Effective Pathways and Countermeasures for Promoting Green Development in Shandong (Postprint)

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Abstract

[Purpose/Significance] The 12th Five-Year Plan first introduced the theme of "green development," and the subsequent Fifth Plenary Session of the 18th Central Committee explicitly articulated that the development objective for the 13th Five-Year Plan period is to firmly establish and implement the development concepts of innovation, coordination, green, openness, and sharing. It is thus evident that pursuing a green economic development model has become imperative, and research on green economic development issues facilitates the implementation of sustainable development strategies. The green economy can reduce greenhouse gas emissions without compromising economic growth. Consequently, the green economy holds significant importance for China' s socialist modernization.

[Method/Process] Based on this premise, we conduct an analytical investigation into the actual conditions of green development in Shandong Province.

[Results/Conclusions] Through the exploration and research presented in this paper, we aim to achieve a more profound understanding of the actual status of green economic development in Shandong Province. Accordingly, through approaches such as industrial structure adjustment and optimization of spatial layout, establishment and implementation of a green economic development system, and improvement of institutional mechanisms, we seek to address the existing challenges in Shandong Province, including uncoordinated industrial structures, a singular energy consumption pattern, and environmental issues arising from economic development, thereby fostering the sustainable development of the green economy in Shandong Province.

Full Text

Effective Paths and Countermeasures for Promoting Green Development in Shandong

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Abstract

[**Purpose/Significance**] The 12th Five-Year Plan first took "green development" as its central theme, explicitly stating that in the face of increasingly severe resource and environmental constraints, China must enhance its sense of crisis, establish green and low-carbon development concepts, focus on energy conservation and emission reduction, improve incentive and constraint mechanisms, accelerate the construction of resource-saving and environment-friendly production and consumption patterns, enhance sustainable development capacity, and improve ecological civilization levels. Subsequently, the Fifth Plenary Session of the 18th CPC Central Committee emphasized that to achieve the development goals of the 13th Five-Year Plan period, China must firmly establish and earnestly implement the development concepts of innovation, coordination, green development, openness, and sharing.

[**Method/Process**] Based on this background, we conducted an analytical study of the actual situation of green development in Shandong Province.

[**Result/Conclusion**] This research helps us gain a deeper understanding of the actual conditions of green economic development in Shandong Province, including what problems remain to be solved and where greater efforts are still needed. Additionally, empirical research on the efficiency of green economic development in Shandong can help us understand the achievements of the province' s green economy development.

Keywords: Shandong Province, green development, industrial structure, development history, circular economy
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1.1.1 Problem Statement

Against the backdrop of rapid socio-economic development, the contradiction between human progress and the ecological environment has become increasingly prominent. While industrial advancement has driven growth, it has also led to the continuous consumption of fossil fuels such as coal, oil, and natural gas. These precious non-renewable resources have been diminishing year by year, making resource shortages a critical factor hindering sustainable socio-economic

development. Furthermore, various types of industrial waste have caused significant damage to our living environment. Therefore, it is evident that if we cannot transform our development model and actively pursue a path of circular economy and sustainable development, we will ultimately face nature' s retaliation. Consequently, we must urgently explore a green and circular development pathway.

1.1.2 Research Objectives and Significance

Since the Industrial Revolution, modern science and technology have experienced rapid development, and people' s quality of life has improved significantly, bringing profound changes to all aspects of life. However, these changes have come at the cost of excessive fossil energy consumption, over-exploitation and utilization of resources, and destruction of the ecosystem' s internal balance. Therefore, seeking a green economic development model has become an irreversible trend. As the world' s largest developing country and the largest carbon dioxide emitter, China' s carbon emissions have attracted increasing attention from scholars both domestically and internationally. A green economy can reduce greenhouse gas emissions without sacrificing economic development, making it highly significant for China' s socialist modernization efforts.

