Research on Current Situation and Existing Problems of Urban Green Development Under the "Dual Carbon": Based on Wenzhou City

Xingcheng Ge[1] Feng Guo[2] Yi Feng[3] Lu Ji[4]

[1,2,3] *School of Management, Wenzhou Business College, Wenzhou 325035, China*
[1] *Faculty of Humanities and Social Sciences, Macao Polytechnic University, Macau 999078, China*
[4] *College of Public Administration, Nanjing Agricultural University, Nanjing 210095, China*
[4]*Corresponding author. Email: jl@njau.edu.cn*

ABSTRACT

Promoting green urban development is the only way to realize the dream of a beautiful China and promote sustainable human development. Based on a survey conducted in Wenzhou, this study systematically analyzes the city's current status in green energy transition, ecological conservation and restoration, green manufacturing system development, environmental governance, and institutional innovation. It highlights persistent challenges including intense pressure for industrial structure transformation, significant gaps in environmental infrastructure, underdeveloped cross-regional coordination mechanisms, insufficient promotion of green concepts, and the arduous task of optimizing energy structures. The research shows that although Wenzhou has initially formed a green development path with local characteristics, structural, institutional and conceptual obstacles still restrict its in-depth development. Therefore, it is suggested that we should optimize the industrial structure, make up for the shortcomings of facilities, improve the collaborative governance mechanism, strengthen the publicity of green concepts and public participation, and build a low-carbon energy system, so as to promote the high-quality development of Wenzhou and provide reference for similar cities to achieve the "dual carbon" goals.

Keywords: *Green development of cities, Current development status, Existing problem, Wenzhou city.*

1. INTRODUCTION

Urban green development is a new paradigm that prioritizes ecological conservation and low-carbon growth. Through technological innovation, institutional safeguards, and public engagement, it achieves coordinated and sustainable development across economic, social, and environmental dimensions. This approach emphasizes integrating ecological civilization principles into urbanization processes, optimizing spatial planning, upgrading industries, and promoting green technologies to ensure efficient resource utilization and effective pollution control. Improving the level of green development in cities is the only way to realize the dream of a beautiful China, and it is also the inherent requirement of higher level of urban civilization and sustainable development of human beings.[1] The Party and the state attach great importance to the construction of ecological civilization and the green development of cities. At the same time, the green development of cities is closely related to the strategic tasks of carbon neutrality and carbon peak. The report to the 20th National Congress of the Communist Party of China emphasized accelerating the green transformation of development patterns and promoting the formation of green and low-carbon production and lifestyles. The 2025 Government Work Report further stipulated that efforts to strengthen ecological and environmental protection should be sustained, with the level of green and low-carbon development enhanced. General Secretary Xi has elevated the strategy of green urban development to the level of human civilization, stating: 'The concept of green development must be integrated into all aspects of ecological conservation, environmental construction, manufacturing, urban development and people's livelihoods, accelerating the building

of a Beautiful China.' Consequently, how to advance urban green development, foster green growth in cities, and achieve high-quality development of the urban economy has become a focal point of current academic discourse.

Research by scholars both domestically and internationally in the field of urban green development has primarily focused on qualitative and quantitative approaches. Qualitative analysis primarily focuses on examining the current state of urban green development, identifying development pathways, and conducting international comparisons. Shi and Liu (2013) constructed a green city index and its indicator system to conduct an international comparative analysis of the green development status of 58 prefecture-level cities and 25 international cities in China. They analyzed the gaps and their causes, and pointed out the problems in the green development of Chinese cities and the future improvement direction.[2] Liu (2021) measured the green development level of Beijing-Tianjin-Hebei urban agglomeration from four aspects, including economic development, environmental pressure, ecological response, and resource conservation, and put forward suggestions for improving the weak links of green development in Beijing-Tianjin-Hebei.[3] Li et al. (2023) proposed a strategy for renovating old residential communities in accordance with the concept of green development, using Huainan City as an example, hoping to provide reference for the renovation of old residential communities in other resource-based cities.[4] Wang (2025) contends that within the context of a low-carbon economy, resource-based cities must steadfastly implement the concept of green development, transform their economic development models, and cultivate and refine low-carbon markets, thereby leveraging the low-carbon economy to propel the sustainable development of resource-based cities.[5] Quantitative research mainly focuses on the measurement of urban green development level, efficiency evaluation and empirical analysis of green development. Fu and Liu (2019) contend that collaborative governance provides an institutional platform for the diffusion of green technologies and the implementation of green institutions, thereby lowering the institutional barriers to corporate adoption of green technologies and facilitating the rapid spread of green production models within the region.[6] Zhou and Lu (2025) investigated the impact of coordinated environmental governance in the Yangtze River Delta on urban green development. Their study revealed that the implementation of green development policies significantly enhanced efficiency, demonstrating that these policies substantially improve the green development level of cities in the region.[7] Chen et al. (2025) measured the green development efficiency of the Yangtze River Delta urban agglomeration. The study found that the static efficiency of green development in the Yangtze River Delta urban agglomeration generally showed a fluctuating upward trend, but there were significant inter-city differences and an imbalance phenomenon.[8] Lu and Guo (2025) investigated the impact of the digital economy on green development efficiency. Their research revealed that the digital economy significantly enhances green development efficiency by boosting technological innovation capabilities and optimizing industrial structures.[9] To sum up, the existing research has enriched the attention to the green development of Wenzhou city, which can provide guidance and reference for the green development of Wenzhou.

