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Problems and Future Development of Ecological Civilization Construction in Northeast China's Old Industrial Base

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ABSTRACT

The Northeast Old Industrial Base serves as a vital industrial hub in China and a crucial ecological security barrier for northern China. Boasting abundant natural resources, robust industrial foundations, comprehensive infrastructure, and numerous national key projects, the region has achieved remarkable progress in ecological civilization construction since the 18th National Congress of the Communist Party of China, guided by Xi Jinping's Ecological Civilization Thought to address regional ecological challenges. However, persistent issues remain in the current ecological development efforts. In this new era, how to resolve existing ecological challenges and explore a green, low-carbon development path that balances environmental sustainability with economic prosperity continues to be a significant theoretical and practical challenge for the socio-economic development of the Northeast Old Industrial Base

Keywords: Northeastern old industrial base, Ecological civilization, Ecological civilization construction

1. Introduction

The old industrial base in Northeast China is the foundation of China's modern industry and the cradle of new China's industry, making significant historical contributions to the formation of an independent and complete industrial system and national economic system in our country, as well as to reform, opening up, and modernization. The old industrial base in Northeast China includes Liaoning, Jilin, Heilongjiang, and a small part of Inner Mongolia. The old industrial base not only possesses abundant natural resources such as black soil, forests, wetlands, and minerals, but also serves as an important ecological security barrier in northern China. On the new journey of the new era, how the old industrial base in Northeast China can better promote ecological civilization construction by leveraging its regional characteristics, how to balance environmental benefits with the sustainable utilization and development of resources, and how to explore a green and low-carbon development path that achieves both green mountains and clear waters and golden

mountains and silver mountains, thereby realizing high-quality development with green as its foundation, remain major theoretical and practical issues that the region continues to explore in its socio-economic development.

Since the 18th National Congress of the Communist Party of China, General Secretary Xi Jinping has visited Northeast China more than ten times and made a series of important remarks and instructions on the ecological civilization construction of the region. Under the guidance of Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era, the old industrial base in the new era, relying on its natural resources, has steadfastly practiced the "Two Mountains" concept that "lucid waters and lush mountains are invaluable assets," actively promoting the transformation of ecological advantages into economic benefits; resolutely fought the battle against pollution, and continuously achieved new progress in ecological protection and restoration.

2. General Secretary Xi Jinping's Strategic Guidance on Ecological Civilization Construction in the Old Industrial Bases of Northeast China

The northeastern region is an important industrial and agricultural base in China, bearing significant responsibilities in safeguarding national defense security, food security, ecological security, energy security, and industrial security. From the perspective of national defense security, the northeastern region is located in northern Xinjiang, serving as the core area of Northeast Asia and a barrier for maintaining the security and stability of northern Xinjiang. From the perspective of food security, the northeastern region has flat terrain and high land utilization efficiency. According to the "Announcement on the 2025 Grain Production Data" released by the National Bureau of Statistics in December 2025, the total grain production in China reached approximately 714.88 million tons, with Heilongjiang Province contributing about 82 million tons, Liaoning Province about 25.77 million tons, and Jilin Province about 43.58 million tons, accounting for approximately 21% of the national total. This clearly demonstrates that the three northeastern provinces are China's granaries. Simultaneously, the northeastern region serves as a crucial strategic pivot for national grain reserves and a key transportation hub for "north-to-south grain transport." From the perspective of ecological security, the northeast is the largest concentration area of natural forests in China. The forest resources are an integral part of China's ecological security framework, including the "two screens and three belts" pattern and the "three zones and four belts" ecological restoration system, and have been incorporated into the overall layout of national important ecosystem protection and major restoration projects. They form the "green Great Wall" that sustains ecological security across northeastern China. Additionally, the region boasts the largest and most concentrated freshwater marsh wetland clusters in China, including the Sanjiang Plain, Songnen Plain, and Liaohe Delta, which play core ecological functions such as water source regulation, water purification, and carbon sequestration. From the perspective of energy security, Northeast China possesses inherent resource advantages that play a crucial role in safeguarding national energy security. In terms of traditional energy sources, the region boasts abundant mineral resources with diverse varieties. Regarding renewable energy, it has substantial wind and solar resources, which are vital for advancing clean energy development in this former industrial base and ensuring energy security. From the standpoint of industrial security, traditional manufacturing remains one of the pillar industries in Northeast China. The region continuously strengthens its real economy development to maintain the stability and security of industrial and supply chains, thereby enhancing people's quality of life and meeting the nation's strategic needs.