1.2.1 International Literature Review

Western countries first proposed the concept of green economic development in the 1960s, gradually extending from green production and consumption to green distribution and green civilization, allowing the green concept to take root in the hearts of modern people. Between the 1960s and 1970s, the green concept gradually entered the political arena, with the "greening" of governing platforms in some Western countries playing a substantial promotional role. Beginning in the 1980s, ecological Marxism' s transformation of green development theory generated considerable influence. The concept of green economy was formally introduced in 1989, emphasizing ecological and environmental protection during socio-economic development. Starting in the 1990s, green concepts based on sustainable development theory gained further traction, focusing on studying the environmental impacts of socio-economic development and exploring scientific approaches to environmental issues from comprehensive perspectives spanning technology, political systems, and cultural viewpoints. After 2008, to address global climate and energy shortage issues, the green development concept gradually differentiated from ecological economics and underwent further refinement, becoming an effective measure for restructuring the world economic system and global environmental governance.

1.2.2 Domestic Literature Review

Domestic research on green economic development formally began with Mr. Hu Angang, after which numerous experts and scholars conducted extensive studies

on theoretical foundations, development pathways, and green economy evaluations. Regarding green development theory, Wang Lingling and Zhang Yanguo view green development as a modern development approach and a new ecological concept encompassing green environmental development, green economic development, and green cultural development, with its primary goal being to ensure sustained and balanced development between society, economy, and ecological environment, with scientific resource utilization and ecological balance protection at its core. Qi Jianguo proposes that the essence of the financial crisis lies in problems with the global economic development model, and that global economic recovery requires a complete transformation of past economic development patterns. He argues that promoting green development and green technology revolution represents the optimal path out of economic crisis, with the advent of the green development era serving as an important pathway to achieving circular economy and sustainable development. Jiang Nanping and Xiang Renkang believe that green development focuses primarily on balancing socio-economic development and ecological environmental protection to achieve socio-economic harmony. Therefore, the essence of green development includes not only the scientific and rational utilization of natural resources but also ensuring sustainable socio-economic development while maintaining the balance between depletion and compensation to guarantee harmony between humans and nature. Chen Huawen analyzes the connotation of green economy from the ancient Chinese concept of "unity between heaven and humanity," using this perspective to interpret current domestic ecological issues. He argues that addressing green economic development requires promoting industrial structure transformation, reforming green economic compensation and constraint mechanisms, and improving environmental protection policies and regulations.

1.3.1 Green Development and Sustainable Development

Green development and sustainable development are deeply interconnected. The green development path essentially constitutes an important component of sustainable development strategy planning. Their relationship can be summarized as follows: sustainable development strategy encompasses the green development concept, while green development can promote the implementation of sustainable development. Compared to sustainable development, green development represents a broader concept, emphasizing the close relationship between humans and the environment. The goal of sustainable development is to leave more available resources for future generations, whereas green development aims to create resources for future generations.

1.3.2 Green Development and Circular Economy

The characteristic of circular economy is to minimize natural resource input during production processes, extend product life cycles as much as possible through reuse, minimize waste discharge, strive for harmless emissions, and achieve resource recycling. Green economy and circular economy share many similarities.

However, green economy encompasses broader content than circular economy, such as including green distribution during product allocation processes. Circular economy places greater emphasis on resource recycling and can be regarded as an important approach and essential measure for realizing green economy.

1.3.3 Green Development and Low-Carbon Economy

As a new economic model, low-carbon economy focuses on reducing carbon emissions per unit of energy consumption and controlling the growth rate of carbon dioxide emissions. The development of low-carbon economy primarily involves transforming modern people' s high-carbon consumption preferences, reducing fossil energy consumption, and thereby achieving sustainable development. Green economy and low-carbon economy also share many commonalities. For instance, both emphasize minimizing mineral energy use during production input stages and replacing mineral energy with renewable and new energy sources. Therefore, green economy encompasses low-carbon economy and represents a broader concept than low-carbon economy.

