

Research on the Path of Green Technology Innovation Driving Low-Carbon Transformation of Manufacturing Industry

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Abstract. Against the backdrop of the new industrial and technological revolutions, China is in a critical period of progressing from a large industrial country to an industrial power. It has become imperative to promote the high-quality development of China's manufacturing industry through green technology innovation. At present, as the top-level design of China's green technological innovation continues to improve, and the policy support continues to increase, the lack of coordination of policy system, resources and financing mechanisms has become a key bottleneck restricting the development of green technological innovation. This paper adopts the literature research method to integrate the information related to the development status of China's manufacturing industry and the development status of green and low-carbon technological innovation in recent years to provide theoretical support for this study. The study found that green technologies have contributed to the growth of manufacturing. However, the development of green technology innovation needs to be combined with a scientific and complete development system.

Keywords: Manufacturing, Low-carbon transition, Green Technology Innovation.

1. Introduction

The expansion of reform and opening - up across China, akin to a spring breeze, has led to a significant surge in China's manufacturing industry. In the initial stages of economic development, the focus was heavily on the rate of growth, with environmental protection being neglected. In the initial stages of economic development, the focus was heavily on the rate of growth, with environmental protection being neglected. To meet people's expectations for a better life and address existing social tensions, the notion of environmental friendliness has gained deep-seated significance in their minds. China is making significant efforts to promote the advancement of green and low-carbon technological innovations. China has attained notable achievements in the development of green and low-carbon technological innovations. For instance, there has been continuous improvement at the top-level design stage. Regarding investment in research and development resources, there has been a growing focus on green and low-carbon initiatives. In the realm of popularization and application, continuous innovation has been evident. However, China's share of manufacturing value-added to GDP is still very high, reaching 26.2% in 2020, while the US and EU countries were already below 17% in 2007 [1]. Compared to Western countries, China's manufacturing industry has a long way to go on the road to low-carbon transformation. Among them, the imperfections in the policy system, financing guarantee mechanism, and resource coordination are the elements that restrict the development of green technology innovation in China's manufacturing industry. Adopting the literature research method, this paper first takes the prominent contradiction between economic growth and low carbon emission in China's manufacturing industry as an entry point, and points out the current development status of China's manufacturing industry and the problems it faces. Next, we identify suitable paths for China's manufacturing industry to realize high-quality development by combing the relevant literature, and put forward suggestions to drive the green development of the manufacturing industry in terms of adjusting the energy structure of China's manufacturing industry as well as improving innovative technologies. Numerous researchers share the perspective that low-carbon development within the manufacturing sector is an unavoidable necessity. In the upcoming days, the transition to green manufacturing will be the

unavoidable route to achieving the dual carbon objectives and driving high-quality economic development. Furthermore, sustainable design holds immense significance in constructing a harmonious China, delivering enduring advantages to the Chinese nation and serving as a pivotal component in fostering global integration towards a community characterized by a shared future.

2. Study on Low Carbon Transition of Manufacturing Industry

2.1. Analysis of Low Carbon Development Issues in China's Manufacturing Industry

2.1.1 Unreasonable energy consumption structure

In China, carbon emissions from manufacturing are the second largest source of carbon emissions outside of energy production. Research on low-carbon development in China's manufacturing industry indicates that, given China's resource endowment of being abundant in coal but scarce in oil and gas, coal resources occupy a prominent position in the power mix [2]. On the other hand, it is related to the high level of energy dependence that characterizes China's manufacturing sector. As of 2019, China still uses coal as the main energy source for consumption, with its share of the energy structure reaching 40%, while the share of non-fossil energy sources in energy consumption is only 15%, which is still a big gap compared to the goal of achieving a 25% share by 2030, as mentioned in the Peak Carbon Action Plan by 2030. The energy mix of China's manufacturing sector is moving ever cleaner. Relevant surveys show that China's coal consumption as a share of primary energy consumption has declined, using 2012 to 2021 as the time line. However, based on China's coal energy consumption accounted for a relatively large proportion of energy consumption characteristics, the task of reducing carbon emissions is very heavy. Improving the utilization of coal and changing the structure of energy consumption has become a top priority for the high-quality development of the manufacturing industry.