As the third largest economic city in Zhejiang Province, Wenzhou has the advantages of abundant ecological resources, excellent ecological environment quality, huge ecological common prosperity potential, first-mover reform and innovation advantages, and good social co-construction foundation. The green development of Wenzhou plays an important role in the whole Zhejiang Province and even the southeast coastal areas. In recent years, Wenzhou has been guided by the "Eight-Eight Strategy", deeply implemented the concept that "green mountains and clear waters are golden mountains and silver mountains", and taken "green and low-carbon development as the basic concept of Wenzhou's future development", requiring high-quality promotion of ecological civilization construction. In this context, this study takes Wenzhou as an example to analyze the current situation and problems of green development in Wenzhou, and analyze the key factors affecting green development in Wenzhou, in order to better promote green development in Wenzhou.

2. THE CURRENT SITUATION AND PROBLEMS OF GREEN DEVELOPMENT IN WENZHOU

2.1 Analysis of Green Development in Wenzhou

2.1.1 Green Energy Transition and Progress in Carbon Emissions Trading

Wenzhou has made significant progress in the transition to green energy, especially in the field of distributed photovoltaic power generation. According to the Wenzhou Municipal Development and Reform Commission 2025 second quarter data, the city's 12 districts and counties have more than 2.5GW of distributed PV openable capacity, and all districts and counties have a green consumption rating, indicating that the grid has sufficient consumption capacity. This capacity is equivalent to reducing the consumption of about 1.5 million tons of standard coal and reducing carbon dioxide emissions by about 3.7 million tons per year. Wenzhou has actively promoted the "Forestry Common Prosperity Carbon Sink" application, innovatively combining carbon sink trading with common prosperity. As of September 2025, the carbon sink purchase volume of this platform has exceeded 1,950 tons, increasing the income of village collectives by 195,000 yuan. It is estimated that the income of the first batch of pilot villages will increase by more than 12 million yuan.

In addition, Wenzhou has also done a lot of work in terms of green energy policy support. The government encourages enterprises and residents to install distributed photovoltaic power generation systems through policy guidance, financial subsidies and technical support. At the same time, Wenzhou is also actively exploring the development of offshore renewable energy such as offshore wind power and tidal energy, and making use of its coastal city's geographical advantages to continuously optimize the energy structure and reduce the dependence on fossil energy. These measures have laid a solid foundation for Wenzhou to achieve the "double carbon" goal.

2.1.2 Ecological Protection and Restoration Projects

Wenzhou attaches great importance to the protection and restoration of the ecosystem, and improves the ecological service function and biodiversity through systematic engineering. In September 2025, Wenzhou released the "Wenzhou Beautiful Forest Landscape Enhancement Project Plan (2025-2030)", which plans to implement four major beautiful forest landscape enhancement tasks, including key nodes, major transportation routes, both banks of rivers and important mountains, through a spatial layout of "three rivers, two belts, multiple zones and multiple points". In terms of biodiversity conservation, Wenzhou Ouhai District has established a species resource database and completed the first phase of the whole-area biodiversity background survey and assessment, providing a scientific basis for biodiversity conservation. Meanwhile, Wenzhou has established a solid ecological invasion defense line, completing the prevention and control of pine wood nematode disease on 30,900 mu of land. It has respectively controlled 6 mu of red imported fire ants and 3,000 mu of citrus yellow dragon pathogen (Asian species), effectively curbing the invasion of alien species.