General Secretary Xi Jinping has shown great concern for the development of Northeast China, making multiple visits to the region. During his inspections of the old industrial bases in Northeast China, he formulated numerous important insights on ecological civilization construction tailored to local realities. These insights constitute invaluable assets within Xi Jinping's Ecological Civilization Thought, significantly enriching its theoretical framework.

(1) Ecology is resources, and ecology is productivity

On May 23,2016, during an inspection tour in Yichun City, Heilongjiang Province, President Xi Jinping emphasized that ecology is both a resource and a productive force. Forest resources constitute a vital component of Northeast China's ecosystem, accounting for one-fifth of the nation's total forest stock. These forests serve as crucial ecological assets and function as

"reservoirs, money banks, granaries, and carbon sinks." The "Four Forest Functions" enable the transformation of green mountains and clear waters into economic wealth. President Xi stated: "We need both green mountains and clear waters, and gold mountains and silver mountains. We would rather prioritize green mountains and clear waters than gold mountains and silver mountains, for green mountains and clear waters themselves are gold mountains and silver mountains." The term "green mountains and clear waters" refers to intact natural ecosystems including forests, wetlands, and grasslands1, representing not only natural and ecological assets but also social and economic 2wealth. Specifically, reservoir functions demonstrate forests 'water conservation 3capacity; money bank functions reflect the monetization of forest products 4and ecological services; granary functions highlight forests' food supply value; and carbon sink functions illustrate their carbon absorption capabilities. The Four Forest Functions concept reveals the multifaceted benefits of forests. By completely halting commercial logging in old industrial bases, forest resources have been restored to their natural state. Industries such as forest-based economies, wellness tourism, and forestry carbon sequestration have flourished, enabling forestry workers to prosper without 5cutting trees. Continuously transforming forest resources and ecological advantages into industrial strengths and competitive edges ensures synergistic interactions between ecological protection and economic development.

General Secretary Xi Jinping has attached great importance to the development of ice and snow resources, successively proposing a series of statements such as "Green mountains and clear waters are as valuable as gold and silver," "Ice and snow are also gold and silver," and "Vigorously develop the cold-region ice and snow economy." The three northeastern provinces are located in China's high-latitude region, almost at the same latitude as the world's developed ice and snow economic zones, making them part of the global "golden latitude belt for ice and snow." The northeastern region is rich in ice and snow resources, which are precious and unique natural, ecological, and developmental resources within the region. The old industrial base has implemented the development concept that "ice and snow are also gold and silver," deeply exploring 6ice and snow resources to drive sustainable development of characteristic cultural tourism throughout the region and all seasons through ice and snow tourism, while promoting the growth of industries such as ice and snow sports, ice and snow culture, and ice and snow equipment. Transforming "cold resources" into "hot economy." Accelerating the pace of building a "China ice and snow economic hub" to boost the ice and snow economy. The concept that "ice and snow are also gold and silver" not only profoundly reflects the dialectical unity between humans and nature, production, and ecology, but also embodies the theoretical connotation and practical path that "protecting the ecological environment is protecting productivity, and improving the ecological environment is developing productivity." Only by safeguarding the integrity and sustainability of the ice and snow ecosystem can we achieve a virtuous cycle of ecological

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protection, productivity, and economic growth.

(II) It is essential to effectively protect black soil, the "panda of cultivated land".

Black soil conservation is a matter of national importance. In China, black soil is primarily distributed in the Songnen, Songliao, and Sanjiang Plain regions of Northeast China, serving [7]as a key grain production zone and commercial grain export base. It acts as both [8]a "stabilizer" and "ballast stone" for national food security. However, due to soil erosion and prolonged intensive cultivation with inadequate fertilization, black soil has become increasingly thin, depleted, and hardened.

On July 22,2020, during his inspection tour in Jilin Province, President Xi Jinping emphasized the need to implement effective measures to protect and utilize the black soil – often referred to as the "panda of farmland" – ensuring its sustainable benefits for the people. On December 28 of the same year, at the Central Rural Work Conference, President Xi reiterated the importance of "properly managing and preserving black soil, treating [9]its conservation as a top priority." To implement President Xi's directives on sustainable black soil management, the Chinese Academy of Sciences launched the "Black Soil Granary" scientific initiative [10]in March 2021. By leveraging technological innovation to address black soil challenges such as thinness, hardness, and nutrient deficiency, the program aims to boost grain production capacity, achieve the goal of "storing grain in land and technology," and strengthen China's agricultural foundation. Through key technologies for black soil protection and utilization, significant progress has been made: the area under conservation tillage reached 83 million mu (approximately 5.5 million hectares) by the end of 2022. According to the Northeast China Black Soil Protection and Utilization Report (2023), the conservation tillage area [11]has expanded to 95 million mu, with marked improvements in soil quality.

