategy.

The practical significance of transition finance lies in its ability to support gradual yet measurable emissions reduction among carbon-intensive firms and industries. Instead of restricting capital only to already low-carbon activities, transition finance seeks to direct

financial resources toward enterprises that are willing and able to move along a verifiable decarbonization pathway. This makes it particularly relevant for industries such as steel, cement, chemicals, thermal power, and transport, where technological substitution is costly, time-consuming, and institutionally complex. By focusing on these high-emission sectors, transition finance can facilitate a more inclusive and pragmatic approach to achieving carbon peaking goals [2].

Despite growing policy attention, transition finance remains underdeveloped in both conceptual and operational terms. Existing debates often focus on broad principles, but practical implementation requires more specific answers to several pressing questions [3]. For instance, what activities should be recognized as transition-eligible? How should financial institutions identify credible transition projects? What forms of policy support are necessary to reduce uncertainty and attract long-term capital? Additionally, how can emission reduction outcomes be monitored effectively without creating excessive compliance burdens? These questions are particularly urgent in the context of carbon peaking, where the policy time horizon is relatively near, and the demand for real-sector adjustment is high. Addressing these challenges is essential for ensuring that transition finance can fulfill its potential as a tool for sustainable development.

This paper addresses these issues by examining the practical pathways of transition finance in the context of carbon peaking. It argues that transition finance should be understood as a governance instrument rather than merely a financing category. Its effectiveness depends on the interaction between classification standards, financial product design, disclosure infrastructures, and public policy coordination. By integrating these elements, transition finance can move beyond policy rhetoric and become a tangible mechanism for driving decarbonization. The paper adopts a theoretical and policy-analytical approach, drawing on the emerging literature on sustainable finance, transition planning, and climate governance [3]. The objective is to identify operational mechanisms through which transition finance can be effectively implemented in institutional practice, thereby contributing to the broader goals of carbon peaking and climate resilience.

The remainder of this paper is organized as follows. The next section reviews the literature on green finance, transition finance, and climate-related financial governance [4, 5]. The third section presents the analytical framework used in this study. The fourth section examines the major practical pathways for developing transition finance under carbon peaking conditions. The fifth section discusses major implementation constraints and governance implications. The final section concludes by summarizing the key findings and offering recommendations for future research and policy development.

Table 1 summarizes the core distinctions between green finance and transition finance as used in this paper. This table provides a clear conceptual framework for understanding how these two approaches differ in terms of objectives, eligibility criteria, and implementation strategies [6]. By highlighting these distinctions, Table 1 serves as a foundational reference for the subsequent analysis and discussion.

Table 1. Conceptual Distinction between Green Finance and Transition Finance

Dimension	Green Finance	Transition Finance
Primary target	Already low-carbon or environmentally beneficial activities	Carbon-intensive sectors moving toward lower-carbon pathways
Eligibility logic	Static environmental performance	Dynamic improvement and transition credibility
Core financing focus	Expansion of green assets	Decarbonization of hard-to-abate sectors

Main governance need	Green taxonomy and use-of-proceeds control	Transition taxonomy, milestones, and accountability
Key risk concern	Greenwashing	Transition washing and carbon lock-in

2. Literature Review

The literature on sustainable finance has historically focused on the role of financial systems in supporting environmentally beneficial activities, particularly in areas such as renewable energy, clean technology, and pollution control [7]. Within this body of work, green finance has been widely regarded as an overarching concept that includes green credit, green bonds, green investment, and climate-related disclosure. However, the expansion of green finance has also highlighted a significant limitation. Its eligibility criteria often favor activities that are already low carbon or environmentally positive, thereby leaving limited opportunities for sectors where decarbonization is a gradual, complex, and capital-intensive process.

This limitation has spurred increasing academic and policy interest in the concept of transition finance. Transition finance is described as a mechanism designed to support firms, projects, or sectors in moving from high-carbon to lower-carbon states through credible and time-bound transformation strategies. Unlike green finance, which is primarily defined by the current environmental status of an activity, transition finance emphasizes directionality, improvement potential, and accountability [8]. This shift from a static classification system to one focused on dynamic transformation represents a key conceptual advancement in the emerging literature.