Wetland and forest protection is also an important part of ecological construction in Wenzhou. Wenzhou has implemented an ecological space protection plan, building a three-dimensional protection network of "forest-river and lake-wetland", which has kept the forest coverage rate, water surface rate and the area under wetland management stable. Therefore, it is necessary to strengthen the supervision of nature reserves. The resolution rate of cases and issues related to forest supervision and the "Green Shield" enhanced supervision of nature reserves should reach 100%. These measures have effectively maintained the continuity and integrity of the ecosystem and provided a good habitat for wildlife.

2.1.3 Green Manufacturing System and Industrial Upgrading

Wenzhou has taken the creation of green and low-carbon factories as a key point to vigorously promote the green and low-carbon transformation of its industry. In 2025, five enterprises from Haijing District—Zhejiang Goldwind Science & Technology Co., Ltd., Weiyi Hongji (Zhejiang) Electric Power Co., Ltd., Wenzhou Jinma Stationery Co., Ltd., Wenzhou Haicheng Optics Co., Ltd., and Zhejiang Zhongyi Hao Technology Co., Ltd.—were selected as Wenzhou's Green and Low-Carbon Factories for 2025. These companies operate across five key industrial sectors: smart equipment, new energy, life sciences, and healthcare. Green technology innovation is an

important support for green manufacturing system in Wenzhou. The enterprises in Wenzhou actively adopt advanced technologies and energy-saving processes to promote energy conservation and carbon reduction transformation, and increase investment in green technologies and innovation. For example, through the upgrading of environmental protection facilities, Ruian Baoyuntai Industrial Co., Ltd. ensures the comprehensive collection and efficient treatment of all kinds of waste gas and dust, so as to achieve stable and standard emission. In addition, relevant functional departments will strengthen guidance services to help enterprises optimize production processes and promote green transformation and sustainable development.

The construction of green manufacturing system in Wenzhou not only improves the environmental performance of enterprises, but also enhances the market competitiveness. Through green transformation, enterprises can better adapt to the demand for environmental protection products in domestic and foreign markets, avoid green trade barriers and gain more market space. At the same time, green manufacturing also brings cost saving. Through the efficient use of energy and resources, production costs are reduced and economic benefits are improved.

2.1.4 Environmental Governance and Pollution Prevention and Control

The Secretary Zhang highlighted key aspects of ecological and environmental protection during his research, noting that Wenzhou has employed a combination of targeted and area-wide measures to combat pollution prevention and control. The city has identified underlying causes and issues, enhanced regional coordination, effectively tackled challenges, addressed deficiencies, and rigorously enforced responsibilities. To ensure successful implementation, Wenzhou has adopted a “one district, one plan, one task force” strategy. In terms of water environment management, Wenzhou has continued to promote the upgrading of sewage treatment facilities, improve the capacity of sewage treatment, strengthen the operation and maintenance of pipe networks, improve the water quality of river networks, and make every effort to prevent the rebound of black and smelly rivers. In terms of air pollution prevention and control, Wenzhou has taken extraordinary efforts to carry out emission reduction projects and industrial upgrading, and carried out pollution prevention and control in industries with concentrated emissions on a “one enterprise, one policy” basis. For example, in Ruian City, in view of the dust pollution problems in the factory area of enterprises, enterprises are required to strictly implement the main responsibility of air pollution prevention and control, complete the upgrading of environmental protection facilities within a time limit, and ensure the comprehensive collection and efficient treatment of all kinds of waste gas and dust.

Wenzhou also pays attention to the construction of a long-term environmental supervision mechanism. Wenzhou employs a balanced approach of leniency and strictness, enhancing closed-loop governance across monitoring, law enforcement, and control. The city invests in the “hardware” of infrastructure while simultaneously improving the “software” of environmental protection supervision. Efforts are underway to refine the working system for ecological civilization construction and to bolster capacity in environmental supervision and monitoring, risk prevention and control, as well as emergency response and management. The reinforcement of long-term mechanisms, such as “River (Lake) Chief System” and “Forest Chief System”, has contributed to the sustainability and stability of environmental governance, effectively preventing pollution from rebounding.

