WEP Warwick Evans Publishing

International Journal of Natural Resources and Environmental Studies

ISSN: 3006-2012 (Print), ISSN: 3006-0834 (Online) | Volume 2, Number 1, Year 2024
DOI: https://doi.org/10.62051/ijnres.v2n1.24
Journal homepage: https://wepub.org/index.php/IJNRES/index

Research on the Industrial Transformation Pathways in China Under the Background of Dual Carbon Background

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ABSTRACT

The industrial transformation is an important path for China to continuously advance towards the goals of carbon neutrality and peak carbon emissions. It is also an essential route for China's industries to move towards higher stages of development. The industrial transformation in China carries multiple significances, yet it is also confronted with various challenges. These include significant energy demands, insufficient levels of manufacturing capabilities, and economic disparities among different regions, all of which hinder the development of a low-carbon economy in China. To promote the transformation of Chinese industrial enterprises under the guidance of the new development philosophy, several key measures should be taken. Firstly, it is essential to establish a diversified energy supply system and vigorously develop the green energy industry. Secondly, efforts should be made to develop a green and low-carbon new industrial system while gradually phasing out industries with excess capacity. Thirdly, policies conducive to low-carbon transformation should be implemented, alongside the improvement and development of carbon financial markets and the strengthening of the role of technological innovation in driving industrial transformation and upgrading.

KEYWORDS

Peak carbon emissions; Carbon neutrality; Industrial transformation; Green and low-carbon; Path research.

1. INTRODUCTION

With the continuous development of global technology, the consumption of fossil fuels such as oil and coal has sharply increased, leading to a significant emission of greenhouse gases and frequent occurrences of natural disasters such as glacier melting, droughts, and floods. Since the 18th National Congress of the Communist Party of China, the Chinese industry has entered a new stage of low-carbon and green development, focusing on resource conservation and ecological environment protection, and embarked on a new path of industrialization. The strategic goal of this transformation is to establish a low-carbon, green, and sustainable industrial economic system. The orientation of ecological civilization construction was emphasized at the 18th National Congress, firmly establishing the development concept of "Lucid waters and lush mountains are invaluable assets." At the 19th National Congress, building an ecological civilization was further positioned as a "millennial cause," and green development was elevated to one of the five development principles, reaching a new height in national development strategy. In September 2020, President Xi Jinping announced, "China will strive to peak carbon dioxide emissions by 2030 and achieve carbon neutrality by 2060."

Industry is one of the key sectors generating carbon emissions, and actively promoting green and low-carbon development in the industry is of great significance for achieving the goals of peaking carbon emissions and carbon neutrality.Accelerating the low-carbon transformation of industrial enterprises is not only an inevitable requirement for ecological civilization construction but also an essential path for high-quality economic development. Currently, research on industrial industries under the "dual carbon" background mainly focuses on the impact factors of resource consumption or carbon emissions and their relationship with industrial structure. However, there is relatively less research on the transformation path of China's industrial industry. Therefore, this paper will explore the research on the transformation path of China's industrial industry from different perspectives.

2. THE SIGNIFICANCE OF CHINA'S INDUSTRIAL TRANSFORMATION

2.1. Effective participation in global environmental governance

In today's world of rapid development, international exchanges are increasingly close, and countries have formed interdependent interests. Global environmental governance concerns the common interests of all countries. Effective participation in global environmental governance is conducive to win-win cooperation and coexistence among different cultures and civilizations.

Extreme environments have no borders, and the adverse effects of climate change are a common challenge faced by all countries. This is not something that can be solved by one or a few countries alone. It requires the establishment of international governance mechanisms and cooperation in environmental governance on the widest scale possible. In addition, as the world's largest carbon emitter, China has the responsibility and obligation to participate in efforts to reduce carbon emissions. It can utilize its strong industrial strength and low-carbon technologies to continuously reduce carbon emissions in the industrial sector and export more low-carbon products to the world.