2.1 Shandong' s Green Economic Development History

Since the implementation of China' s reform and opening-up policy, Shandong Province has achieved remarkable socio-economic development results, though its quality management has remained relatively extensive with considerable resource and environmental pressures. Since 2000, Shandong' s green development has primarily emphasized environmental protection systems and promoted the application of circular economy models. The 2001 *Shandong Province Environmental Protection Regulations* explicitly proposed developing circular economy and strengthening ecological construction and protection as important components. In 2005, Shandong became one of the first batch of national circular economy pilot provinces. The province' s 12th Five-Year Development Plan Outline clearly stated that it must emphasize ecological civilization, energy conservation, and low-carbon development. In May 2013, an ecological development construction leading group was formally established with the Provincial Party Secretary as group leader and the Governor as deputy leader. In 2014, Shandong further promoted ecological construction, achieving a 16% reduction in average fine particulate matter concentration province-wide and an 11.2% reduction in inhalable particulate matter. The 2015 Shandong Provincial Government Work Report once again explicitly stipulated strengthening ecological protection as a key focus for future work.

2.2 Shandong' s Green Economic Development Advantages

First, Shandong possesses rich green economic development experience. Since 2000, the province has been practicing green economic development, continuously exploring and accumulating experience for nearly two decades. Regarding the adjustment of high-pollution industrial structures, the Shandong

Provincial Government was initially concerned that imposing high standards on high-pollution industries would impact pillar industries and hinder socio-economic development, potentially causing many high-pollution enterprises to face bankruptcy crises. However, during the implementation of key enterprise reforms, many former high-pollution enterprises managed to meet environmental protection standards through optimized production technology improvements, thereby promoting economic development while effectively protecting the environment.

Second, Shandong's economy has maintained strong growth momentum. Among domestic provincial economies, Shandong has made substantial contributions to national GDP due to its rapid socio-economic growth. Since 1978, Shandong' s GDP has consistently grown, from 25.476 billion yuan initially to 5,924.674 billion yuan in 2014. The value-added of the primary industry reached 479.836 billion yuan, the secondary industry 2,878.811 billion yuan, and the tertiary industry 2,584.012 billion yuan. The value-added of agriculture, forestry, animal husbandry, and fishery totaled 499.288 billion yuan, industrial value-added reached 2,534.086 billion yuan, total fixed-asset investment of the whole society was 4,249.552 billion yuan, and urban fixed-asset investment

3.1 Current Problems in Shandong' s Green Development Path

First, the industrial structure is uncoordinated. The current overemphasis on heavy industry at the expense of light industry has caused significant energy and resource waste while creating environmental pollution problems. Resource-intensive enterprises dominate while technology-intensive enterprises are relatively few, with the former leading to low economic efficiency and the latter hindering effective employment of rural surplus labor and urban development.

Second, the energy consumption structure has not diversified. At present, Shandong' s energy consumption relies basically on raw coal and crude oil, while various modern new energy sources have not been fully developed. Additionally, because Shandong' s current scientific and technological development level still needs further improvement, development processes often cause certain pollution to the natural environment.

Third, regarding Shandong' s cultivated land resources, agricultural land is increasingly occupied by industrial and urban construction projects. Moreover, the province has relatively scarce water resources, with the Yellow River as its main water source. However, due to urban development causing relatively serious industrial pollution, the Yellow River' s water volume has decreased year by year, imposing certain constraints on irrigation using Yellow River water.

Fourth, Shandong' s recent economic development has come at the cost of massive energy resource consumption and ecological environmental pollution. Such an economic development model must be transformed as soon as possible. Due

to deteriorating ecological environments, many problems have already significantly affected people' s production and daily lives. The Shandong Provincial Government has gradually realized the economic and health problems caused by ecological environmental pollution and recognizes that only by transforming traditional economic development methods can healthy and sustainable development be ensured.