2.1.5 Ecological System Innovation and Judicial Guarantee

In terms of ecological and environmental damage compensation, in 2024, Wenzhou Ouhai District organized professional forces to comprehensively screening 198 case leads. Through meticulous investigation and assessment, 8 cases of ecological and environmental damage compensation were concluded, holding those who damaged the ecological environment legally liable for compensation. The total amount of compensation reached 327,100 yuan, strengthening the rigid constraints on ecological and environmental protection. Furthermore, Wenzhou has actively enhanced the coordination mechanism between ecological environmental protection administrative law enforcement and criminal justice. By establishing an efficient and standardized cross-departmental and cross-regional joint prevention and control mechanism, the city has achieved “horizontal collaboration and vertical integration” in environmental law enforcement. The city has strengthened technical evidence review to

accurately determine the value of ecological damage, and legally pursued environmental tort liability through criminal incidental civil public interest litigation.

Wenzhou has actively explored environmental value-added services, deepened the integrated reform of environmental administrative licensing, piloted permit processing with incomplete documentation, and shortened approval timelines to help businesses streamline procedures. The city has steadily advanced the paid use and trading of emission rights, conducting 110 emission rights transactions worth 3.2061 million yuan, thereby promoting rational resource allocation.

2.2 Analysis of Problems in Green Development of Wenzhou

2.2.1 Structural Contradictions and Transformation Pressure of Green Industry

The industrial structure of Wenzhou still has the problems of high proportion of traditional industries and great pressure of green transformation. The Standing Committee of the Wenzhou Lucheng District People's Congress pointed out that the endogenous driving force for green industrial development is insufficient, industries with high energy consumption and high emissions still occupy a considerable proportion, and green emerging industries have not yet formed effective support. The green transformation of enterprises is faced with technical and financial bottlenecks. Although Wenzhou has cultivated a number of green and low-carbon factories, the overall green manufacturing system is still in its infancy, with a small number of green enterprises and limited coverage. A large number of small and medium-sized enterprises have financial and technical difficulties in the application of green technology and the transformation of environmental protection facilities, and are difficult to bear the high cost of green transformation. At the same time, the green financial support system is not perfect, and it is difficult for enterprises to obtain low-cost green credit support, which further delays the green transformation process. One issue is that the policy support system for the green industry remains inadequate. Coordination among policies is insufficient, support is weak, and an effective incentive and guidance mechanism has yet to be established. In particular, policies aimed at fostering and supporting small and medium-sized green enterprises, advancing research on green technologies, and facilitating the market expansion of green products are still lacking, thereby hindering the development and growth of the green industry.

2.2.2 Environmental Protection Infrastructure and Pollution Control Weaknesses

The Standing Committee of the Wenzhou Lucheng District People's Congress pointed out that the shortcomings of environmental protection infrastructure need to be addressed, the household garbage classification and transportation system needs to be improved, and some localities have mixed collection and transportation. The capacity of sewage treatment facilities is insufficient, and projects such as the reclaimed water utilization project of the central sewage treatment plant and the second phase of the light industry park sewage treatment plant need to be accelerated. During his research in Yongjia County, Mayor Zhang observed that addressing river pollution requires a dual approach, focusing on both symptomatic and root cause treatment, as well as implementing precise measures. It is essential to enhance efforts in sewage interception, pipe connection, river cleaning, and ecological restoration, while firmly preventing the recurrence of these issues. The efficiency of urban domestic sewage collection and treatment is not high, and the problems of pipeline leakage, wrong connection and mixing are prominent, and the pollution of overflow is serious in the rainy season. It is difficult to control agricultural non-point source pollution, and the level of pollution control in livestock and poultry breeding needs to be improved. The comprehensive utilization of solid waste is not high, the effectiveness of garbage classification is not strong, and the channels for resource utilization are not smooth. In particular, the disposal capacity of construction waste and industrial solid waste is insufficient to meet the actual demand.

Insufficient investment in environmental protection infrastructure is a fundamental problem. Wenzhou City faces a significant gap between its environmental infrastructure investment scale and actual demand. Key infrastructure projects like sewage networks, waste treatment facilities, and hazardous waste disposal systems require substantial funding, yet suffer from low investment returns and limited private sector participation. These projects remain heavily reliant on

government funding, creating immense financial pressure. Additionally, inadequate operational maintenance investments and imperfect management mechanisms have hindered the full utilization of existing facilities.