As an active participant in global environmental governance, China voluntarily joined the Kyoto Protocol under the United Nations Framework Convention on Climate Change and made significant contributions to the Paris Agreement. China has also collaborated with relevant countries and regions to issue joint statements such as the China-US Joint Statement on Climate Change, the China-US Joint Statement on Addressing the Climate Crisis, the China-EU Joint Statement on Climate Change, the China-EU Leaders' Joint Statement on Climate Change and Clean Energy, the China-France Joint Statement on Addressing Climate Change, and the Joint Statement of the BRICS Countries High-Level Meeting on Climate Change. Additionally, China has implemented the Belt and Road Initiative South-South Cooperation Plan on Climate Change

2.2. Responding to the new round of energy revolution

Carbon peaking and carbon neutrality are essentially industrial energy revolutions. Today, with the accelerated pace of global energy transformation, China's industrial sector is actively transitioning and adapting to the trend of energy revolution. This is of significant importance for enhancing the stability and security of China's energy supply system[2]。Although China still relies primarily on fossil fuels as its main source of energy, it also boasts the world's largest renewable clean energy system. Accelerating the construction of a green and low-carbon energy system and fundamentally changing the energy structure are of great significance for China's transformation of its economic development model and the promotion of industrial structural transformation and upgrading. This approach can also help China seize opportunities in the new round of energy revolution.

2.3. Adapting to the complex and ever-changing international situation

Economic growth rate slowed down, issues such as excessive consumption of fossil fuels, environmental pollution, and regional development imbalances became increasingly prominent.

Additionally, rising prices of various production factors led to the gradual transfer of China's low-end manufacturing industries to lower-cost developing countries. Furthermore, influenced by anti-globalization and trade protectionism, high-end manufacturing industries also tended to move to more developed countries, ultimately squeezing China's manufacturing industry from both ends. Therefore, the transformation of Chinese industrial enterprises can not only alleviate the situation of overconsumption of non-renewable resources such as fossil fuels caused by the past extensive economic development model but also force enterprises to shift towards more efficient and lower-emission directions[3].This, in turn, promotes the development of a series of emerging industries, facilitates the emergence of more green and low-carbon technological innovations, and enables China to stand firm in the face of complex and changing international situations.

3. CHALLENGES FACING INDUSTRIAL TRANSFORMATION IN CHINA

3.1. High energy demand in the post-Industrialization stage

Although China has essentially achieved industrial modernization, it still faces challenges such as overcapacity in low-end industries, insufficient capacity in high-end industries, and an overly single energy structure. With the continuous advancement of urbanization and the improvement of people's quality of life, the demand for energy is rapidly increasing. Looking at China's energy consumption structure, coal, oil, and natural gas remain the three main fossil fuels on which China relies, with their consumption accounting for over 80% of China's total energy consumption for an extended period. In this situation, to comprehensively promote the industrialization process, it is inevitable to increase the use of fossil fuels, leading to more carbon emissions. However, excessive emission reduction may also slow down the industrialization process and result in a lower economic growth rate. Although the implementation of various national energy-saving and emission reduction policies has led to a reduction in coal consumption, the consumption of oil and natural gas continues to rise, making it challenging to replace traditional fossil energy sources in the short term. China's efforts in energy conservation and emission reduction still face significant challenges.

3.2. Manufacturing industry still at a medium-low evel

China is currently in the post-industrialization era, with the manufacturing industry's structure still dominated by labor-intensive and resource-intensive industries, while the proportion of high-tech industries, high value-added products, and services remains relatively low. Although China's position in the global industrial and value chains has greatly improved in recent years, it still remains at the middle-to-low end overall, bearing a considerable amount of implicit carbon emission responsibility. In 2019, China's trade-related implicit carbon net exports reached 1.575 billion tons, accounting for approximately 13.7% of the country's production-side carbon emissions. In fact, this portion of carbon emissions still falls under the responsibility of carbon emissions associated with foreign consumption [4].

3.3. Regional disparities in economic and industrial development in China

Since the reform and opening up, China's eastern and western regions have gradually formed different development patterns. While the central and western regions possess abundant resources, the main economic focus remains concentrated in the eastern region. Development in the central and western regions lags behind, yet their carbon emission intensity exceeds that of the eastern region. Furthermore, in response to energy-saving and emission reduction policies, many energy-intensive industries have relocated from developed areas to underdeveloped ones, placing significant pressure on local emission reduction efforts. Additionally, due to the imbalance in economic and industrial development among regions, funding for technological innovation and energy conservation in the

central and western regions is more limited, posing numerous challenges to industrial transformation and upgrading.