A related area of research underscores that transition finance should not be broadly applied to any carbon-intensive investment. Without clear and rigorous standards, the concept risks becoming indistinguishable from conventional industrial finance or being misused to justify investments that perpetuate high-emission practices. To address this, several scholars emphasize the importance of transition taxonomies, science-based targets, interim milestones, and disclosure obligations [9]. These governance tools are critical for distinguishing genuine transition efforts from superficial claims and for mitigating the risks of greenwashing or transition washing.

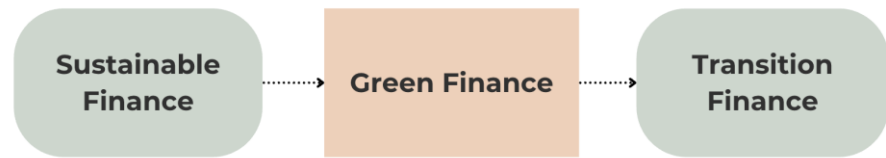
Another important focus of research examines the role of financial institutions in facilitating climate transition. Banks, insurers, asset managers, and capital market intermediaries are increasingly expected to assess transition risks alongside physical climate risks [10]. This involves evaluating whether firms have credible decarbonization plans, determining the technological feasibility of sectoral transition pathways, and assessing whether regulatory frameworks are stable enough to justify long-term investments. The literature highlights the necessity of aligning micro-level investment decisions with macro-level transition strategies to ensure coherence and effectiveness.

There is also a growing body of work exploring the political economy of transition finance. Decarbonization is not merely a technical process; it also involves significant distributional challenges across sectors, regions, ownership structures, and labor markets [11]. Financial support for transition can therefore lead to conflicts over eligibility criteria, subsidy allocation, and the sequencing of regulatory measures. Research in this area suggests that effective transition finance requires robust public policy coordination, particularly in contexts where market incentives alone are insufficient to drive early-stage industrial transformation.

Despite the rapid development of international literature on this topic, several limitations persist [12]. First, many discussions remain focused on principles and offer limited guidance for operational design in specific policy contexts. Second, there is a need for more research on how transition finance interacts with carbon peaking targets, which demand substantial emissions reductions within compressed time frames. Third, there is

insufficient integration between the fields of financial innovation, industrial policy, and carbon governance. This paper aims to address these gaps by exploring practical pathways for implementing transition finance under carbon peaking conditions.

Figure 1 illustrates the conceptual positioning of transition finance within the broader sustainable finance framework.



Transition finance links climate goals to the decarbonization of hard-to-abate sectors

Figure 1. Conceptual Positioning of Transition Finance

3. Theoretical Framework

This study develops an analytical framework for transition finance based on four interconnected dimensions: standards, incentives, information, and governance. These dimensions collectively provide a comprehensive explanation of whether transition finance can serve as a credible and scalable mechanism for supporting carbon peaking efforts. By addressing these dimensions systematically, the study aims to offer insights into the practical challenges and opportunities associated with transition finance.

The first dimension, standards, emphasizes the necessity of establishing clear and enforceable rules that define which sectors, activities, and projects qualify for financial support. These standards must include specific baselines, anticipated improvement trajectories, exclusion boundaries, and robust verification methods. Without such well-defined rules, financial actors face difficulties in distinguishing genuine transition activities from routine investments, leading to potential credibility deficits in the market. The establishment of rigorous standards is therefore essential for ensuring the legitimacy and effectiveness of transition finance mechanisms.

The second dimension, incentives, addresses the financial challenges inherent in transition activities, which often involve substantial upfront costs, uncertain returns, and extended payback periods [13]. Financial institutions may hesitate to invest in such activities unless policy instruments are in place to mitigate risks or enhance profitability. Effective incentive structures can include interest subsidies, credit enhancement measures, guarantee mechanisms, tax preferences, and supportive monetary tools. The central challenge lies in designing reward systems that promote measurable emissions reductions while maintaining market discipline and avoiding distortions in financial decision-making processes.