2.2.3 Lack of Coordinated Governance and Long-term Mechanism

The imperfect cross-regional collaborative governance mechanism is a prominent problem. Although Ouhai District and Lucheng District have signed the "Horizontal Ecological Compensation Agreement for the Upstream and Downstream of Wenruitang River Basin" the cross-regional collaborative governance mechanism across the city remains inadequate. There are differences in environmental standards, law enforcement and governance input among different regions, and the lack of effective coordination and compensation mechanisms makes it difficult to completely solve the problem of transboundary pollution. The responsibility and benefit distribution of environmental governance between the upper and lower reaches and the left and right banks of river basin are not clear, and it is difficult to coordinate the governance. The long-term environmental supervision mechanism is not perfect. The Secretary Zhang emphasized the need to strengthen supervision, implement long-term governance, improve the "hardware" of infrastructure, and enhance the "software" of environmental protection supervision. However, at present, environmental supervision in Wenzhou still has the characteristics of campaign-style law enforcement and surprise rectification, and the regular and long-term supervision mechanism is not perfect. The construction of smart environmental protection lags behind, the monitoring network coverage is not complete, the data sharing is not sufficient, and the early warning and prediction capacity is insufficient, making it difficult to achieve accurate and scientific pollution control.

2.2.4 The Gap Between Green and Low-carbon Concepts and Practices

The environmental awareness and responsibility of enterprises in Wenzhou need to be strengthened. During a supervisory review, Li Jian, Secretary of Ruian Municipal Committee, observed that enterprises had not adequately fulfilled their primary responsibility for environmental protection. Several enterprises exhibited issues, including the malfunctioning of environmental protection facilities and inadequate safety production management. Notably, concerning the dust pollution present within factory premises, it is imperative that enterprises rigorously adhere to their primary responsibility for air pollution prevention and control, and ensure the timely completion of upgrades and transformations of environmental protection facilities. The garbage classification and transportation system in Wenzhou needs to be improved. Some places have mixed collection and transportation, and the green living habit has not yet been formed. Meanwhile, the promotion of green lifestyles, including green travel, low-carbon consumption, and energy conservation and emission reduction, remains inadequate. Public awareness and acceptance of green products are limited, and the green market has yet to reach maturity.

Moreover, ecological civilization education in Wenzhou has not been systematically integrated into the national education framework. The educational content and training programs lack comprehensiveness and depth, the delivery methods are monotonous, and the overall effectiveness is limited. Environmental protection publicity and education focus on form rather than content, and on key points rather than daily routine, failing to form a regular mechanism. Enterprises and the public exhibit a limited understanding of the urgency and significance of green and low-carbon development. This lack of awareness is accompanied by a weak sense of concern and responsibility regarding ecological and environmental issues, as well as a low level of initiative and enthusiasm for engaging in green development.

2.2.5 The Challenges of Energy Structure and Low-carbon Transformation

Despite the available capacity of distributed photovoltaic power generation exceeding 2.5 GW, the energy consumption structure remains predominantly reliant on fossil fuels, characterized by a significant proportion of coal consumption and a minimal share of renewable energy. Notably, the manufacturing sector exhibits substantial energy consumption, where the costs associated with substituting clean energy are high, and the technical challenges are considerable, thereby presenting numerous obstacles to achieving low-carbon transformation. Energy infrastructure is not suitable for green and low-carbon development, energy storage facilities are insufficient, peak regulation

capacity is weak, and energy supply security is at risk.

Furthermore, the energy utilization efficiency in Wenzhou's traditional manufacturing industries remains suboptimal. The advancement of energy-saving technologies is inadequate, energy management practices are rudimentary, and significant energy waste persists. The online energy consumption monitoring system for key energy-consuming units lacks comprehensiveness, and the quality of data is insufficient, hindering effective energy management. Additionally, the policy framework supporting renewable energy development in Wenzhou is incomplete; the sustainability of subsidy policies is weak, and the market-oriented development mechanism is not robust. The energy pricing mechanism fails to accurately reflect resource scarcity and external environmental costs, which undermines efforts toward energy conservation and the optimization of the energy structure. Moreover, the energy regulatory system is flawed, law enforcement is lax, and illegal and non-compliant energy usage behaviors have not been effectively addressed.

