



FINANCIAL INSTRUMENTS TO STIMULATE GREEN INNOVATION IN CHINA WITHIN THE FRAMEWORK OF GLOBAL ECONOMIC TRANSFORMATION

*Instrumentos financeiros para estimular a inovação verde na China no âmbito
da transformação económica global*

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ABSTRACT

The relevance of this study is underscored by the growing need to align economic systems with the requirements of sustainable development and the mitigation of climate change. In this light, green investments emerge as a pivotal mechanism for business transformation and the facilitation of environmentally sustainable economic growth, particularly against the backdrop of China's rapid economic advancement. The objective of this study was to scrutinize both the theoretical and practical dimensions of utilizing financial instruments in China to bolster green innovation. To address this objective, a set of practical methodologies was employed, in particular econometric analysis, indicator monitoring, system-logical modeling, comparative analysis, and the computation of the Investment Efficiency Index (IEI). It was found that China achieved remarkable progress in the evolution of a green financial framework and the implementation of sustainable energy technologies in recent years. China is vigorously implementing sustainable development strategies that encompass investments in renewable energy sources, green finance, and clean Technologies. Keywords: low-carbon energy, sustainable development, energy strategies, ecological transformation, investments in the green sector, green technologies.

Keywords: Low-carbon energy, Sustainable development, Energy strategies, Ecological transformation, Investments in the green sector, Green technologies

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INSTRUMENTOS FINANCEIROS PARA ESTIMULAR A INOVAÇÃO VERDE NA CHINA NO ÂMBITO DA TRANSFORMAÇÃO ECONÓMICA GLOBAL

Financial instruments to stimulate green innovation in china within the framework of global economic transformation

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RESUMO

A relevância deste estudo é destacada pela crescente necessidade de alinhar os sistemas econômicos com as exigências do desenvolvimento sustentável e da mitigação das mudanças climáticas. Nesse contexto, os investimentos verdes emergem como um mecanismo fundamental para a transformação empresarial e a facilitação de um crescimento econômico ambientalmente sustentável, especialmente diante do rápido avanço econômico da China. O objetivo deste estudo foi analisar tanto as dimensões teóricas quanto práticas do uso de instrumentos financeiros na China para fortalecer a inovação verde. Para atingir esse objetivo, foi empregado um conjunto de metodologias práticas, em particular análise econométrica, monitoramento de indicadores, modelagem lógica de sistemas, análise comparativa e o cálculo do Índice de Eficiência de Investimentos (IEI). Foi constatado que a China alcançou progressos notáveis na evolução de um arcabouço financeiro verde e na implementação de tecnologias de energia sustentável nos últimos anos. A China está implementando vigorosamente estratégias de desenvolvimento sustentável que abrangem investimentos em fontes de energia renovável, finanças verdes e tecnologias limpas. **Palavras-chave:** energia de baixo carbono, desenvolvimento sustentável, estratégias energéticas, transformação ecológica, investimentos no setor verde, tecnologias verdes.

Palavras-chave: Energia de baixo carbono, Desenvolvimento sustentável, Estratégias energéticas, Transformação ecológica, Investimentos no setor verde, Tecnologias verdes

INTRODUCTION

Currently, the world faces unprecedented challenges pertaining to global environmental, economic, and energy transformations. Climate change, environmental degradation, the depletion of natural resources, growing energy needs of the population, as well as geopolitical instability— all this requires rethinking conventional paradigms of economic development. The establishment of a novel paradigm based on the principles of sustainability, environmental safety, and energy efficiency is not merely a desirable direction, but an imperative for preserving the global economic system's viability (Ren et al., 2022; Malik et al., 2020).

Against this backdrop, the concept of a green economy emerges as a pivotal strategic response from the global community to the imperative for environmentally sustainable growth. It entails the profound integration of innovative technologies into the spheres of production, consumption, logistics, and energy distribution, thereby facilitating a reduction in greenhouse gas emissions, the rational use of resources, and the enhancement of the population's living standards. Nevertheless, the real implementation realization of this green transformation requires robust financial support—financial instruments serve as the major mechanism for channeling capital into eco-oriented sectors (Zhang et al., 2023a).

The contemporary framework of financial incentives for green innovations encompasses a wide range of mechanisms, ranging from "green" bonds and government subsidies to preferential loans, tax incentives, specialized investment funds, and ESG financing instruments. Their judicious application not only makes it possible to accelerate the enterprises' technological modernization but also fosters the transition to a circular and low-carbon economy on a global scale (Shi et al., 2025; Lin et al., 2023).

The experience of the People's Republic of China, which has emerged over the past several decades as one of the main global actors in the field of green transformation, has attracted significant attention from researchers and international institutions. Amidst the environment characterized by pronounced industrialization and a dense production's concentration, the People's Republic of China has confronted serious environmental challenges, which prompted the country to develop a large-scale ecological modernization strategy (Qiu et al., 2020).