The third dimension, information, highlights the critical role of reliable data in transition finance. Accurate information regarding carbon intensity, technological pathways, enterprise transition plans, and actual emissions performance is essential for informed decision-making. Information asymmetry poses significant challenges, particularly in heavy industry and other hard-to-abate sectors where emissions accounting is complex and transition timelines vary widely. To address these challenges, robust disclosure practices, advanced data infrastructure, third-party verification mechanisms, and digital monitoring systems are necessary to reduce uncertainty and enhance accountability across stakeholders.

The fourth dimension, governance, underscores the importance of effective coordination across institutional boundaries. Transition finance operates at the intersection of climate policy, industrial policy, financial regulation, and corporate strategy, making governance quality a critical determinant of implementation outcomes.

Effective governance requires collaboration among regulators, standard-setting bodies, financial institutions, industry associations, and enterprises [14]. Additionally, adaptive mechanisms for iterative adjustment are essential, as transition pathways may evolve in response to technological advancements, market fluctuations, and policy learning processes.

Building on these four dimensions, this paper argues that the successful development of transition finance under carbon peaking conditions hinges on an integrated institutional logic. Standards provide legitimacy, incentives mobilize capital, information facilitates accurate assessment, and governance ensures sustained coordination [2]. Weaknesses in any one dimension can compromise the overall effectiveness of the system, underscoring the need for a holistic approach to transition finance governance.

Table 2 presents the analytical framework utilized in this study, offering a structured overview of the governance dimensions critical to transition finance.

Table 2. Analytical Framework for Transition Finance Governance

Dimension	Core question	Main institutional requirement	Failure risk
Standards	What qualifies as transition activity?	Sector-sensitive taxonomy and baselines	Boundary ambiguity
Incentives	Why would capital flow to transition projects?	Risk-sharing and return enhancement	Underinvestment
Information	How can transition credibility be assessed?	Disclosure, verification, and carbon data systems	Adverse selection
Governance	How are cross-sector actors coordinated?	Policy alignment and adaptive regulation	Fragmentation

4. Practical Pathways of Transition Finance under Carbon Peaking

The first practical pathway involves the establishment of a transition finance classification system specifically designed to meet the requirements of carbon peaking [15]. Such a system must go beyond merely listing encouraged activities; it should provide a structured taxonomy that distinguishes between short-term efficiency improvements, medium-term process transformations, and long-term technological substitutions. This differentiation is crucial because sectors exhibit significant variability in terms of their abatement potential, investment timelines, and regulatory pressures. By refining the classification system, financial institutions can make more consistent and informed decisions, fostering a shared market language that aligns with carbon peaking objectives. This structured approach ensures that financing conditions are directly tied to emissions reduction trajectories, thereby enhancing the overall effectiveness of transition finance.

The second pathway emphasizes the innovation of financial products tailored to the unique challenges of hard-to-abate sectors. Traditional green credit instruments often fall short for enterprises undertaking transition projects that are large-scale, multi-phased, and fraught with technological uncertainties. To address this, transition finance must embrace product diversification. Examples of potential instruments include transition loans linked to verified emissions indicators, sustainability-linked bonds with sector-specific performance triggers, and transition-oriented supply chain finance. Additionally, blended finance arrangements can support industrial retrofitting, while insurance mechanisms can mitigate risks associated with adopting new technologies. These financial products should be designed to reflect the operational realities of transition projects, rather than merely extending green labels to conventional lending structures.

This approach ensures that financial tools are both practical and impactful in driving meaningful progress toward carbon peaking.