2.1.2 Elevated Levels of Carbon Emissions

With the expansion of the scale of manufacturing production, the rapid increase in energy consumption in the manufacturing industry, and the subsequent significant increase in carbon emissions is undoubtedly. This shows a significant growth trend from 832 metric tons of energy consumption and 100 metric tons of carbon emissions in 2001 as compared to 2,797 metric tons of energy consumption and 300 metric tons of carbon emissions in 2020. Among them, carbon emissions from five major industries, including the non-ferrous metal smelting and rolling processing industry, account for most of the total carbon emissions from the manufacturing sector. The relevant survey pointed out that the carbon emission intensity of China's manufacturing industry was 2.62 million tons/billion yuan in 2015, and as of 2019, the carbon emission intensity of China's manufacturing industry declined to 2.03 million tons/billion yuan with a 22.5% decrease. China is still far from reaching the goal of reducing industrial carbon emissions by 40% by 2025 compared to 2015. With the rate of decline in carbon intensity gradually slowing in recent years, our task of reducing carbon emissions in manufacturing should not be underestimated.

2.2. Study on the Influencing Factors of Carbon Emissions in the Manufacturing Industry

2.2.1 Impact of technological progress on carbon emissions in manufacturing

Scientific and technological innovation is the core driving force of modern society, and enhancing the ability of green technological innovation is fundamental to promoting the low-carbon transformation of China's manufacturing industry. At the same time, technological innovation is recognized as a key path to carbon reduction. To reduce the energy intensity of the manufacturing industry and its subsectors by improving energy utilization and essentially changing the way energy is used to significantly increase carbon efficiency. Certain academics argue that an increase in technological sophistication can lead directly to the green transformation of the manufacturing sector. Additionally, fostering a greener manufacturing industry serves an indirect solution to resource-related economic and social issues. As the authorities intensify their efforts towards constructing a

beautiful China, the manufacturing industry has witnessed notable advancements in technological innovation and development. Nevertheless, in the area of investment and development of green and low-carbon technologies, policy systems, financing mechanisms and resource coordination are less developed.

2.2.2 Impact of energy mix on carbon emissions from manufacturing

Renewable energy sources, like hydropower and wind power, can effectively reduce energy consumption intensity when utilized as alternative energy options in manufacturing, an industry characterized by high energy use and pollution levels [3]. The pertinent energy-environment model has demonstrated that modifying the energy consumption structure is advantageous for achieving carbon emission reductions in the manufacturing sector [4]. Relevant scholars in the study of the drivers of the evolution of carbon emissions in the manufacturing industry have found that the energy consumption structure tends to develop towards non-fossil energy sources, which can effectively promote carbon emission reduction [5]. The current critical period for hydrogen energy development is also a bottleneck for hydrogen energy research and development. However, China's hydrogen industry still has problems such as high production costs, weak low-carbon hydrogen production capacity, high storage and transportation risks, and single application scenarios. For the time being, increased innovation in the preparation, storage, transportation and application technologies of hydrogen energy is decisive for reducing carbon emissions. R&D efforts should also be increased to keep a good eye on energy security.

3. Research on the path of green technology innovation to drive low-carbon transformation of manufacturing industry

3.1. Strengthening tax policies to change the energy mix of high-carbon industries

Relevant scholars establish a low-carbon development model for China's manufacturing industry based on tax policy to simulate the results. It was found that the total energy consumption of the manufacturing sector in China decreased significantly with the increase of energy tax rate as well as the increase of time. Tax policies related to energy taxes address the root causes of higher corporate energy consumption. An energy tax is levied on companies that exceed standard energy consumption, thus causing a direct loss in profits and effectively forcing companies to reduce their energy consumption, thus reducing carbon emissions [6]. Differentiated tax policies can be formulated to promote the development of enterprises, taking into account their different stages of development, industrial chain status and technological level. More flexible and targeted measures can be adopted for the taxation of enterprises in the following two areas. First, set flexible deadlines and implement them in stages. Secondly, a scientific policy evaluation mechanism should be established.