One of the key vectors of this strategy is the transition from coal-fired power generation to the utilization of natural gas as a more environmentally friendly energy source. China is actively investing in the advancement of international gas supply infrastructure, particularly through the execution of large-scale pipeline transportation projects and the establishment of terminals for the reception of liquefied natural gas (LNG). Noteworthy initiatives include, in particular, the Power of Siberia project, which guarantees reliable gas supplies from Russia, alongside the expansion of collaborative efforts with nations in Central Asia, the Middle East, and Southeast Asia (Liu et al., 2022a).

Such projects possess not only energy but also significant environmental implications, in particular they provide industrial regions of the People's Republic of China with cleaner fuel, thereby contributing to the reduction of greenhouse gas emissions, mitigating air pollution, and enhancing the overall ecological equilibrium in megacities. Furthermore, investment in gas infrastructure establishes the necessary foundations for a subsequent transition to renewable energy sources, ensuring energy flexibility throughout the transitional phase (Du et al., 2021; China Energy Transformation Programme, 2025).

The purpose of the study is to substantiate the theoretical underpinnings and practical approaches for utilizing financial instruments to stimulate green innovations in the context of global economic transformation, taking into account the experience of the People's Republic of China in implementing large-scale projects aimed at transitioning to low-carbon energy.

To achieve this goal, the following tasks were set:

1. Elucidate the principal theoretical foundations of green innovations and their significance in global economic transformation.
2. Analyze the experience of the People's Republic of China in implementing financial instruments that facilitate the transition to low-carbon energy.
3. Identify the factors that determine the effectiveness of green financial instruments and their interplay with economic and environmental conditions.

1 LITERATURE REVIEW

The issue of catalyzing green innovation through financial instruments has been a focal point of scholarly discourse for the past two decades. In light of the escalating challenges posed by climate change and the imperative for energy transition, researchers tend to pay considerable attention to mechanisms that finance innovations centered on environmental sustainability and resource efficiency.

At the conceptual level, theoretical studies of green innovations were laid by the works of authors such as Lee et al. (2025) and Li et al. (2023), who considered economic barriers to the development of environmental technologies. In this light, Hu et al. (2024) underscored the critical role of investment in research and development as a catalyst for innovation in sustainable development. They accentuated the significance of employing economic instruments, including subsidies, tax incentives, and environmental levies, to galvanize the progression of clean technologies.

More recent research underscores the pivotal role of financial instruments in mobilizing investments in green technologies. Notably, Arefiev et al. (2023) and Chen et al. (2023) delve into the significance of "green" bonds, climate funds, subsidies, and public-private partnerships in shaping an innovation ecosystem conducive to sustainable development.

Particularly noteworthy are the scholarly contributions focused on China's economic policy regarding green transformation. For instance, Zhang et al. (2023b) investigates the influence of state financial support on the adoption of energy-efficient technologies within industrial enterprises. Next, Zhong & Cao (2022) scrutinizes the evolution of the green bond market in the People's Republic of China and its implications for the reduction of CO₂ emissions. Furthermore, Zheng et al. (2022) analyzes China's energy policy, emphasizing the transition from a coal-centric model to the utilization of natural gas.

It is worth noting that an important place in the scholarly literature is occupied by the analysis of China's gas infrastructure as an essential component of its green energy policy. For instance, Zhu (2025) elucidates that gas pipeline projects originating from Central Asia (Turkmenistan, Uzbekistan, Tajikistan, Kyrgyzstan) to China yield a dual benefit – fortifying energy security while simultaneously reducing environmental impacts through diminished coal consumption. In turn, Wu et al. (2020) emphasizes the strategic significance of the Myanmar–China gas pipeline, which facilitates China's diversification of natural gas supplies and bolsters its geo-economic stature within the Asian region. Furthermore, the examination of the impact of China's green innovations on the global economy is equally relevant. In particular, Zhou et al. (2025) demonstrates that the environmental innovations executed under the auspices of the Chinese strategy of "green modernization" are catalyzing the transformation of global value chains and also stimulate an increased demand for eco-technologies in emerging economies.

Despite the growing body of research, aspects such as the effectiveness of combining different financial instruments in the green innovation sector, particularly in the context of transboundary energy initiatives, remain inadequately explored. Equally deserving of further investigation is the influence of transnational investments in green gas infrastructure on regional environmental sustainability.

Thus, the existing scientific literature provides a robust foundation for analyzing financial mechanisms that catalyze green innovation; however, it requires supplementation, taking into account China's recent experience in the gas energy sector as part of a comprehensive green strategy.

2 MATERIALS AND METHODS

2.1 Research procedure

The study into the impact of green investment on sustainable business development in China was conducted in several successive stages, each characterized by clearly defined objectives and employing relevant methodologies to achieve a holistic and comprehensive analysis.