3.2 Comprehensive Greening Strategies of South Korea and Germany

As early as 2009, the South Korean government emphasized a national strategic plan for green growth in its five-year plan and first established economic indicators represented by green energy. To further promote green economic development, South Korea invested a total of 100 trillion won with the goal of becoming the world' s largest green nation by 2020. The South Korean government has implemented a very comprehensive system to promote green development, including green structure optimization, green technology research and development, green value chain creation, and green transportation network construction.

Germany' s promotion of ecological green industrial development mainly includes the following aspects: implementing strict environmental protection policies, continuously expanding the application scope of renewable green resources, promoting innovation and reform in the automotive industry, and expanding environmental protection publicity and education. In recent years, the German government has continuously increased investment in environmental protection technology research and development while also supporting corporate investments to form environmental protection and innovation funds, thereby promoting Germany' s green economic development. In recent years, green energy in Germany has accounted for approximately 15% of total energy consumption and has gradually become a new economic growth point.

3.3 New Energy Policies of the United States and Japan

The green new deal implemented by the United States includes new energy research and development, energy efficiency improvement, and climate change response measures. New energy research and development constitutes an important component of green development, primarily including high-efficiency batteries, smart power grid construction, carbon storage technology, and green energy development technologies. This demonstrates that the U.S. government regards supporting green economy development and new energy research and development as an important strategy for economic recovery after the financial crisis, with total investment reaching $800 billion, accompanied by the introduction of the *American Recovery and Reinvestment Act* aimed at stimulating economic development and promoting social employment.

In the draft *Green Economy and Social Transformation* promulgated by the

Japanese government in 2009, the government proposed actively promoting and applying greenhouse gas emission reduction plans to promote Japan' s green economic development. The Japanese government focuses on developing green economy through environmental protection and new energy policies to truly ensure the realization of a harmonious symbiotic society. The government has also implemented an energy-saving home appliance environmental protection system, enabling ordinary citizens to transform their daily consumption behavior into mainstream social consciousness, thereby demonstrating the influence of green economy. As one of the earliest countries to propose the concept of a low-carbon society, the Japanese government has been committed to building itself into a low-carbon green nation in recent years.

3.4 Learning from International Green Development Experience

From the Japanese government' s experience, we can see that green technology innovation and new energy application can effectively promote energy development, improve energy utilization efficiency, and provide good environmental protection. The German government also believes that technological research and development is key to renewable energy development. Germany' s high-tech program has invested 4 billion euros to encourage corporate innovation. From Germany' s renewable energy development reports, we can understand that its energy technology research and development and utilization have reached a relatively mature state. International experience proves that establishing a comprehensive system that enables the entire nation to work toward a green and low-carbon society is an important prerequisite for green economic development to achieve actual results. This typically includes constructing a sound standard system for promoting green economic development, management and service institutions, complete work management systems, and green tax systems. Additionally, experiences from advanced foreign countries also prove that green economic policies and complementary policies can effectively mobilize the enthusiasm and initiative of the private sector, thereby enhancing policy influence. Therefore, we should pay more attention to the role of every individual citizen, enabling the general public to recognize the significance of green economic development and actively participate in green economic construction and development.

4.1 Analysis of Shandong Provincial Government Support Efforts

Government departments represent social public interests and serve as centers of authority, playing a very important function in promoting green economic development. While Shandong Province has promoted socio-economic development, it has also caused considerable environmental damage. To balance the contradictions among socio-economic development, government, and enterprises, many Western developed countries have proposed relying on the establishment

of green government management systems to strengthen environmental management levels, further balance government-enterprise relationships, and effectively promote the sustainable development of green economy.

Shandong began implementing green government construction as early as 2001. After more than a decade of development, it has achieved remarkable results, including further promoting industrial structure adjustment, gradually intensifying efforts to eliminate backward production capacities, and implementing a dual-wheel drive strategy. The province has truly focused on upgrading high-pollution and high-energy-consumption industries while supporting emerging enterprises. In recent years, emissions of sulfur dioxide and chemical oxygen demand have been effectively controlled. The development of the Yellow River Delta and Blue Economic Zone has also been gradually implemented, under which the Shandong Peninsula high-end industrial zone has achieved orderly development.