3.2. Providing support for green technology development

3.2.1 Increased risk compensation mechanisms

Encourage enterprises to develop a sense of responsibility to protect the environment, forming a virtuous circle among economic, social and environmental benefits [7]. Promote the development of venture capital funds targeting green and low-carbon technologies, and encourage long-term investments from insurance and pension funds in green private equity and venture capital funds. Financial institutions should support energy conservation and carbon reduction industries with high carbon and energy consumption, thereby fostering the advancement and innovation of green and low-carbon technologies. Establish financial institutions dedicated to risk compensation, aimed at providing economic support for the development of enterprises' green and low-carbon technological innovations [8]. Meanwhile, the risk compensation system not only facilitates the sharing of losses during the green and low-carbon transformation of the manufacturing sector but also provides authoritative and specialized consulting services to popularize professional knowledge and tools among enterprises, thereby enhancing the effectiveness of the supply chain low-carbon

transformation. The specific measures are as follows. First, based on evaluation indicators such as ESG performance in the enterprise risk assessment system, establish a green finance standard system that can identify, predict, evaluate and manage risks for enterprises at different levels of development. Secondly, a third-party professional team with specialized knowledge and comprehensive judgment ability should be introduced. They will formulate suggestions and guidance for the transformation of enterprises in terms of capital status, talent reserve, digital technology, project feasibility, etc, and assist enterprises in completing supply chain transformation.

3.2.2 Integration and coordination of the resources of all relevant actors

Construct a service platform for green and low-carbon technologies, aiming to fully realize the synergy of the functions of governments at all levels, different professional institutions and social organizations [9]. Promote industry-university-research platforms dominated by corporate objectives, and improve the ability to transform scientific and technological achievements and industrialize them. Strengthening the breadth and depth of cooperation between institutions of higher education and various related entities, such as research organizations and enterprises. In the process of promoting the deep integration of industry, academia and research, it is also necessary to take into account China's national conditions. Specific measures will be taken for industrial sectors with high industrial concentration, low industrial concentration, or strategic emerging industries, depending on the situation. In industries with a high degree of industrial concentration, such as aviation, aerospace, petrochemicals, power grids, communications, rail transportation, etc, the technological research and development institutions of key enterprises in the industry will take the lead, and a mode of supplying innovative technologies that combines industry, academia and research will be set up with the research institutes of large enterprises as the main body. In the areas of low industrial concentration or strategic emerging industries, to establish a mode of supplying innovative technologies that combines industry, academia and research, with public R&D institutions such as new industrial technology research institutes and national innovation centers as the main body. Universities are encouraged to communicate regularly with research institutes and relevant enterprises to plan composite talent training programs to provide talent support for China's green technology development. Simultaneously, formulate a standard comprehensive application model to accelerate the integration of industry, academia, and research, and enhance the ability to transform outcomes towards market-oriented applications [10].

3.3. Development of green alternative energy sources

Hydrogen can replace areas where electricity cannot meet energy needs in a green and environmentally friendly way, becoming an alternative option to energy-intensive and polluting fuels that drive the low-carbon transition. Strengthening policy leadership is a critical step. Leading enterprises and industry organizations must provide enhanced support for the establishment and advancement of critical technical standards pertaining to new technologies, procedures, and methodologies across all stages. This will elevate China's hydrogen energy industry to a higher level. For the development of each place, we should integrate the hydrogen energy supply capacity, industrial base and market space, and reasonably layout the hydrogen energy preparation, storage and transportation, refueling, application and other industrial chain projects. Adoption of initiatives that incorporate local characteristics and utilize various types of hydrogen production technologies in accordance with local conditions. Widely promote low-carbon hydrogen production and reduce the cost of hydrogen production. For example, the Northeast region, where many coal chemical companies are concentrated, is rich in industrial by-products of hydrogen, as well as superior wind and light resources, making it the biggest advantage for hydrogen production from electrolytic water. Similarly, in bioenergy-rich regions, biomass hydrogen production technologies such as marine green algae and straw fermentation are promoted. It should also focus on international exchange and cooperation, innovation and research and development of core technologies for the whole hydrogen energy industry chain [11].

4. Conclusion

This study finds that promoting green technological innovation is conducive to driving a low-carbon transformation of the manufacturing industry to achieve high-quality development. At present, China's manufacturing industry is still in a relatively backward stage compared with other Western countries, through the development of green technological innovation can improve the unfavorable situation of China's manufacturing industry with high carbon emissions. Additional research has revealed that China's manufacturing sector has achieved notable progress in green technology innovation, particularly in policy implementation, high-level planning for green innovation, and scientific R&D. However, carbon emissions from China's manufacturing sector are still high, and achieving high-quality development still requires a great deal of effort. The reason for this is that there are still problems and challenges regarding the policy system, financing guarantee mechanism, and coordination of resources for the development of green and low-carbon technological innovation. For this reason, this paper conducts a study based on this issue and obtains the following conclusions.