At the first stage, a thorough literature analysis and review of pertinent sources were undertaken, encompassing the examination of scholarly articles, analytical reports, statistical data, as well as information from international organizations. This exhaustive review enabled the identification of prevailing trends, challenges, and strategic directions for the development of green investments. Drawing from the insights studied, a robust theoretical framework for the research was established, serving as the cornerstone for subsequent analytical steps.

The second stage involved collecting empirical data from open sources, in particular from Chinese governmental institutions and international analytical agencies, which facilitated the construction of an objective overview of the current state and dynamics of green finance development within the country.

At the third stage, a comparative analysis of the results obtained with international practices was carried out, which revealed common patterns in the development of green investments, as well as identified unique features of the Chinese approach.

2.2 Research methods

A range of methods was used throughout the research process, each contributing significantly to achieving the study objectives and facilitating a comprehensive and objective analysis. One of the key tools was econometric analysis, which enabled a quantitative assessment of the interplay between the dynamics of green investments and macroeconomic indicators, such as gross domestic product and greenhouse gas emissions.

To study the state of green investments, the indicator monitoring method was applied, involving an examination of financial flows' dynamics within the green economy sector, as well as the environmental outcomes realized through investment initiatives' implementation. This approach made it possible to track changes in critical indicators of sustainable development and financial decisions' efficacy. System logic modeling facilitated the construction of a conceptual framework for sustainable business, within which green investments were positioned as a central mechanism for fostering long-term competitive advantages.

The study further incorporated a comparative analysis, which enabled comparing Chinese experiences with international practices. Statistical methodologies were employed to analyze the trends in investment volumes, electricity generation from renewable sources, variations in the proportion of green projects within the national financing structure, as well as other pertinent indicators.

Finally, the method of scientific abstraction played a crucial role in developing the general conclusions of the study. Through this lens, it became possible to elucidate key theoretical provisions regarding the operation of sustainable business in the context of transitioning to a green economy, effectively integrating empirical findings with analytical insights.

2.3 Sample

To conduct the study, a representative sample was formed, synthesizing both quantitative and qualitative data sources while considering the relevance, reliability, and information completeness. The basis of the sample comprised data derived from official reports issued by international and national organizations. An analysis was performed on documents from the United Nations, the Food and Agriculture Organization of the United Nations (FAO), the International Energy Agency (IEA), the International Renewable Energy Agency (IRENA), as well as Chinese institutions, including the National Bureau of Statistics of China (NBSC) and the National Development and Reform Commission (NDRC).

Particular attention was paid to economic indicators that facilitate the evaluation of green investments' impact on national development. These indicators encompass data on gross domestic product, investment levels, and electricity generation from renewable sources, thereby enabling not only a comprehensive overview of the economic landscape but also a quantitative assessment of the efficacy of implementing environmentally friendly financial mechanisms.

An additional layer of information encompassed specific projects and initiatives executed within the framework of green financing. Case studies of funding through green bonds and other financial instruments were scrutinized, allowing us to trace the direct correlation between investment decisions and results achieved.

The sample was formed according to several key criteria. First and foremost, the relevance of the information was taken into account, with a particular emphasis on data from the period 2020–2024. This temporal framework enabled a comprehensive evaluation of contemporary trends and the most recent advancements in the field of green finance. Furthermore, the sources accessibility, their credibility, and methodological rigor were considered.

2.4 Estimated indicators

To assess the economic feasibility of implementing green projects, the Investment Efficiency Index (IEI) was used:

$$IEI = \Delta GDP_{green} / I_{green} IEI$$

where:

ΔGDP_{green} — GDP growth associated with green investments,

I_{green} — the volume of green investments in the corresponding period.

2.5 Research tools

The research employed analytic software, including Excel, to construct tables, process data, and create graphical presentations. Special emphasis was placed on the development of statistical tables and graphs that elucidate the key indicators associated with the advancement of green financing, investment volumes, and the dynamics in electricity production from renewable sources.