China has not only employed technological measures to protect black soil but also enacted policies and legal frameworks to safeguard this critical ecosystem. The nation places high priority on preserving and utilizing black soil resources. Since the 18th National Congress of the Communist Party of China, the Central Committee has introduced multiple conservation initiatives, including the "Northeast Black Soil Protection Plan (2017-2030)" and the "Northeast Black Soil Conservation Tillage Action Plan (2020-2025)." The enactment of the "Black Soil Protection Law of the People's Republic of China" on August 1, 2022, marked a significant milestone in legalizing black soil protection, establishing a national legal foundation for conservation efforts. At the provincial level, Liaoning, Jilin, and Heilongjiang have implemented tailored policies: Liaoning Province released the "Jilin Province Conservation Tillage Promotion Action Plan (2020-2025)" in 2020, while Heilongjiang enacted the "Heilongjiang Province Black Soil Protection and Utilization Regulations." These comprehensive approaches integrate scientific advancements with robust legal frameworks to ensure sustainable management of black soil resources.

(3) The important supporting role of good ecological environment in the revitalization of northeast

In October 2003, the Central Committee of the Communist Party of China and the State Council issued the "Several Opinions on Implementing the Revitalization Strategy for Old Industrial Bases in Northeast China and Other Regions," marking the official launch of the Northeast revitalization initiative. A series of policy measures were introduced to support, assist, and promote regional development. The decade spanning [12]2003 to 2012 not only marked the first

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ten years of implementing the revitalization strategy but also represented a critical phase in transitioning ecological governance from "historical debt clearance" to "systematic restoration." During this period, comprehensive ecological conservation efforts were intensified across Northeast China. For instance, in forest resource protection and restoration, the Natural Forest Resource Conservation Project was deepened through measures such as halting logging, artificial afforestation, and mountain closure for forest regeneration, resulting in a significant increase in forest coverage to 38.8%—18 percentage points above the national average. Regarding wetland conservation, degradation caused by agricultural expansion was reversed through measures like establishing nature reserves and implementing ecological water replenishment projects, forming a basic wetland protection system and initially curbing desertification and land degradation. These initiatives at old industrial bases effectively halted accelerated ecosystem deterioration, achieved breakthroughs in key areas, and laid valuable groundwork for subsequent ecological governance efforts.

Since the 18th National Congress of the Communist Party of China, General Secretary Xi Jinping has conducted multiple inspections in Northeast China, held specialized symposiums, and delivered a series of important speeches and directives on the region's comprehensive revitalization. These initiatives fully demonstrate the Central Committee of the Communist Party of China with Comrade Xi Jinping at its core's high regard and earnest expectations for Northeast revitalization, providing fundamental guidance for the region's development in the new era. The construction of a sound ecological civilization also plays a supporting role in this process. Specifically: (1) Industrial restructuring: Accelerating intelligent, digital, and green transformation of traditional industries while upgrading equipment manufacturing. Strategic emerging industries are developing rapidly through deepening resource utilization and fostering innovative sectors, transitioning from traditional heavy industries to advanced manufacturing and modern services. The government actively supports strategic emerging industries such as new energy, advanced materials, and high-end equipment manufacturing, driving industrial optimization. (2) Energy transition: As a key energy production base, Northeast China has gradually shifted from traditional coal and oil resources to renewable energy sources, undergoing profound transformations from high-carbon fossil fuels to low-carbon clean energy. Old industrial bases are promoting wind power heating systems and diversified biomass utilization, while implementing low-carbon and smart upgrades for coal-fired power plants. Demonstration projects for comprehensive resource utilization in abandoned mining areas reduce waste and transform resources into valuable assets, facilitating the transformation of legacy industrial bases. (3) In green and low-carbon development, the old industrial bases have adhered to sustainable growth strategies while steadily advancing carbon peaking and carbon neutrality initiatives. Heilongjiang Province established a Low-Carbon Enterprise Alliance, with 140 key enterprises incorporated into the national carbon market. These regions have addressed critical ecological challenges, achieving fundamental improvements in environmental quality. The proportion of days with good air quality continues to rise; the implementation of a five-tier river chief system has led to significant improvements in water quality, while soil pollution risks remain effectively controlled. Fushun West Open-pit Mine in Liaoning Province has been developed into a world-class mining heritage park. Jilin Province now boasts 15 national-level garden cities. Heilongjiang Province has executed conservation and restoration projects for the Greater and Lesser Khingan Mountains ecological zones and Sanjiang Plain wetlands. Forest coverage rates have steadily increased alongside rising timber reserves. Energy conservation targets have been fully met, with cumulative reductions in energy consumption per GDP unit and further ecological optimization.