The third pathway focuses on enhancing enterprise transition planning and carbon information disclosure. Effective financial support hinges on the presence of credible transition roadmaps from enterprises. Firms seeking transition finance should be encouraged or mandated to develop medium- and long-term transition plans. These plans should detail baseline emissions, technological pathways, capital expenditure schedules, governance responsibilities, and interim targets. To facilitate evaluation, these plans must be aligned with standardized disclosure templates, enabling lenders and investors to assess their consistency and progress. Carbon information should be elevated from a peripheral compliance issue to a central element of financial due diligence and post-financing supervision. This shift ensures that financial institutions can allocate resources more effectively, fostering accountability and transparency in the transition process.

The fourth pathway involves the establishment of policy-finance coordination mechanisms to address systemic uncertainties. While carbon peaking is a public policy goal, the financing of transition projects often relies on commercial channels, creating a structural tension between public objectives and private risk preferences. To bridge this gap, governments and regulators can implement supportive frameworks such as risk-sharing facilities, guarantee funds, targeted refinancing tools, and coordinated pilot programs in key industrial regions. These mechanisms can reduce financing costs, enhance project bankability, and demonstrate policy commitment. However, it is essential that such coordination mechanisms avoid unconditional support. Public interventions should be tied to transparent performance criteria to ensure accountability and prevent misuse of resources. This balanced approach fosters a collaborative environment where public and private sectors work together to achieve carbon peaking goals.

The fifth pathway highlights the importance of developing transition-oriented assessment and accountability systems. A significant barrier to scaling transition finance is the lack of consistent methods for evaluating whether financed activities genuinely contribute to carbon peaking [16]. To address this, assessment systems should integrate ex ante reviews, ongoing monitoring, and ex post evaluations. Key indicators may include improvements in carbon intensity, progress in process substitution, gains in energy efficiency, and the compatibility of financed assets with long-term decarbonization trajectories. Accountability mechanisms should incorporate disclosure obligations, independent verification, and consequences for significant deviations from transition commitments. These systems are vital for maintaining the credibility of transition finance and ensuring that it remains focused on achieving measurable outcomes rather than devolving into generalized industrial support.

These pathways are interconnected and mutually reinforcing. For instance, classification standards enhance product design by clarifying eligibility criteria, while improved disclosure practices incentivize precise risk pricing. Policy coordination reduces fragmentation, thereby strengthening governance frameworks. Assessment systems, in turn, bolster all other dimensions by linking financial activities to measurable outcomes. This interconnectedness underscores the need to view transition finance as an institutional ecosystem rather than a collection of isolated instruments. By fostering synergy among these pathways, stakeholders can create a robust framework that effectively supports carbon peaking objectives.

Figure 2 illustrates the structural framework of practical pathways through which transition finance contributes to achieving carbon peaking objectives. This visual representation underscores the interconnected nature of the pathways and their collective role in driving systemic change [17].

Practical pathways of transition finance



Figure 2. Practical Pathway Structure of Transition Finance

Table 3 provides a comprehensive summary of the major implementation pathways and the associated policy tools that facilitate transition finance. This table serves as a practical guide for stakeholders, offering a clear overview of the strategies and mechanisms required to support carbon peaking efforts.

Table 3. Practical Pathways and Policy Tools for Transition Finance Implementation

Practical pathway	Main content	Representative tools	Expected contribution
Classification system construction	Define sectoral eligibility and transition milestones	Taxonomy, sector guidelines, exclusion lists	Improves market consistency
Product innovation	Match finance instruments to industrial transition needs	Transition loans, sustainability-linked bonds, blended finance	Expands financing channels
Enterprise planning and disclosure	Improve project credibility and investor assessment	Transition plans, disclosure templates, verification	Reduces information asymmetry
Policy-finance coordination	Share risk between public and private actors	Guarantees, refinancing tools, pilot programs	Lowers financing barriers
Assessment and accountability	Link funds to measurable decarbonization outcomes	KPIs, monitoring, third-party review	Protects credibility

5. Discussion

Although the practical pathways outlined above are feasible, their implementation faces several structural constraints. One significant issue is the challenge of boundary ambiguity. In numerous sectors, it is often difficult to clearly differentiate between legitimate transition activities and the expansion of high-emission production capacities disguised under a low-carbon narrative. If the eligibility boundaries are defined too loosely, the credibility of transition finance may be undermined. Conversely, if the boundaries are overly restrictive, critical decarbonization investments with substantial potential may be excluded. This persistent boundary issue is likely to remain a central governance challenge in the development of effective transition finance mechanisms.