4.2 Problems in Shandong' s Green Development

First, the industrial structure is unscientific. Shandong' s socio-economic development relies mainly on industrial promotion, but the excessive focus on heavy industry while neglecting light industry has led to considerable energy and resource consumption. For industry, resource-intensive and capital-intensive enterprises constitute the majority, while technology-intensive enterprises are relatively few. The former results in difficulty improving economic efficiency, while the latter hinders effective employment of rural surplus labor and urbanization construction.

Second, the energy consumption structure is singular. Shandong' s energy consumption has gradually increased, and the energy consumption structure remains relatively monotonous. For instance, renewable resources such as solar and wind energy have not been promoted on a large scale. Coal still occupies a relatively large proportion in primary energy consumption. Additionally, because Shandong' s current scientific and technological level is not very high, it may cause very serious environmental damage problems during development.

Third, agricultural resources are gradually decreasing. For example, regarding cultivated land resources, agricultural land continues to show a gradual declining trend, with much farmland occupied by urban development. Regarding water resources, Shandong has always been a province with water shortages, with the Yellow River as its main water source. However, due to relatively serious industrial pollution from urban development, the Yellow River' s water volume has decreased year by year, imposing certain constraints on irrigation using Yellow River water.

Fourth, policies and regulations need further improvement. At present, Shandong still lacks policies and regulations specifically targeting green economic development. For example, the key to green industries lies in standardization, but currently Shandong' s green industry technical specifications and quality

testing standards are not very complete, requiring government departments to issue matching standard systems to promote green development. Therefore, to achieve the energy conservation and emission reduction targets in the 13th Five-Year Plan as much as possible, Shandong should establish a green development evaluation index system to conduct quantitative assessments of the province' s green development.

5.1 Actively Adjust Industrial Structure

The Shandong Provincial Government must accelerate industrial structure adjustment, further resolve overcapacity contradictions, and speed up the elimination of backward production capacities. For high-energy-consumption enterprises in thermal power, cement, and steel industries, the government should accelerate product upgrading and replacement, promote the transformation and research and development of production technologies, further reduce energy consumption, and promote economic efficiency improvements. The government should promote the development of strategic emerging industries. Advanced equipment manufacturing, energy conservation and environmental protection, modern materials, and other industries exhibit characteristics of low energy consumption and high added value while possessing significant advantages among domestic counterparts and must receive key support. The government should promote energy structure adjustment and continuously advance new energy development in Shandong by enhancing structural adjustments and technology research and development focused on clean production and using industrial policy guidance to support enterprises in producing low-pollution and high-value-added products.

5.2 Establish a Green Technology System

Shandong must promote independent innovation and truly regard it as an important link in developing green economy. The province should adhere to enterprise-centered, market-oriented, and technology-supported approaches, continuously strengthen industry-university-research connections, support independent innovation and re-innovation through introduction and absorption, and strive for greater breakthroughs in key construction fields and important innovation links of green economic development. Shandong should establish and improve innovation service platforms for major technology research and development and resource sharing, further perfect technology research and development systems and service innovation systems, rely on key provincial universities and major research institutes, accelerate the construction of provincial and ministerial-level research institutes and laboratories, and promote the establishment and innovation of green technology systems.

5.3 Optimize Industrial Development Layout

Shandong must further leverage its advantages in transportation location, characteristic resources, scientific and educational talent, and other aspects. The province should popularize differentiated development strategies, rationally plan and determine green economic development directions, and promote characteristic green economic development. Shandong should invest more human, material, and financial resources to build a batch of advanced equipment manufacturing bases, establish electronic information high-tech industrial bases, establish building energy efficiency and green building demonstration bases, establish provincial agricultural product processing and manufacturing supporting bases, and establish provincial comprehensive manufacturing industrial bases. By relying on a multi-point distribution of important development zones as platforms for industrial gradient development patterns, Shandong should gradually construct a modern industrial system and industrial development pattern compatible with urban agglomeration resources and environments.