4. TRANSFORMATION PATHWAYS FOR CHINESE INDUSTRIAL ENTERPRISES IN THE CONTEXT OF DUAL CARBON

Industrial transformation is imperative for China's industrial sector to advance towards a higher development stage. It serves as a crucial means to achieve the goals of peaking carbon emissions and achieving carbon neutrality, providing strong support for sustainable economic growth in China. Emphasizing the significance of low-carbon transformation in industries under the "dual-carbon" targets, we should analyze the direction and pathways of China's industrial development based on the current status and challenges of industrial development, combining theory with practical scientific analysis. By turning the constraints of carbon peaking into opportunities, we can explore a path for the low-carbon transformation and upgrading of China's industrial sector that aligns with the actual conditions of the industry.

4.1. Building a diversified energy supply system

For Chinese industrial enterprises to fundamentally change the pattern of energy consumption and supply structure, it is imperative to vigorously develop clean energy (renewable energy). With the urgent global demand for environmental protection and sustainable development, clean energy is gradually becoming an important development direction worldwide. The rise of the new energy industry provides enormous development opportunities for China. By vigorously developing the clean energy industry, such as solar energy, wind energy, and hydropower, the Tuojiang River Basin can gradually reduce its reliance on traditional fossil energy, achieve the transformation and optimization of energy consumption structure, and significantly reduce carbon emissions.

4.1.1. Promoting the transformation and upgrading of the coal-fired power industry

Firstly, it is crucial to control the growth of coal consumption reasonably. By strengthening the control of the total coal consumption, excessive mining and consumption of coal resources can be effectively controlled, avoiding over-reliance on coal energy. Simultaneously, phasing out outdated coal production capacity and reducing highly polluting and energy-intensive production methods can promote the structural adjustment and optimization of the coal industry.

Secondly, accelerating equipment upgrades and renovations are key measures to achieve the transformation of the coal-fired power industry. By introducing advanced coal-fired power technologies and equipment, existing coal-fired power facilities can be retrofitted and upgraded to enhance power generation efficiency, reduce carbon emissions, and pollutant emissions. Additionally, promoting the application of coal-fired power cogeneration and ultra-supercritical power generation technologies can improve power generation efficiency and energy utilization efficiency.

Furthermore, vigorously developing the carbon capture, utilization, and storage (CCUS) industry is also one of the important measures to promote the transformation and upgrading of the coal-fired power industry. CCUS technology can capture, transport, store, or utilize the carbon dioxide generated during coal-fired power generation to reduce greenhouse gas emissions. By strengthening research and development of CCUS technology and promoting demonstration projects, its large-scale application can be facilitated, achieving low-carbon and efficient utilization in the coal-fired power industry, thus contributing to the reduction of greenhouse gas emissions.

4.1.2. Promoting the development of green and low-carbon new energy industries

Developing the photovoltaic (PV) power generation industry is one of the crucial measures to optimize the energy structure and reduce carbon emissions. China's PV industry possesses a strong industrial chain advantage and technological capabilities, which can be leveraged through diversified

deployment and the application of intelligent technologies to drive the development of PV power generation industry.

Firstly, diversified deployment is key to the development of the PV power generation industry. In addition to large-scale PV power station construction, PV facilities can also be deployed in various scenarios such as urban rooftops, farmland, and water bodies. By constructing distributed PV power generation systems, diverse energy needs of different regions and industries can be better met, achieving energy supply diversification.

Secondly, the application of intelligent technologies is an important direction for the development of the PV power generation industry. Utilizing technologies such as artificial intelligence, the Internet of Things, and big data, intelligent monitoring, operation, maintenance, and optimization control of PV power generation systems can be achieved. Through the application of intelligent technologies, the efficiency and reliability of PV power generation systems can be improved, operational costs reduced, and the advantages of PV power generation further enhanced.

Additionally, hydropower generation does not produce atmospheric pollutants or greenhouse gas emissions, making it one of the important directions for the future new energy industry. Leveraging the topographic gradient resources of river basins, multiple hydropower stations can be planned and constructed. Based on the characteristics of rivers and the distribution of hydraulic resources, suitable types of hydropower stations can be selected, including large-scale hydropower stations, medium and small-scale hydropower stations, and tidal energy generation, achieving diversified deployment of hydropower generation. By introducing efficient turbines, intelligent control systems, and advanced hydropower station designs, the generation efficiency and operational stability of hydropower systems can be improved. With the assistance of digital technologies and big data analysis, intelligent monitoring and maintenance management of hydropower equipment can be realized, enhancing operational efficiency and reducing costs.