The starting point and ultimate goal of the revitalization of Northeast China are for the people. The value orientation of the people is also an inherent part of building [13]a beautiful Northeast. The assertion that "a good ecological environment is the fairest public product and the most inclusive benefit for people's livelihoods " not only reflects the people-centered development philosophy in

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the field of ecological environment, highlighting [14]the connection between the environment and people's livelihoods, but also points out that the ecological environment possesses the attribute of the fairest public product, indicating that it is one of the shared and inclusive benefits for people's livelihoods. It reveals the intrinsic relationship between the ecological environment and people's livelihoods while enriching the connotation of ecological environment in terms of people's livelihoods. As socialism with Chinese characteristics enters a new era, the principal contradiction in Chinese society has shifted from the contradiction between the people's growing material and cultural needs and backward social production to the contradiction between the people's growing needs for a better life and unbalanced and inadequate development. The general public has evolved from "seeking subsistence" to "seeking environmental protection," from "seeking survival" to "seeking ecology" and "seeking green." The ecological civilization construction in the old industrial bases of Northeast China has always adhered to Xi Jinping's thought on ecological civilization as its action guide; always taken the well-being of the people as its core goal; restored beautiful blue skies for people through air pollution prevention and control, and made water clearer through watershed management and water ecosystem restoration. The old industrial bases have consistently addressed survival-oriented livelihood needs through ecological benefits for the people, met developmental livelihood needs through ecological benefits for the people, and satisfied quality-oriented livelihood needs through ecological benefits for the people, continuously fulfilling the people's growing demand for a beautiful ecological environment.

3. The Main Problems of Ecological Civilization Construction in the Old Industrial Base of Northeast China

General Secretary Xi Jinping pointed out, "Protecting the ecological environment and improving the level of ecological civilization are important components of transforming development patterns, adjusting structures, and upgrading development stages. Currently, structural ecological and environmental contradictions remain prominent in old industrial bases."

（1）Facing challenges in industrial structure transformation

In the process of advancing ecological civilization construction and achieving carbon peaking and carbon neutrality goals in Northeast China's old industrial base, traditional fossil fuels remain a significant source of high emissions. The region's energy system has long relied heavily on fossil fuels, with the emission pressures from high-carbon energy structures posing a major bottleneck for short-term low-carbon transition. Although clean energy sources like solar, wind, nuclear, and hydrogen energy offer advantages such as environmental friendliness, abundant reserves, and wide distribution, their development scale and application levels remain insufficient. This has resulted in a single-minded energy supply structure and weak energy security capabilities, making it difficult to effectively mitigate climate change or improve regional air quality. Meanwhile, the cultivation of new productive forces and industrial upgrading urgently require green energy support. However, limited development and utilization of clean energy have failed to fully unleash the potential for green economic growth. Constrained by inadequate technological innovation and application promotion, regional development continues to largely follow traditional patterns characterized by high consumption, high pollution, and low efficiency. This not only hinders the low-carbon transformation of energy structures but also impedes the coordinated realization of ecological civilization construction and sustainable development goals.