5.4 Formulate Energy Development Strategy

As comprehensive deepening of reforms gradually advances, Shandong must identify its positioning, improve its functions, and truly give play to the fundamental and pioneering role of new energy strategy in green economic development. Promoting reform and innovation in energy production and consumption patterns and adhering to a clean and safe new energy development path constitute an important issue facing the Shandong Provincial Government. To implement the strategy of "gasifying Shandong," the province must regard the exploration and development of coalbed methane, tight gas, biogas, geothermal energy, and other new energy sources as major strategic deployments for restructuring the geological exploration economy.

5.5 Improve Institutional Mechanism Construction

First, continuously improve the supporting system of relevant policies and regulations, strengthen government support, and promote the development of green industrial structures. For energy conservation, environmental protection, and green industries, Shandong should promptly improve corresponding policies and regulations to ensure the sustained and healthy development of green economy. Additionally, the province needs to increase financial investment, especially providing further support for enterprises with leading energy conservation and emission reduction technologies and projects with advanced energy-saving technologies, ensuring adequate funding. Shandong should rely on complete policies and regulations to safeguard legitimate rights and interests and carry out green brand promotion and construction efforts.

Second, improve the natural resource property rights system and ecological compensation mechanism. A clear property rights system can ensure the sustained and healthy operation of environmental protection markets, allowing enterprises

participating in environmental protection to truly participate in green economic construction. The government should provide appropriate ecological compensation to enterprises with relatively large contributions to maximize the value and role of this mechanism.

5.6 Mobilize All Social Sectors

Promoting green economic development is a cause that concerns all industries and millions of households, requiring joint efforts from all social sectors. All organizations, including government agencies, schools, and hospitals, must truly integrate green environmental protection concepts with actual life and work, resist waste phenomena throughout society, and make green development and ecological civilization construction the foundation of social development. We know that all corporate behaviors require human participation, and building green homes and cities also needs the joint efforts of the general public. Becoming an environmental protector and low-carbon practitioner must become a popular slogan in contemporary society. Promoting low-carbon economic development and reducing carbon emissions are directly related to every citizen' s life. The government should vigorously advocate green consumption and support consumers in purchasing more energy-saving products. Here, we must maximize the important role of commercial enterprises in regulating production and guiding consumption processes, enabling them to truly focus on energy conservation and emission reduction, continuously innovate marketing and production methods, and use their out-of-store publicity advantages to promote energy-saving and environmentally friendly products throughout society, making green consumption a social fashion.

5.7 Strengthen Government Department Supervision

Ensuring the implementation of government department responsibilities and improving service efficiency constitute essential tasks. The government should further promote administrative management system reform, accelerate the transformation of government functions, and truly strengthen economic regulation capabilities and market supervision levels to build a service-oriented and responsible government. Local governments should actively formulate corresponding policies and regulations, relying on mandatory provisions to ensure environmental protection and new energy development. Shandong should improve the administrative accountability mechanism for green development, establish a relatively complete green development assessment and evaluation system, establish a market mechanism for adjusting resource and energy prices, promote green credit development, and create an innovation system conducive to energy conservation and emission reduction. The government must strive to improve corresponding policies and regulations, strengthen administrative law enforcement, and truly make these supporting mechanisms effective for supervising and managing relevant government departments.

In summary, green development is a concept that must be followed for sustained and healthy socio-economic development, while socio-economic development is the foundation for realizing green development concepts. To truly achieve the goals outlined in Shandong' s 12th Five-Year Plan, we should propose targeted strategic measures based on the actual situation of green economic development in Shandong. Government departments at all levels must further rely on their own advantages when formulating green development plans to achieve sustained and healthy green economic development in Shandong through environmental protection and transformation of economic development modes.

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Note: Figure translations are in progress. See original paper for figures.