4.1.3. Developing the energy internet industry

Given the stochastic and fluctuating nature of new energy generation such as photovoltaic, wind, and solar thermal power, their integration into the grid significantly impacts the stability of the power system. Therefore, we need to actively develop integrated energy systems, energy internet, and smart grids to mitigate the negative effects caused by the variability of new energy generation and enhance the scale of new energy grid integration.

Integrated energy systems involve the integration and optimized management of different types of energy, including the coordinated supply and utilization of both traditional and new energy sources. Through the construction of integrated energy systems, better coordination between new energy generation and traditional energy supply can be achieved, balancing grid loads, improving energy utilization efficiency, and reducing energy consumption and emissions.

Energy internet refers to a system that utilizes information technology and intelligent means to intelligently dispatch and interconnect distributed energy, energy storage facilities, and energy demand. By constructing an energy internet, flexible matching between new energy generation and user demand can be realized, reducing reliance on traditional power systems and improving supply-demand balance and system stability.

Smart grid, on the other hand, involves the intelligent operation and management of power systems using advanced sensing, communication, control, and information technologies. Through the application of smart grids, intelligent monitoring and scheduling of new energy generation equipment and user-side energy management can be achieved, enhancing the reliability, flexibility, and response speed of the power system.

The construction of these integrated energy systems, energy internet, and smart grids will effectively address the challenges posed by the variability of new energy generation, enhancing the stability and sustainability of the power system. Through proper planning and the application of innovative

technologies, we can eliminate uncertainties in the power system, promote the large-scale integration of new energy, and provide reliable support for the development and application of renewable energy.

4.2. Developing green and low-carbon new industrial systems

4.2.1. Gradual elimination of excess production capacity industries

In addressing overcapacity in the mid-to-low-end manufacturing sector, it is essential to employ a comprehensive approach that combines market mechanisms with government guidance to ensure that enterprise competitiveness determines prices and the allocation of production factors. This means that we should gradually phase out inefficient and outdated production capacity from the market through market competition[5].

It is important to note that when dealing with overcapacity, we should not indiscriminately close down high-energy-consuming and highly polluting enterprises on a large scale. Instead, we should conduct a scientific assessment to determine which production capacities are genuinely surplus and take appropriate measures to adjust them, taking into account the rationality of capacity adjustments and social stability. At the same time, we should also emphasize the exit mechanism for high-energy-consuming and highly polluting enterprises to ensure that the exit process is compliant and orderly, avoiding social instability and environmental degradation issues.

4.2.2. Promoting green and low-carbon development of industrial system

To expedite the green upgrade and transformation of traditional industries, it is imperative to rigorously implement relevant industrial capacity replacement policies, strictly control the addition of capacity in related industries, and promote the development of the industrial system towards reduction, intensification, and greenization. Simultaneously, adjusting the energy consumption structure of industries is essential. Efforts should be made to enhance industrial parks in regions abundant in new energy resources, such as Chengdu's New Energy Industry Park. This involves constructing infrastructure for new energy generation and transmission, encouraging enterprises within these parks to increase their utilization of clean energy sources such as solar, wind, and hydrogen energy, and improving related energy storage facilities. Furthermore, promoting the electrification of end-use energy consumption is vital. This entails vigorously advocating for the substitution of electricity for other energy sources. Support should be provided for enterprises to adopt practices such as using electricity instead of coal, electricity instead of oil, and electricity instead of gas. Through these measures, we can advance the green transformation of traditional industries and promote the sustainable development of the industrial sector.

4.2.3. Developing green service industry

To propel the deep integration of green and low-carbon services with industrial sectors, development in areas such as big data services, industrial Internet application services, artificial intelligence services, full-industry chain industrial design services, and modern supply chain management services is essential. The advancement of these service industries can facilitate the intelligentization and decarbonization of production processes within industrial sectors. Through the analysis and application of big data, the provision of refined services can help industrial sectors optimize production processes, conserve energy, and reduce carbon emissions. Industrial Internet application services can facilitate interconnection and communication between equipment, enabling real-time monitoring and control of production environments, thereby enhancing production efficiency and resource utilization. The provision of solutions by the artificial intelligence services industry can assist industrial sectors in achieving automated and intelligent production processes.