3 RESULTS

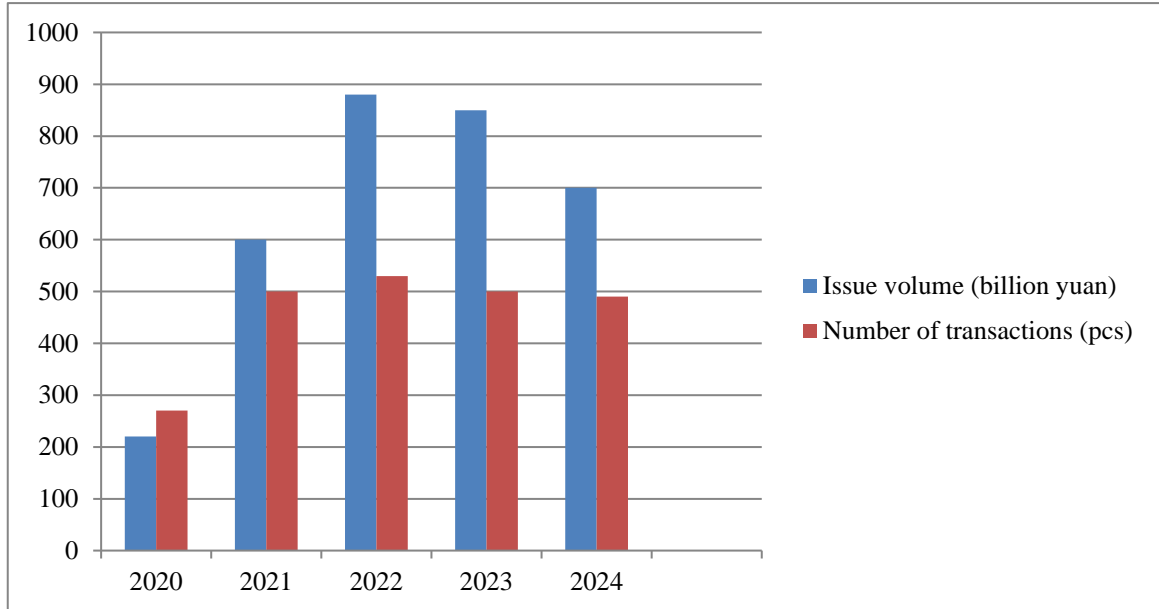
China is presently one of the most dynamic players in the global green investment market, demonstrating leadership at both the public policy level and within private sector activities. The Chinese government actively supports the advancement of clean technologies by instituting systems of subsidies, preferential taxation, and other incentives for companies to invest in renewable energy, energy efficiency, and emissions reduction. Furthermore, China actively participates in international initiatives aimed at combating climate change, providing financial and technological assistance to emerging economies.

The market for green financial instruments, which exhibited remarkable growth over the past decade, warrants particular scrutiny. Figure 1 illustrates the dynamics of green bond issuance in China through two key indicators, namely: total issuance volume and the number of transactions finalized. An analysis of this data reveals a significant escalation in bond issuance during the initial three years, soaring from 220 billion yuan in 2020 to 880 billion in 2022, thereby underscoring an elevated interest in financing environmentally friendly projects. At the same time, the stability in the number of transactions suggests a potential concentration of bond issuance attributable to a diminished number of substantial deals. Nevertheless, a decline in issuance volumes is evident in 2023 and 2024, which may be attributed to shifts in the economic landscape or emerging political and economic challenges confronting China's green bond market.

A significant indicator of the "green economy's" expansion is the proliferation of green energy certificates issued. By mid-2022, this figure had reached 20.6 million, corresponding to the generation of 20.6 billion kWh of electricity, that is a 135% increase as compared to 2021. The volume of transactions involving these certificates increased to 9.69 million, reflecting a 15.8 times rise as compared to the preceding year. By the end of 2022, the total number of certificates issued reached 59.54 million, with transaction totals accounting for 10.31 million. Furthermore, the total volume of green bonds issued in China in 2023 approached approximately \$64.2 billion, while in 2024 it surpassed \$68.9 billion. This remarkable growth can be attributed to the intensification of

decarbonization policies and the bolstering of financial instruments aimed at fostering sustainable development (preliminary data derived from market monitoring results and publications by the China Green Finance Committee, 2024).