The industrial green transition faces challenges including delayed progress and incomplete supporting systems. Key manifestations include: (1) Slow green transformation of traditional

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industries with structural weaknesses in industrial systems. Zombie enterprises, high-energy-consuming, high-pollution, and high-emission businesses remain unaddressed, overcapacity issues persist unresolved, and extensive development models in traditional industries have not fundamentally shifted, creating significant gaps compared to green, low-carbon, and intensive development requirements. (2) Insufficient cultivation of strategic emerging industries. Knowledge-intensive green sectors like biomedicine, new materials, and renewable energy have yet to achieve scale advantages, failing to effectively drive industrial structure optimization. The development of new growth drivers for industrial green development remains lagging. (3) Incomplete supporting systems for industrial green development. Shortcomings in talent supply, public services, management mechanisms, and governance efficiency hinder comprehensive support for green transformation, limiting its effectiveness. Fourthly, suboptimal industrial spatial layout prevents full utilization of regional resource endowments. Low efficiency in converting ecological resources into economic benefits, insufficient development of eco-cultural tourism industries, and lack of coordinated green industrial ecosystems prevent ecological advantages from being effectively translated into developmental strengths.

The leading role of green energy development has not been fully realized, specifically manifested in the following aspects: (1) Insufficient large-scale development of green energy, with energy supply structures still dominated by traditional fossil fuels. A diversified energy supply system remains underdeveloped, coupled with strong path dependence on conventional fossil fuels and significant pressure from greenhouse gas emission controls, which hinders the provision of solid energy support for industrial green transformation. (2) Incomplete policy support systems for green energy development. The enabling effects of fiscal and tax incentives have not been fully unleashed, while high investment thresholds and operational costs for green energy projects deter private capital participation. Additionally, insufficiently scientific green energy development indicators and industry standards, along with an underdeveloped societal guidance mechanism for green energy consumption, have delayed energy consumption structure transition. (3) Insufficient R&D investment in core green energy technologies. Collaborative R&D mechanisms among governments, enterprises, and research institutions remain ineffective. Breakthroughs have yet to be achieved in key technologies such as energy conversion, energy storage, smart grids, and energy efficiency. Challenges related to intermittent renewable power generation remain unresolved, and limited scenario-based applications of green energy technologies hinder standardized and sustainable industry development. These factors ultimately constrain the synergistic progress of ecological civilization construction alongside economic, environmental, and social benefits.

(II) The ecological security barrier still needs to be strengthened

National security and social stability serve as the fundamental prerequisites for reform and development[15]. Only with national security and social stability can progress in reform and

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development be continuously advanced[]. Ecological security constitutes a vital component of national security and has become a hallmark of ecological civilization. The ecological security barrier comprises natural elements such as mountains, rivers, forests, farmlands, lakes, grasslands[16], and deserts, which exhibit interdependent relationships and dynamic interactions characterized by systematicity, dynamism, complexity, and diversity. As the cornerstone of national security and social stability, strengthening ecological security barriers has become a foundational, comprehensive, and strategic systemic project crucial to safeguarding national ecological security[]. The northeastern region boasts abundant ecological resources including forests, wetlands, and grasslands. The forest belt forms China's "Two Screens and Three Belts" ecological security framework, playing a strategic role in regulating water cycles and local climate patterns in Northeast Asia, while also maintaining national timber resource security.

The ecological security barrier of China's old industrial bases faces challenges both domestically and internationally. Domestically, the Northeast Forest Belt serves as a critical component of the "Two Screens and Three Belts" ecological security strategy and the "Three Zones and Four Belts" framework for major ecosystem conservation and restoration projects. However, prolonged intensive logging and land reclamation have degraded the original forest and wetland ecosystems. Additionally, low processing rates of forest and grass products, a high proportion of small and medium-sized enterprises, insufficient leadership from industry leaders, low product value-added, and weak brand influence necessitate the establishment of a "Northeast Ecological Label" certification system. The development level of forest-based economies requires improvement, and tourism offerings remain insufficiently diverse. Infrastructure gaps in transportation and accommodation, coupled with peak-season overburden, create a mismatch between reception capacity and demand. Furthermore, the integration of tourism with cultural elements remains underdeveloped, failing to fully leverage its potential.

Geographically, Xilingol League in Inner Mongolia borders Mongolia's East Gobi Province, Sukhbaatar Province, and Eastern Province, sharing extensive borderlines with the country. Despite Mongolia's initially sound ecological foundation, global warming and accelerated economic development have led to progressive environmental degradation. Currently, 76.9% of Mongolia's territory—equivalent to 120 million hectares—suffers from desertification and land degradation. Climate disasters have become increasingly severe in recent years, with southern Mongolia serving as a major source of sandstorms for China. These widespread sandstorms cause significant environmental damage, air pollution, and disruptions to daily life across China.17

(III) Issues in the Modernization of Ecological Environment Governance Systems

The modernization of the ecological environment governance system encompasses not only the modernization of regulatory frameworks, economic policies, legal systems, [18]and social action mechanisms for ecological governance, but also the advancement of institutional mechanisms, legal frameworks, and technological approaches in environmental management[]. Currently, the Northeast region faces certain challenges in its ecological governance framework, including issues related to accountability systems, regulatory structures, and market mechanisms.