First, optimize the industrial energy consumption structure. Through the introduction of relevant policies and the levying of energy taxes and charges, enterprises will thus be forced to increase the utilization rate of non-fossil energy and achieve the goal of reducing carbon emissions. Secondly, to improve the scientific and technological innovation capacity of the manufacturing industry. Scientific and technological innovation is the first productive force, and it is important to avoid neck-breaking problems in key technologies. Next, in response to a series of problems faced by the manufacturing industry in the process of developing green technological innovation, For example, the lack of funds, as well as authoritative enterprise risk assessment system, thus restricting the green technology research and development, a series of problems have been revealed the establishment of financing guarantee mechanism can become a solution to the status quo, to deepen the support for low-carbon development of enterprises, all-round for the development of enterprises to overcome the difficulties of green innovation technology. The establishment of a financing guarantee mechanism can be a good solution to this status quo, deepen the support for the low-carbon development of enterprises, all-round for the development of green innovation technology for enterprises to overcome the difficulties. Finally, combining local characteristics, developing green and clean energy in accordance with local conditions, realizing the high-quality production by the regional energy enterprise, and accelerating the clean and low-carbon transformations from the manufacturing enterprise.

Current research has lacked practical experience as well as modeling simulation results based on current data related to manufacturing. Future research should establish relevant models to test the feasibility of green technology innovation solutions while proposing them, so as to reduce risks and costs and maximize benefits.

References

- [1] Liu Chuanjiang, Zhao Xiaomeng. Is there industrial heterogeneity in the strong Porter's hypothesis? -- Based on the perspective of industrial carbon intensity segmentation [J]. *China Population-Resources and Environment*, 2017, 27 (06): 1-9.
- [2] Luo Shixing, Wang Xi. Measurement of coupled coordination and identification of obstacles to high-quality development of coal industry Identification [J]. *Coal Economy Research*, 2024, 44 (9): 117-123.
- [3] Claudia Sheinbaum, Belizza J. Ruíz, Leticia Ozawa. Energy consumption and related CO₂ emissions in five Latin American countries: Changes from 1990 to 2006 and perspectives [J]. *Energy*, 2010, 36 (6):
- [4] A.S. Dagoumas, T.S. Barker. Pathways to a low-carbon economy for the UK with the macro-econometric E3MG model [J]. *Energy Policy*, 2010, 38 (6):
- [5] SHAO Shuai, ZHANG Xi, ZHAO Xingrong. Empirical Decomposition and Peak Pathways of Carbon Emissions in China's Manufacturing Industry--Generalized Diels-Alder Index Decomposition and Dynamic Scenario Analysis [J]. *China Industrial Economy*, 2017 (03): 44-63. DOI: 10.19581j.cnki.ciejournal.2017.

- [6] Wei Peng. Research on Low Carbon Development Issues and Policy Simulation of China's Manufacturing Industry under the Background of Carbon Peak [D]. Party School of Jiangsu Provincial Committee of the Communist Party of China, 2022. DOI: 10.27475/d.cnki.gzjsd.2022.000031.
- [7] Guo Qianwen. Countermeasures Research on Green Finance Enabling Low-Carbon Transformation of Manufacturing Enterprises--Taking Jinhua City as an Example [J]. Industrial Innovation Research, 2023, (14): 81-83.
- [8] Zhang Shengjie. China's hydrogen energy industry agglomeration effect highlighted [N]. China Energy News, 2024-08-05 (007). DOI: 10.28693/n.cnki.nshca.2024.001028.
- [9] Mo Junyuan . Current Situation and Countermeasures for the Development of Green and Low-Carbon Technological Innovation [J]. Electrical Appliances Industry. 2022 (05): 4-7.
- [10] Zhang Wei, Gong Piqin. Research on the status quo and path of green low-carbon technology innovation development [J]. China Energy, 2022, 44 (12): 43-49.
- [11] Zhang Shengjie. China's hydrogen energy industry agglomeration effect highlighted [N]. China Energy News, 2024-08-05 (007). DOI: 10.28693/n.cnki.nshca.2024.001028.