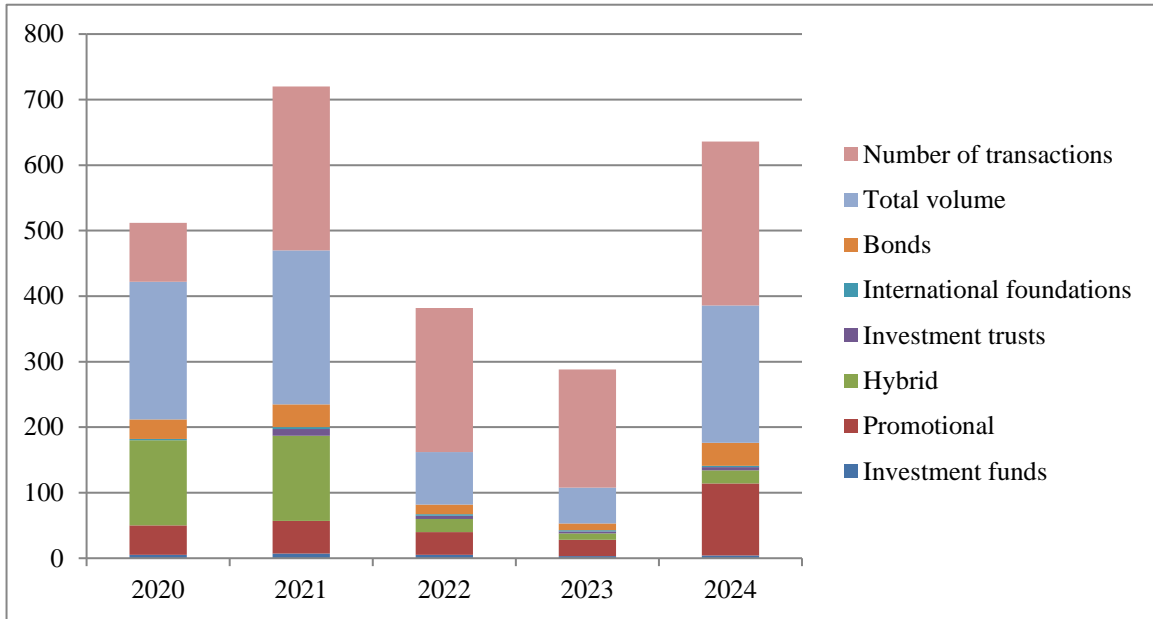
Figure 1 - China Green Bonds 2020-2024



Source: developed by the author drawing on The Green Finance & Development Center (2024), China International Capital Corporation (2023)

It is noteworthy that an examination of the green fund market dynamics in China from 2020 to 2024 reveals a remarkable surge in activity in 2021, when the total investment volume rose to 235 billion yuan and the number of transactions escalated to 250. However, in the subsequent years of 2022 and 2023, there was a pronounced contraction in both investment volumes (falling to 80 billion and 55 billion, respectively) and the number of transactions (220 and 180). Nevertheless, 2024 heralded a resurgence in the market, with the total investment volume returning to 210 billion, rose in equity funds, which reached 110 billion. Further, the number of transactions also experienced an upturn, returning to 250. This pattern underscores the cyclical nature of investor interest in green initiatives and suggests a potential reassessment of portfolio allocation strategies, favoring equity instruments amid fluctuations in the hybrid fund and bond issues (Figure 2).

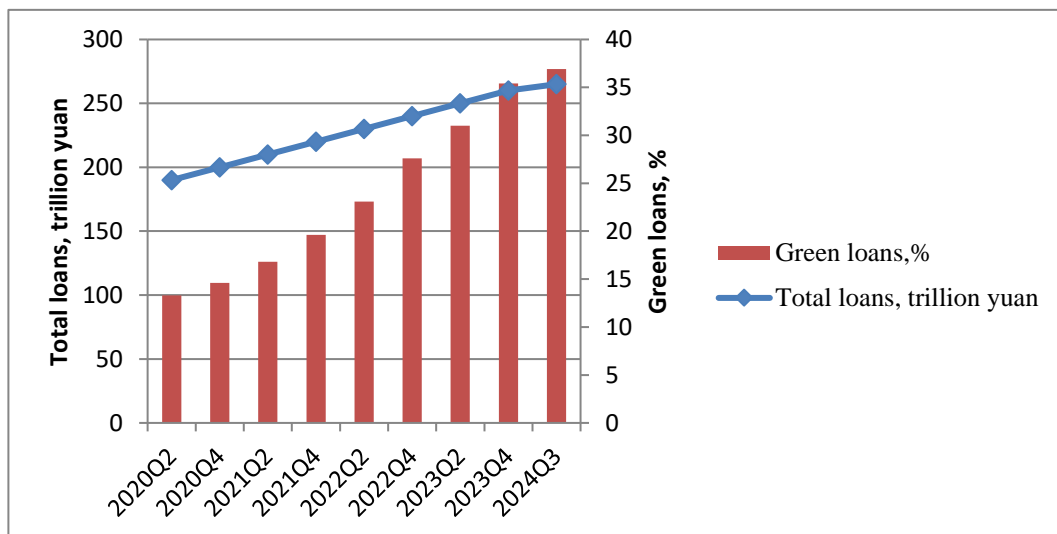
Figure 2 - China Green Funds 2020-2024



Source: developed by the author drawing on The Green Finance & Development Center (2024), China International Capital Corporation (2023)

During the period under analysis, the total volume of loans issued in China by financial institutions exhibited consistent growth. A particularly pronounced acceleration in this growth has been observed since 2020, which is likely attributable to government’s implementation of new initiatives aimed at decarbonizing the economy and fostering green energy development. For instance, between 2020 and 2022, green loans surged from 13.3 trillion yuan to 27.6 trillion yuan, effectively more than doubling within a span of two and a half years. Admittedly, this trend underscores China’s increasing integration of sustainable development principles within its financial framework. The proportion of green loans within the overall loan portfolio has also experienced steady growth: from 13.3% in 2020, while exceeding 36% by 2024 (Figure 3). This dynamic not only indicates an absolute growth in financing for sustainable projects but also reflects their gaining significance in the broader context of the nation’s economic development.