Regarding the responsibility framework for ecological governance: (1) Unclear role definitions among stakeholders and inadequate accountability implementation. Effective environmental management requires coordinated efforts from governments, enterprises, social organizations, and the public. However, the Northeast region's entrenched "big government" model has perpetuated a government-dominated governance approach, resulting in ambiguous accountability frameworks. Enterprises often demonstrate weak environmental responsibility awareness, prioritizing

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economic gains over ecological conservation and public welfare. Limited public participation channels and ineffective communication mechanisms further reduce environmental consciousness and engagement. Social organizations face challenges including insufficient numbers and lack of professional expertise to fulfill third-party oversight and public education roles. (2) Ambiguous responsibility allocation and low regional coordination. Ecological governance involves multiple sectors including environmental protection, forestry, water resources, natural resources, and agriculture. Yet the Northeast region remains entrenched in compartmentalized administrative practices, leading to inefficient interdepartmental collaboration. Despite the region's ecosystem integrity, cross-regional coordination mechanisms remain underdeveloped, compounded by the absence of legal enforceability provisions and accountability mechanisms that hinder effective cross-jurisdictional responsibility implementation.

In terms of the ecological environment governance supervision system: (1) Mismatch between regulatory teams and tasks. Traditional industrial bases face complex composite pollution challenges requiring highly qualified professionals. Current personnel lack sufficient expertise and demonstrate suboptimal enforcement capabilities. Ecological regulators exhibit uneven professional competence and enforcement skills, with some lacking essential knowledge and practical experience in environmental governance supervision. Northeast China's ecological oversight predominantly relies on traditional methods such as manual inspections, periodic checks, and post-event penalties, with insufficient technological empowerment. This results in inadequate real-time monitoring capabilities for large-scale regional pollution, unorganized emissions, and covert illegal discharges, leading to inefficient regulatory implementation. (2) Insufficient regulatory coordination and collaborative challenges. Cross-provincial ecological issues in Northeast China remain prominent. Administrative barriers and lack of interest coordination mechanisms have caused poor inter-regional coordination in environmental governance supervision. Concurrently, inadequate information sharing among departments leads to redundant oversight and regulatory blind spots, significantly reducing cross-regional and cross-departmental environmental governance efficiency.

In the market system for ecological environment governance: (1) Inadequate market mechanisms and low governance efficiency. The pricing mechanism for ecological environment governance services remains imperfect, failing to reflect market supply-demand dynamics and governance costs, resulting in inefficient allocation of ecological resources. The absence of a unified and standardized trading platform for environmental governance services leads to information asymmetry and high transaction costs. Unclear trading rules further compromise the protection of rights and interests for both parties. (2) Market entities face challenges of limited quantity, weak capabilities, and structural imbalance. Domestic enterprises lack sufficient capital and risk resilience, while foreign enterprises show low participation motivation [19]and struggle to retain existing players. (3) Insufficient market system innovation and low governance effectiveness. The financing mechanism for ecological environment governance remains underdeveloped, with restricted channels for social capital to enter the field. This results in inadequate R&D investment for technological innovation, slowing progress in developing and applying new technologies, processes, and equipment for ecological governance. Low technology transfer rates further hinder the practical application of research achievements in ecological environment governance.

III. Future Development of Ecological Civilization Construction in the Old Industrial Base of Northeast China

(1) Adhere to ecological priority and lead industrial transformation and development with new-quality productive forces

During the 11th collective study session of the Political Bureau of the CPC Central Committee, General Secretary Xi Jinping emphasized: "Green development forms the foundation of high-quality development, and new-type productive forces inherently constitute green productivity." New-type productive forces represent advanced production capabilities aligned with green development principles. Developing such productive forces [20]essentially means advancing

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green productivity. Therefore, new-type productive forces themselves are fundamentally green productivity[]. Green new-type productive forces not only drive the growth of green industries, ecological industries, strategic emerging industries, and future industries, but also serve as crucial tools for achieving carbon peaking and carbon neutrality goals. To harness new-type productive forces for green development, Northeast China must prioritize green technological innovation as the 21driving force, expand green industries as practical objectives, and accelerate green energy development as key momentum sources, thereby expediting the empowerment of green development through new-type productive forces.