Another constraint relates to the capability of enterprises. Many firms, particularly those in traditional industries, currently lack the technical, managerial, or informational

resources necessary to develop credible and actionable transition plans. For instance, they may not have access to accurate carbon accounting systems, the ability to conduct scenario analyses, or robust internal governance frameworks that align environmental objectives with investment strategies. This deficiency weakens the demand for transition finance, as financial instruments cannot operate effectively without a pipeline of investable and verifiable transition projects. Addressing these capability gaps is essential for fostering a more robust and functional transition finance ecosystem.

A further challenge is the limited maturity of performance measurement systems. Carbon reduction outcomes often materialize over extended timeframes and are influenced by external factors beyond the direct control of firms or financiers. This complexity makes it difficult to design performance indicators that are both rigorous and practical. Overly intricate metrics may deter participation due to their complexity, while overly simplistic metrics risk failing to accurately capture genuine progress in transition efforts. Therefore, developing a balanced and effective measurement framework is critical to ensuring that transition finance achieves its intended objectives without creating unnecessary barriers.

Institutional fragmentation presents another significant issue. Transition finance spans multiple sectors, including finance, ecology, industry, energy, and local development. Without effective coordination among these diverse departments, policy objectives may conflict or remain poorly aligned. For example, industrial support policies might prioritize production stability, whereas financial regulators could focus on maintaining prudential caution. Additionally, local governments may adopt varying approaches based on regional development pressures and industrial structures. These disparities complicate the establishment of a nationally coherent framework for transition finance, highlighting the need for improved interdepartmental coordination and alignment of objectives.

The governance implication is that transition finance should not be perceived as an isolated innovation within the financial sector. Instead, it should be understood as a cross-sector governance arrangement that necessitates strategic coordination, phased experimentation, and adaptive regulatory frameworks [18]. In practical terms, policymakers should focus on implementing sector-specific pilot programs, establishing high-quality disclosure standards, and developing shared evaluation frameworks. Financial institutions must enhance their internal capabilities for managing transition finance, treating it as a core component of their operations rather than a peripheral extension of green business lines. Enterprises, on the other hand, should prioritize strengthening their transition planning processes and integrating carbon management into their capital budgeting and governance structures to ensure alignment with broader environmental objectives.

From a broader perspective, transition finance represents a fundamental shift in the relationship between finance and industrial transformation. Under the conditions of carbon peaking, finance is no longer merely a passive allocator of capital based on existing market signals. Instead, it assumes an active role in shaping industrial trajectories, influencing technological choices, and distributing risks. The challenge lies in fulfilling this transformative role while maintaining transparency, discipline, and long-term climate credibility. This evolving dynamic underscores the importance of fostering a financial system that is both innovative and accountable in supporting the global transition to a low-carbon economy.

Figure 3 illustrates the governance constraints that impact the scaling of transition finance, providing a visual representation of the multifaceted challenges discussed in this section.