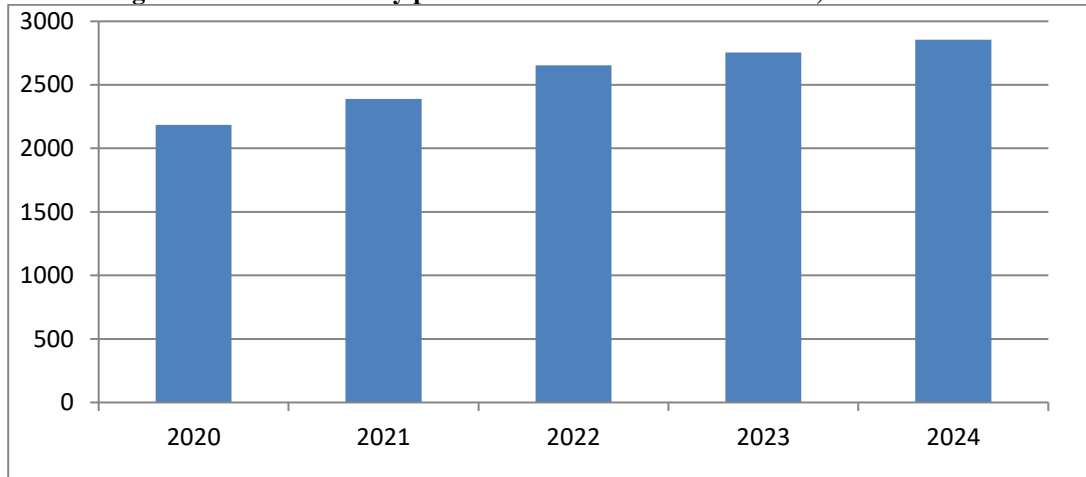
Figure 3 - Share of China's green credits in total 2020-2024



Source: developed by the author drawing on The Green Finance & Development Center (2024), China International Capital Corporation (2023)

When examining the dynamics of electricity generation from renewable sources in China, it is imperative to highlight that between 2020 and 2024, the nation consistently increased its electricity output from renewables, escalating from 2,185.13 TWh in 2020 to 2,854.15 TWh in 2024. The most dynamic growth occurred at the onset of this period; specifically, in 2021, production surged by over 9%, followed by an increase of more than 11% in 2022. Nonetheless, in 2023 and 2024, the growth rates slowed down to approximately 3.7% and 3.6%, respectively, signifying the gradual saturation of the renewable energy market. This trend underscores the critical necessity for introducing the innovative technological solutions and the enhancing the governmental incentives to facilitate the ongoing energy transition (Figure 4).

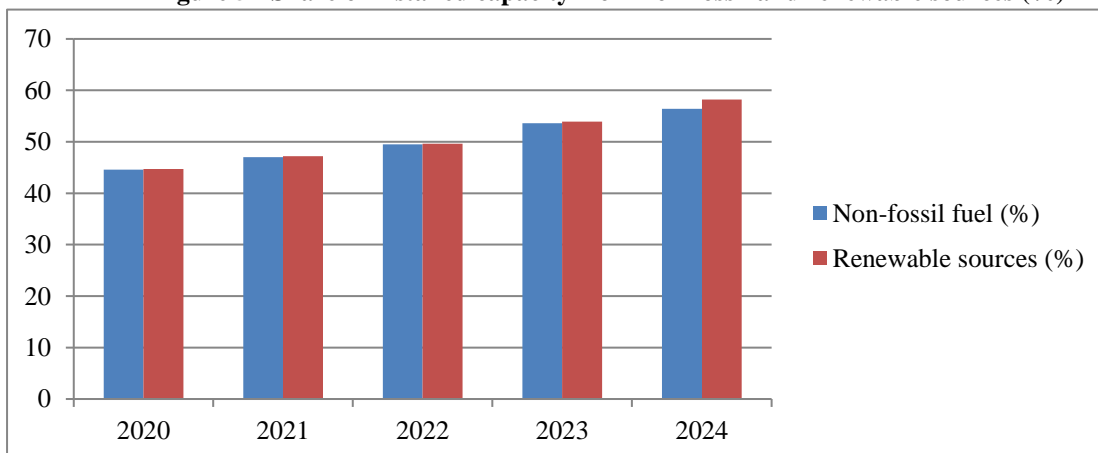
Figure 4 - Total electricity production from renewable sources, terawatt-hours



Source: International Renewable Energy Agency (IRENA)

Data regarding the configuration of installed capacity serve as a valuable indicator. Specifically, the proportion of non-fossil sources within China’s installed capacity in 2020 stood at 44.6%, while renewable sources accounted for 44.7%. Notably, within a four-year span, both metrics surpassed the 50% threshold—by 2023, non-fossil fuels accounted for 53.6%, and renewable sources reached 53.9%. This momentum of accelerated growth persisted into 2024, when the share of non-fossil technologies reached 56.4%, and purely renewable technologies attained 58.2%. The above trend underscores that the predominant elements driving the energy transition remain wind and solar installations, whose advancement continues to outpace the broader adoption of other “carbon-free” alternatives, in particular nuclear energy (Figure 5).