4.3. Implementing policies for low-carbon transition

4.3.1. Optimizing fiscal and tax policies

Fully leveraging the government's role in guiding investment in the green and low-carbon industries, establishing an investment and financing system aligned with the carbon peak target is crucial. This can be achieved through the continuous development and optimization of green industry funds, the provision of development-oriented low-interest loans, financing guarantees, and other investment tools, actively encouraging private capital to enter the green industry, and continuously expanding the green and low-carbon industries.

Increasing fiscal expenditures on key industries is also essential. For instance, providing subsidies to clean energy industries such as wind power and photovoltaic power generation; exempting and subsidizing new energy vehicle purchase taxes, providing incentives for the construction of new energy vehicle charging stations, and subsidizing new energy public transportation operations; offering fiscal subsidies for renewable energy utilization and energy-saving renovations in the construction sector; providing tax incentives for environmental protection industries and energy-saving and water-saving industries; increasing transfer payments for green ecological industries such as agriculture and forestry to enhance the carbon sequestration capacity of ecosystems.

4.3.2. Improving and developing diversified carbon financial markets

Financial support is crucial for industrial structural transformation and upgrading. The green finance market can help lower the "green premium" through market mechanisms, promote energy and industrial structural transformation, and thus achieve the goal of carbon peaking.

Firstly, continuously enhancing the professional service capabilities of carbon finance is essential. Encourage financial institutions to establish carbon finance departments or specialized agencies to meet the financing needs of green and low-carbon industries, and continuously improve the service quality of carbon finance. Strengthen the talent pool in the field of carbon finance by providing expert training, university-enterprise cooperation, and other methods to enhance the service level and supply quality of talent in the field of carbon finance. Enhance the integration of financial technology and carbon finance, improve online carbon finance service platforms, realize the online and visualized carbon finance services, precisely meet the financing needs of low-carbon industries, and improve the service efficiency, quality, and intelligence level of carbon finance.

Secondly, while increasing the supply of carbon finance products, it is important to improve their quality. Financial institutions should align with the nodes and goals of carbon peaking, increase the quantity and proportion of traditional financial industries such as green credit and green bonds. Innovate financial products that cater to the development of low-carbon industries, such as carbon index mortgage loans, carbon technology innovation development loans, etc., to promote industrial structural development towards green and low-carbon development with higher-quality carbon finance product supply. Financial institutions should focus on leading enterprises and core enterprises in the carbon industry chain, alleviate the financing difficulties of upstream and downstream enterprises in the carbon industry chain through financing methods such as bill discounting and accounts receivable financing, and activate the transformation and upgrading of industrial structure in the Tuo River Basin through financial support for the development of the carbon industry chain.

4.3.3. Enhancing the role of technological innovation in industrial transformation and upgrading

Technological innovation serves as a catalyst and accelerator for achieving carbon peaking and neutrality, and it is also a crucial support for industrial upgrading under the constraints of carbon peaking.

Firstly, utilizing technological innovation to support carbon peaking involves establishing low-carbon technology research and demonstration projects in national key R&D centers, universities, research

institutes, etc. By adopting a mechanism of "competition leads to excellence," focus is placed on key areas of the new energy industry to deepen applied basic research, strengthen core technology research, and support enterprises with core technologies to undertake major scientific research projects related to green and low-carbon initiatives. Furthermore, efforts are made to promote the construction and improvement of green and low-carbon technology intellectual property trading centers, accelerate the transformation of scientific research achievements, and strengthen intellectual property protection.

Secondly, encouraging universities to cultivate and develop disciplines and innovative talents in new energy, energy storage, carbon reduction, and other fields is essential. This involves establishing a batch of vocational schools, colleges, and industrial colleges in the green and low-carbon fields to cultivate innovative talents at different levels. Promoting deep integration of production, learning, and research for carbon peaking, conducting collaborative projects between universities and enterprises, establishing industry-education integration alliances, and constructing a batch of national-level green and low-carbon industry innovation and research platforms are also vital steps.

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