We must drive progress through green technological innovation. By leveraging scientific advancements, we can accelerate the development of renewable energy sources. While traditional industrial bases are rich in fossil fuels, "the high emissions from conventional 22fossil fuels remain the biggest bottleneck for short-term carbon peaking and carbon neutrality goals." Renewable energy sources cause minimal environmental impact or pollution, possess abundant reserves, and are widely distributed. Utilizing renewables reduces dependence on traditional energy systems, mitigates supply chain risks, enhances energy security, contributes to climate change mitigation, and improves air quality. The growth of new productive forces requires support from renewable energy—particularly green energy. Effective development and utilization of clean energy sources like solar, wind, nuclear, and hydrogen power can unlock economic potential. Through green technological innovation and continuous renewable energy development, we can transform 23traditional growth models characterized by high resource consumption, pollution, and low productivity, ultimately achieving sustainable development objectives.

With the cultivation and expansion of green industries as the core focus of practice, we systematically advance industrial structure optimization and transformation. In upgrading traditional industries, optimizing the industrial system requires dual approaches: On one hand, driving the transition of traditional industries toward greener practices through financial innovation and improved social security systems, orderly phasing out zombie enterprises, high-energy-consuming, high-pollution, and high-emission businesses, continuously addressing overcapacity issues, and promoting industrial transformation toward low-carbon and intensive development. On the other hand, fostering the rise of strategic emerging industries guided by ecological development concepts, implementing systematic ecological design for modern industrial development, increasing support for knowledge-intensive sectors like biomedicine, new materials, and renewable energy, and cultivating new growth drivers for green industrial development. Industrial greening is a comprehensive and systematic project, where deepening supporting reforms serve as prerequisites for achieving green transformation. To this end, we must strengthen talent cultivation and recruitment, enhance public service quality, optimize management mechanisms, and improve governance efficiency to provide all-round support for industrial green development. Simultaneously, leveraging regional resource endowments, optimizing industrial

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spatial layouts, focusing on converting ecological advantages, vigorously developing eco-cultural tourism industries, and efficiently transforming ecological resources into economic assets will help establish a new pattern of coordinated green industrial development.

Green energy development serves as the core driving force for industrial green transformation. Large-scale green energy development can effectively curb greenhouse gas emissions, promote diversification of energy supply structures, reduce dependence on volatile and highly uncertain traditional fossil fuel markets, and lay the energy foundation for industrial green upgrading. Two key dimensions can be prioritized to facilitate high-quality green energy development: (1) Strengthening policy support systems to empower green energy growth. Governments can utilize fiscal subsidies and tax incentives to lower investment thresholds and operational costs for green energy projects, guiding orderly capital inflows into this sector. Concurrently, technical guidance and market empowerment services should be leveraged to drive technological innovation and practical applications of green energy solutions. Additionally, scientifically defined green energy development indicators and industry standards are essential to encourage enterprises and the public to increase green energy adoption rates, fostering sustainable energy consumption patterns across society. (2) Increasing R&D investment to bolster green energy development. Governments, enterprises, and research institutions should establish collaborative R&D mechanisms, continuously boosting investments in core technologies such as energy conversion systems, energy storage solutions, smart grid technologies, and energy-saving innovations. The mature application of these technologies not only enhances energy conversion efficiency and reduces consumption/carbon emissions but also improves renewable energy supply reliability. This addresses the industry challenge of intermittent renewable generation, promotes standardized and healthy development of the green energy sector, and ultimately achieves synergistic benefits across economic, environmental, and social dimensions.

(2) Adhere to the Systematic Concept and Promote the Comprehensive Management of Ecological Environment

A sound ecological environment serves as a priority area for enhancing public welfare and forms the essential foundation for building a beautiful old industrial base in Northeast China. President Xi Jinping emphasized: "Protecting the ecological environment [1]is equivalent to safeguarding productive forces, while improving the ecological environment constitutes the development of productive forces. A sound ecological environment represents the most equitable public good and the most inclusive form of public welfare[]." Therefore, it is imperative to balance high-quality development with stringent environmental protection, firmly establish the concept that ecological conservation equates to productivity preservation and that new-generation productive forces inherently embody green productivity, fundamentally transform development paradigms, and innovate growth models.