Figure 5 - Share of installed capacity from non-fossil and renewable sources (%)



Source: developed by the author drawing on The Green Finance & Development Center (2024), China International Capital Corporation (2023), IRENA (2025)

It is noteworthy that the Chinese government’s initiatives to develop environmentally friendly technologies and projects have a profound impact on improving the environmental conditions within the country and enhancing the population’s living standard. Such measures facilitate a gradual reduction in greenhouse gas emissions and render the national economy more resilient and aligned with the principles of sustainable development. The efficacy of these efforts can be evaluated through the statistics presented in Table 1. During the period from 2016 to 2020, the objective for reducing energy consumption per unit of GDP was set at 15%; however, only 13.2% was realized, illustrating certain challenges in increasing energy efficiency. Still, with regard to carbon emissions, expectations were notably surpassed, achieving a reduction of 18.8% instead of the anticipated 18%, thereby signifying the successful implementation of strategies aimed at reducing the carbon footprint.

A target of a 13.5% reduction in energy intensity was established for the period spanning 2021 to 2025, which slightly surpasses the preceding five-year plan’s achievements (13.2%). What is more, this goal necessitates the further deployment of cutting-edge technologies and the optimization of energy consumption practices. In contrast, the new target for diminishing carbon emissions per unit of GDP, namely a reduction of 17.6%, is comparatively less ambitious than the 18.8% target set for 2020 and entails the consolidation already attained in the pursuit of carbon neutrality.

Table 1 - Reduction of energy consumption and carbon emissions per unit of GDP

	2016-2020, compared to 2015		2021-2025, compared to 2020
	target	achievement	target
Reduction in energy consumption per unit of GDP	15%	13.2%	13.5%
Reduction of carbon emissions per unit of GDP	18%	18.8%	17.6%

Source: developed by the author

Table 2 presents the computation of the Investment Efficiency Index (IEI) for green projects in China for the year 2024. The calculations are predicated on the increase in GDP per capita attributable to a 1% increase in the share of solar energy. According to the World Bank’s estimate, this enhancement is quantified at 0.39%. With a GDP per capita of \$12,500 and a national population of 1.4 billion, the resulting total GDP increase approximates \$68.25 billion, or 491.4 billion yuan, as based on the exchange rate of 1 USD = 7.2 CNY.

At the same time, the volume of green investment for 2024 reached \$68.9 billion, equivalent to 496.08 billion yuan. By dividing the GDP growth by the total investment, we derive the IEI index = 0.99. This figure signifies an exceptionally high efficiency of green investments: nearly every yuan invested yielded one yuan of economic growth.

Table 2 - Calculation of China’s Green Investment Efficiency Index (IEI) for 2024

Indicator	Value
GDP per capita growth from solar energy	0,39%
GDP per capita in China	12 500
Population of China	1.4 billion
Volume of green investments	USD 68.9 billion ≈ RMB 496.08 billion
Dollar to yuan exchange rate	1 USD = 7.2 CNY
Total GDP growth	$0.0039 \times 12,500 \times 1.4 \text{ billion} = 68.25 \text{ billion USD} \approx 491.4 \text{ billion yuan}$
IEI	0,99

Source: developed by the author

Thus, the analyzed data corroborate that China’s state policy as regards fostering sustainable development not only exerts a substantial environmental impact, but also engenders powerful economic incentives for further investment in green technologies.

4 DISCUSSION

China has emerged as a global leader in green investment, and its paradigm is groundbreaking for many nations endeavoring to achieve carbon neutrality. A principal factor underpinning China's success is its clearly defined government policy that champions the advancement of environmentally sustainable technologies. The Chinese government fervently supports this sector by offering financial incentives, including subsidies and tax concessions for enterprises engaged in renewable energy production, alongside through credit mechanisms as well as preferential terms for companies operating in the field of green technologies.

China is actively increasing its share of renewable energy sources. Substantial investments are being channeled into the establishment of solar and wind power facilities, which markedly reduces the country's reliance on fossil fuel sources. It should be noted that this initiative not only enables China to diminish greenhouse gas emissions but also fosters the creation of new employment opportunities. That being said, in 2023 alone, the renewable energy sector in China created over 2.5 million new jobs, representing a significant contribution to the nation's economy.

As for green bonds, China has become in their issuance on the international market. The green bond market allows for financing for environmentally projects, such as the construction of energy-efficient facilities and infrastructure projects that contribute to emissions. China continues to its green bond issuance capabilities, which As for green bonds, China has emerged as a leader in their issuance within the international market. The green bond market facilitates financing for environmentally friendly projects, including the development of energy-efficient facilities and infrastructure initiatives that contribute to reducing emissions. China continues to expand its green bond issuance capabilities, which is evidence of effective policies and robust investor interest in this sector.

In examining the findings of comparable studies, it is worth considering Han's et al. study (2022), which corroborates China's vigorous advocacy for green financing policies. The scholar underscores that China not only exhibits ambition in the implementation of environmentally sustainable financial instruments but has also established itself as a leader in the global green bond marketplace. The above findings reinforce our conclusions regarding the significance of state support. On the other hand, Huang et al. (2021) notes that further reforms are imperative, particularly concerning control of allocating financial resources within the green economy. This issue remains pertinent in other scholarly works, such as the study by Dinca et al. (2022), which highlights those investments in renewable energy sources, in particular wind and solar energy, are instrumental in diminishing China's reliance on fossil fuels, while simultaneously generating new employment opportunities, thereby positively influencing the economic landscape. The results presented, in turn, confirm the conclusions that green investments can stimulate economic development and enhance energy security.