3. SUGGESTIONS FOR PROMOTING GREEN DEVELOPMENT IN WENZHOU

3.1 Optimizing the Industrial Structure and Promoting Green Transformation and Upgrading

Wenzhou should expedite the green transformation of traditional industries while fostering the development of emerging green sectors. It is recommended that a "Special Fund for Green Industry Transformation" be established to specifically support high energy-consuming industries, such as footwear, electroplating, and plastics, in their efforts to implement energy-saving technological advancements and clean production practices. Additionally, the promotion of a "green technology sharing platform" would provide enterprises with essential technical consultation, technology transfer, and talent training services. Meanwhile, Wenzhou should enhance its investment promotion and policy orientation toward green industries, including new energy, energy storage, and environmental protection equipment, to facilitate the establishment of a comprehensive industrial chain. It is essential to encourage leading enterprises to spearhead the development of a green supply chain system, promote sustainable management throughout the entire life cycle, and improve the overall green competitiveness of the industry.

3.2 Making Up for the Shortcomings of Environmental Protection Infrastructure and Improving Governance Efficiency

Wenzhou should enhance governmental investment in environmental protection infrastructure, prioritizing the upgrading and renovation of sewage treatment plants, reclaimed water utilization projects, and the construction of facilities for waste classification and resource recovery. The city should promote the application of the Public-Private Partnership (PPP) model within the environmental protection sector to attract private capital for investment and operation. Furthermore, it is essential to establish and refine the "Smart Environmental Protection" platform, which integrates Internet of Things and big data technologies to facilitate intelligent management of environmental monitoring, pollution source tracking, and emergency response. Additionally, Wenzhou must strengthen the governance of agricultural non-point sources and industrial solid waste, enhance the comprehensive supervision system for hazardous waste, and reinforce the fundamental principles of ecological and environmental safety.

3.3 Improving Cross-regional Coordination and Long-term Governance Mechanisms

It is necessary to establish a city-wide ecological environment collaborative governance committee in Wenzhou to unify environmental standards, law enforcement protocols, and data-sharing mechanisms, and enhance the cross-regional ecological compensation system and advance the Ouhai-Lucheng model, clarifying the distribution of responsibilities and benefits between upstream and downstream entities, as well as between the left and right banks. It is also necessary to strengthen the integration of administrative law enforcement with criminal justice by creating a joint case-handling mechanism involving environmental protection police, prosecutors, and judges, thereby increasing the penalties for environmental violations. Transition environmental supervision from a "campaign-style" approach to a "regularized" framework by implementing an

annual environmental audit and public evaluation system, ensuring the sustained effectiveness of governance.

3.4 Strengthening the Publicity of Green Concept and Public Participation

Wenzhou can incorporate ecological civilization education into the national education system and cadre training programs, while promoting the establishment of "green schools" and "green communities", enhance public awareness of green consumption and low-carbon travel through diverse methods, including media outreach, community initiatives, and environmental protection public welfare activities, establish an enterprise environmental protection credit evaluation system, publicly disclose environmental performance, and guide market choices toward green products and services. It can also support the development of environmental protection social organizations, expand avenues for public participation in environmental oversight and decision-making, and foster a collaborative governance model involving the government, enterprises, and society.

3.5 Optimizing the Energy Mix and Building a Low-carbon Energy System

Wenzhou should expedite the development of renewable energy projects, emphasizing offshore wind power, distributed photovoltaic systems, and tidal energy, to increase the share of non-fossil energy consumption. The city must promote the intelligent transformation of the power grid to enhance its capacity for integrating distributed energy sources. Additionally, it should implement energy conservation and carbon reduction initiatives in key industries and enterprises while advancing energy management systems and energy-saving technologies. Strengthening the green financial system is essential; this includes introducing financial products such as low-carbon transformation credits and carbon quota pledges to lower the costs associated with enterprises'green transformations. Furthermore, Wenzhou should explore the establishment of a regional carbon trading market to unlock the value of carbon assets, thereby aiding the city in achieving its "dual carbon" objectives.