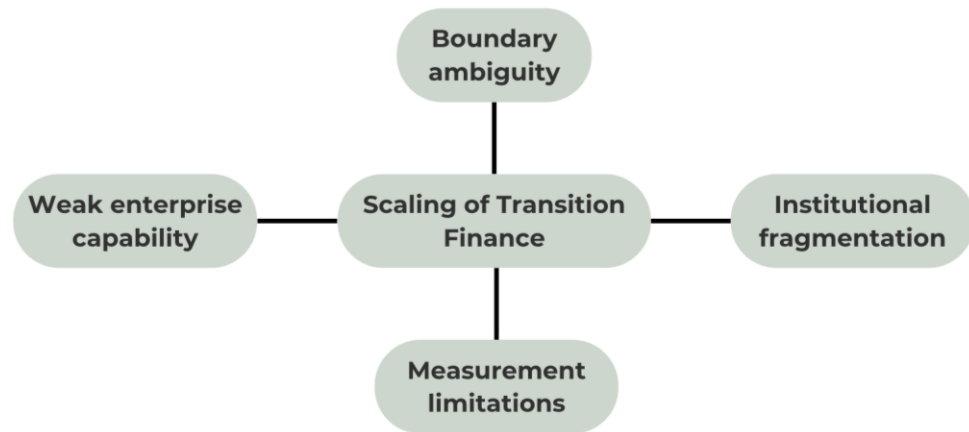


Figure 3. Governance Constraints on Scaling Transition Finance

6. Conclusion

In the context of carbon peaking, transition finance serves as a critical mechanism to bridge the gap between ambitious long-term climate objectives and the immediate challenges of industrial transformation. Its significance lies in its ability to facilitate emissions reductions in sectors that are not only economically vital but also heavily reliant on carbon-intensive processes, where immediate green alternatives are either unavailable or impractical. This paper has underscored that the successful implementation of transition finance requires a comprehensive and integrated framework. Such a framework must be constructed around key pillars, including the establishment of clear standards, the provision of targeted incentives, the enhancement of information transparency, and the development of robust governance mechanisms. By addressing these foundational elements, transition finance can evolve into a practical tool capable of driving meaningful progress toward carbon neutrality.

The analysis presented in this paper has identified several actionable pathways to operationalize transition finance effectively. These include the development of sector-specific classification systems that account for the unique characteristics and decarbonization challenges of different industries. Additionally, the design of diverse financial products tailored to varying transition needs can enhance the accessibility and applicability of transition finance. Strengthening enterprise-level transition planning and improving carbon disclosure practices are also critical steps, as they provide the necessary transparency and accountability to ensure that financial resources are directed toward credible transition efforts. Furthermore, the establishment of policy-finance coordination mechanisms can align public and private sector efforts, while the enhancement of assessment and accountability systems can ensure that transition finance initiatives are both measurable and impactful. Collectively, these pathways offer a structured approach to translating the theoretical principles of transition finance into practical, institutionalized solutions that are well-suited to the carbon peaking phase.

At the same time, this paper has highlighted several constraints that currently limit the effectiveness of transition finance. These include ambiguities in defining the boundaries of transition activities, insufficient capabilities within enterprises to plan and execute transitions, the lack of mature tools for measuring progress, and fragmented governance structures that hinder coordinated action. Addressing these challenges will require a multifaceted approach that goes beyond financial innovation. Regulatory clarity is essential to establish consistent guidelines and expectations, while industrial coordination can facilitate the alignment of efforts across sectors. Institutional learning, driven by iterative feedback and adaptive management, will also play a crucial role in refining transition finance practices over time. Ultimately, the success of transition finance should be evaluated based on its ability to support credible, measurable, and economically viable transition processes, rather than merely expanding the volume of

labeled financial products. This perspective ensures that transition finance remains focused on achieving tangible environmental and economic outcomes.

The broader implication of this analysis is that achieving carbon peaking necessitates a form of finance that is both disciplined in its approach and developmental in its impact. Transition finance has the potential to fulfill this dual role if it is embedded within a governance framework that effectively integrates public objectives with private capital. Such a framework must prioritize transparency, accountability, and the alignment of financial flows with long-term sustainability goals. Future research could build on this foundation by conducting detailed sectoral case studies to explore how transition finance operates in specific industrial contexts. Comparative institutional analyses could provide insights into how different governance models influence the effectiveness of transition finance, while empirical evaluations of pilot programs could offer valuable lessons for scaling up successful initiatives. By addressing these areas, future studies can contribute to the refinement and expansion of transition finance as a pivotal tool for achieving carbon peaking and, ultimately, carbon neutrality.

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