Studies by Liu et al. (2022b) and Koçak et al. (2020) that investigate the role of green bonds in China's economic development underscore that China stands globally as the preeminent issuer of green bonds. Nevertheless, the authors also note that robust monitoring and reporting frameworks for projects must be established, aligning with their findings that highlight the necessity of institutional reforms in the green investments oversight. Indeed, our analysis further indicates that the successful advancement of green finance is unattainable without a clear system in terms of monitoring and evaluating the outcomes.

Also, to juxtapose the findings with those of other scholarly works, it is pertinent to highlight the contributions of Feng & Hu (2022) and Li et al. (2020), which underscore the critical role of innovation in green finance, particularly in terms of investing in sustainable technologies. The authors argue that China actively fosters the adoption of pioneering technologies within the environmental finance sector; however, in the above study it is cautioned that for sustainable development to be realized, it is imperative to enhance the involvement of the private sector. Hence, this standpoint bolsters our assumption regarding the necessity of harmonizing governmental support with attracting private investment.

Against this backdrop, comparing the results obtained with other studies, it can also be noted that problems with the effectiveness of green investments in other countries such as the USA and the European Union are predominantly attributed to policy fragmentation and political instability (Prokopenko et al., 2023; Thi et al., 2022; REN21, 2024). In contrast, the Chinese model, characterized by proactive government coordination and support

for green initiatives, facilitates swifter and more tangible outcomes. Therefore, the centralized governance characteristic of China gives it a distinct advantage in implementing the green initiatives.

Thus, the findings pertaining to China are consistent with other scholars' emphasis on the significance of state support and political stability for the advancement of green investments. However, the Chinese example illustrates that not only state support but also transparent governance and robust oversight mechanisms are critically important for this sector's sustainable development. The above considerations are equally relevant for other nations, where issues of regulation and transparency frequently pose substantial obstacles to success in developing a green economy.

4.1 Study limitations

The methodological approaches used to calculate indicators may not fully take into account the specifics of individual regions or sectors of the economy, which may affect the general applicability of the results.

4.2 Recommendations

Drawing upon the findings obtained, it is expedient:

- ✓ improve the system of state support for environmental projects by developing more effective financial instruments to stimulate green innovations, in particular through tax breaks, subsidies, and accessible financing for small and medium-sized businesses implementing environmental technologies.
- ✓ develop and implement mechanisms for predicting the effectiveness of investments in the green economy using the proposed IEI, CEI, and SDI indicators.
- ✓ strengthen cross-sectoral cooperation between government, financial institutions, and enterprises to create a sustainable ecosystem aimed at supporting green investments.

CONCLUSION

The findings of the study substantiate that China is actively employing financial instruments as a key mechanism for catalyzing green innovation in the context of global economic transformations. Among the most effective instruments, it is noteworthy to underscore green bonds, investment funds, preferential lending, and government subsidies, which not only provide support for sustainable initiatives but also facilitate the transformation of the financial sector into one that is environmentally friendly.

The significant growth in green bond issuance underscores an increase in environmental projects among investors. The robust performance of the green investment fund market, particularly in hybrid and equity funds, serves as compelling evidence that the state has created a favorable environment for the advancement of innovations in renewable energy, electric transportation, energy-efficient technologies, and many more.

Moreover, the high investment efficiency index (IEI = 0.99) attests to these instruments' remarkable capacity to transform financial resources into tangible economic growth. Such efficacy was made possible by comprehensive governmental policies, including tax incentives, subsidies, and institutional support for financial markets.

Against the backdrop of the global course towards decarbonization and adaptation to climate challenges, the Chinese model of financing green innovations demonstrates remarkable flexibility and adaptability, serving as a benchmark for other nations. It adeptly integrates market mechanisms with state participation, thereby fostering the engagement of private capital in the ecological transformation of the economy.

Consequently, it can be inferred that the financial instruments employed by China have emerged as a catalyst for profound transformations across production, energy, and innovation sectors, facilitating not only the mitigation of environmental risks but also the emergence of new perspectives for economic growth.

The study makes a substantial contribution to the advancement of theoretical and methodological frameworks for evaluating the efficacy of financial instruments aimed at fostering green development amidst the

ongoing global economic transformation. Furthermore, this research paves the way for further scientific inquiry in domains such as environmental economics, financial policy, and strategic planning.

The study findings can be applied to the development of national and regional sustainable development strategies, particularly in establishing an effective system for promoting green innovations. What is more, these results may enhance the modernization of governmental support mechanisms for environmental initiatives by refining financial instruments, subsidies, and tax incentives.

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