4. CONCLUSION

As an important economic center and coastal open city in Zhejiang Province, Wenzhou has made remarkable achievements in green development in recent years, which are reflected in green energy transformation, ecological protection and restoration, green manufacturing system construction, environmental governance efficiency improvement, institutional innovation and judicial guarantee. Wenzhou actively embraces the principle that "green mountains and clear waters are as valuable as mountains of gold and silver" The city promotes the optimization of its energy structure by prioritizing distributed photovoltaic power and carbon sink trading. Additionally, it strengthens ecosystem functions by focusing on the Beautiful Forest Phase project and biodiversity conservation. Wenzhou also advances the low-carbon transformation of industries through the establishment of green factories and the modernization of traditional industries. By enhancing environmental governance via smart environmental protection and cross-regional collaborative mechanisms, Wenzhou has begun to establish a green development model that reflects its unique characteristics.

However, Wenzhou still faces challenges such as significant pressure in industrial restructuring, deficiencies in environmental infrastructure, underdeveloped cross-regional coordination mechanisms, insufficient promotion of green concepts, and arduous tasks in optimizing the energy structure. These structural, institutional, and conceptual barriers hinder the deep advancement of green development.

In the future, Wenzhou should further strengthen systematic thinking and multi-dimensional collaboration, continuously optimize its industrial and energy structures, increase support for green technology and financial initiatives, improve infrastructure and long-term governance mechanisms, promote the deep-rooted adoption of green concepts, and establish a new development paradigm involving joint participation from the government, enterprises, and society. This study not only provides Wenzhou with a localized green transition pathway tailored to its actual conditions, but also offers valuable references for similar cities to advance high-quality development under the "dual carbon" goals.

AUTHORS' CONTRIBUTIONS

Xingcheng Ge and Lu Ji developed the idea of the study, participated in its design and coordination and helped to draft the manuscript. Xingcheng Ge and Yi Feng collected the data and

Xingcheng Ge wrote the paper; Feng Guo provided critical review and substantially revised the manuscript. All authors read and approved the final manuscript.

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REFERENCES

[1] Lu K., Zhang G.Q., Li G.M. The Impact and Mechanism of Regional Integration on Urban Green Development Efficiency in the Pearl River Delta Region, China Population, Resources and Environment 35(06) (2025) 190-200. DOI: 10.12062/cpre.20241121

[2] Shi M.J., Liu Y.Y. Green Urban Development: International Comparisons and Critical Issues, Urban Development Studies 20(05) (2013) 140-145. DOI: 10.3969/j.issn.1006-3862.2013.05.021

[3] Liu X. Analysis of Green Development Status and Improvement Suggestions for Beijing-Tianjin-Hebei Urban Agglomeration, China Collective Economy (04) (2021) 27-29.

[4] Li Y.L., Wang X., Ning L.L., et al. Strategies for Urban Old Residential Area Renovation under the Green Development Concept: A Case Study of Huainan City, Construction Economy 44(12) (2023) 67-72. DOI: 10.14181/j.cnki.1002-851x.202312067.

[5] Wang L.K. Pathways to Low-Carbon Economy Development in Resource-Based Cities, Contemporary county economy (08) (2025) 85-87. DOI: 10.16625/j.cnki.51-1752/f 2025.08.025

[6] Fu J, Liu J. The Governance Effect of Atmospheric Joint Prevention and Control Policy--An Empirical Test Based on Key Prevention and Control Urban Groups, Modern Economy 10(01) (2019) 29. DOI: 10.4236/me.2019.101003

[7] Zhou J.G., Lu A.J. Research on the Impact of Environmental Collaborative Governance in the Yangtze River Delta on Urban Green Development, Journal of Nanchang University(Humanities and Social Sciences) 56(03) (2025) 42-56. DOI: 10.13764/j.cnki.ncds.2025.03.011.

[8] Chen H.Z., Dai Y.F., Huang T., et al. Spatio-temporal Differentiation and Influencing Factors of Green Development Efficiency in the Yangtze River Delta Urban Agglomeration, Economic Geography 45(04) (2025) 47-55. DOI: 10.15957/j.cnki.jjdl.2025.04.005.

[9] Lv P., Guo J.H. Digital Economy and Green Development Efficiency: An Empirical Analysis of Three Major Urban Agglomerations, Statistics & Decision 41(14) (2025) 127-132. DOI: 10.13546/j.cnki.tjyjc.2025.14.022.