Comprehensively advance the coordinated governance of the "Three Major Pollution Control Campaigns" to break down administrative barriers. Strengthen integrated planning for pollution prevention efforts, enhancing synergistic effects in air, water, and soil pollution control. For regions with irrational pollution control structures, implement top-level design and targeted measures to address weak links, while summarizing effective pollution control experiences from critical sectors. Drive significant reductions in agricultural non-point source pollution, ensure industrial emissions meet regulatory standards, and achieve comprehensive urban-rural pollution management. Actively promote straw energy utilization to sustain steady improvements in ecological environment quality.

Establish a collaborative regulatory mechanism to build an integrated system featuring real-time early warning, dynamic monitoring, comprehensive law enforcement, emergency coordination, and information-sharing. Strengthen cross-departmental and cross-regional environmental cooperation frameworks, formulate unified ecological protection policies and

pollution control action plans, implement routine joint environmental law enforcement emergency protocols, initiate unannounced environmental inspection modes, refine environmental accountability systems and evaluation mechanisms, and establish a joint environmental reporting and disclosure system.

Enhance the ecological environment governance system and capabilities. Refine local regulations and standards related to environmental protection, and establish corresponding accountability frameworks. Implement performance evaluation and accountability mechanisms for environmental protection with due emphasis, improving governance capacity while ensuring effective pollution control measures to avoid short-term investment overperformance. Develop ecological environment balance sheets, and establish mechanisms for environmental damage compensation and liability pursuit to significantly strengthen government agencies, enterprises, and public awareness of environmental responsibilities and enforcement capabilities. Fully implement environmental protection obligations through public disclosure of environmental responsibility lists, enhanced supervision and inspections, and guaranteed task execution.

(III) Implementing the "Two Mountains" Theory to Establish a Robust Northern Ecological Security Barrier

Establishing ecological security redlines. The ecological carrying capacity of old industrial bases is limited, and regional ecosystems have inherent constraints in resisting external climate changes and human interference. Exceeding certain "thresholds" may trigger metabolic disturbances in ecosystems. Therefore, the three northeastern provinces must scientifically calculate regional environmental carrying capacity, establish dynamic spatial zones based on maximum thresholds, and define corresponding development intensity levels to delineate ecological security redline areas. For instance, Liaoning Province strictly adheres to ecological protection redlines to ensure no degradation of ecological functions or alteration of environmental characteristics. Jilin Province has implemented the "Several Measures for Strengthening Ecological Environment Zoning Control" to enhance regional management and rigorously safeguard ecological protection redlines. Heilongjiang Province has launched the "Green Shield 2025" initiative to intensify supervision of nature reserves, focusing on investigating illegal activities within protected areas and ecological protection redlines across the province.

We must continuously expand pathways for ecological value conversion and accelerate the transformation of ecological advantages into economic benefits. Ecological resources not only possess environmental values such as climate regulation and water conservation but also hold significant socioeconomic value. Green mountains and clear waters represent not only natural and ecological wealth but also social and economic assets. Traditional industrial bases should broaden ecological value conversion strategies and expedite ecological industrialization. Vigorous development of eco-agriculture, eco-tourism, and eco-healthcare industries is essential to meet public ecological demands. Tailored approaches should be adopted based on provincial characteristics, including expanding production bases for Donggang strawberries, Liuhe County grapes, and Baoqing red raspberries. Support should be given to leading enterprises while strengthening technical collaborations with regional partners to develop innovative products like beverages and organic foods, creating influential regional brands and specialty agricultural products that meet both consumer needs and local livelihood requirements. Leveraging forest ecosystems, wetlands, and lakes, we should promote eco-tourism integration that combines experiential tourism with local cultural elements. Advancing smart integration of agriculture, tourism, and healthcare industries will drive sustainable economic and ecological development within regions. Accelerating carbon sink accounting systems for forests, wetlands, and grasslands, along with carbon trading mechanisms, is crucial for achieving dual benefits in economic growth and environmental protection.

Enhance cross-border ecological governance capabilities. The Northeast region should align with the "dual carbon" strategic goals by establishing a coordinated mechanism for ecological conservation and cultural-tourism resource development, capitalizing on the growth opportunities spurred by the winter sports boom. Through innovative approaches in specialty folk tourism, border tourism, and winter sports tourism, the region can foster deep integration of culture, tourism, and ecology. This will inject intrinsic momentum into regional ecological governance practices, thereby strengthening the ecological security barrier along China's northern frontier.