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Study on the Path of Low-Carbon Transformation of Energy Industry in Resource-Based Cities Promoted by Digital Technology

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Abstract: As an important support for China's economic development, resource-based cities have played a very significant role in China's economic development and energy supply. Constrained by "double carbon" goal, the economy of resource cities is confronted with the challenge of "Green and Low Carbon Transition", which concerns the achievement of the goal of reducing carbon emissions in China and modern urban development. Therefore, it has important practical meaning for us to further integrate and develop energy industry and the next generation of digital techniques, so as to improve the efficiency of low carbon transition in resource cities. Based on this, this paper analyses the development of low-carbon transformation of energy industry in resource cities based on the status quo of energy industry development and the application of emerging digital technologies in resource cities at home and abroad, and puts forward suggestions for path selection.

1. Introduction

Resource-based cities, as important growth poles for China's economic development, have achieved rapid development over the past few decades. However, the long-standing pattern of overdependence on the development and consumption of fossil energy resources, such as coal, oil and natural gas, has caused these cities to face serious problems of environmental pollution, low energy utilization efficiency and high carbon emissions. In China's lack of oil, less gas, depleted uranium, relatively coal-rich energy resource endowment conditions, in environmental pollution, ecological degradation and destruction, global warming pressure constraints, as well as in China's current efforts to strive for carbon dioxide emissions to reach the peak by 2030, 2060 years ago to achieve carbon neutral "double carbon" goal constraints, coal, Constrained by the "double-carbon" target for China to reach carbon-neutral by 2030, developing and using conventional fossil fuels, such as coal and oil, will not be able to satisfy the demand for a green, low carbon and secure economy. To realize the sustainability, speed up the low carbon transition in the energy sector, and push forward the high-efficiency, economic, and intense utilization of energy, the development of clean energy is an inevitable choice to respond to climate change and achieve sustainable development.

With the emergence and rapid development of a new generation of digital technologies such as 5G,

big data, cloud computing, blockchain, etc., are exploring the exploitation of new digital technologies, integrating and developing industry with a view to connecting and supporting low carbon energy sector transition in resource-intensive cities by integrating the digital world with the real economy. And to realize the transformation and development of industrial development to a high degree of automation, intelligence, digitalization, and low-carbon transformation and development, which is the future-oriented intelligent manufacturing industry development. Thus, it is very important to study deeply integrating new digital techniques with conventional ones, to push forward the transition and development of resource cities' energy sector towards low carbon, high quality, smart, digitized and green, to speed up the development of clean energy, and to support low carbon conversion and reuse of resource cities.

2. The development status of industrial digital technology application

2.1 Digitalization of Energy Industry in Foreign Resource-Based Cities

The new generation of emerging digital technologies has gained worldwide attention and recognition since its emergence, and has become one of the important directions for global industrial development. Since 2011, countries have strengthened the research and practice of emerging digital technologies, promoted the application of digitalization, automation and intelligent technologies in industries, actively used Internet of Things (IOT) devices, big data and artificial intelligence (AI) and other emerging digital technologies to transform and upgrade industries, integrated renewable wind and solar energy, regulated and optimized the supply and consumption of energy, optimized the production processes, reduce dependence on fossil fuels, improve production efficiency and resource utilization efficiency, and reduce carbon emissions in the production process, thus providing new possibilities for the low-carbon transformation of the energy industry[1].

Many countries have put in place medium and long term development strategies for the application of new digital technologies to deal with the low carbon transition in resource based urban areas, including the European Strategy on Industrial Digitization of the European Union, Industrial Connectivity 4.0 in Spain, the German "Industry 4.0" in Germany, the New Strategy for Japanese Robotics in Japan, New Industrial France in France, Manufacturing Innovation 3.0 in South Korea, and the New Industrialization Strategy in South Africa. EU Industry 4.0, Spanish Industrial Connectivity 4.0, Japanese New Robotics Strategy, French New Industrial France, South Korea Manufacturing Innovation 3.0, and Indian Manufacturing Innovation 3.0. South Korea "Build in India Strategy", "National Technology Program" in India, "Russian National Technology Program"[2]. The implementation of these strategic plans opens up new possibilities for the application of industrial production technologies and will reshape the layout of the industrial division of labour.

Overall, some developed countries such as Germany, the United States and Japan have already made significant progress in the area of energy management and production. Some emerging economies are also increasing their efforts to promote the application of emerging digital technologies in the energy industry. However, some developing countries are lagging behind due to issues such as old infrastructure, low level of technology, high investment costs, and policy and regulatory uncertainties.

2.2 Digitalization of Energy Industry in China's Domestic Resource-Based Cities

At present, although China's resource cities are at different stages of development, there are common problems in energy utilization, namely, low energy utilization efficiency, serious environmental pollution and high carbon emissions. At the same time, in the "double carbon" target constraints, these resource cities low-carbon transformation and development of the time window is

tight, the technical reserves are insufficient, the development of low-carbon transformation of the energy industry is imminent.

China is vigorously developing renewable energy sources such as solar energy, wind energy, hydroelectric energy and biomass energy in accordance with local conditions, and is actively promoting the transformation of traditional energy sources into clean energy sources. Resource-oriented cities are actively establishing a number of smart manufacturing demonstration zones and industrial parks, actively carrying out the pilot carbon emissions trading market, and encouraging the energy industry to utilize digital technologies such as robots, automated production lines, and the Internet of Things (IoT) to improve production efficiency and product quality, reduce energy consumption and waste emissions in the production process, and promote carbon emission reduction. Through the establishment of smart grids, energy Internet and other intelligent energy management systems, the energy industry promotes the realization of intelligent management by energy enterprises and improves the efficiency of energy utilization. By using highly integrated data platforms and advanced real-time monitoring technologies, energy enterprises can optimize resource allocation and improve energy utilization efficiency. Energy enterprises should also continue to carry out research and development and innovation of relevant new technologies to better adapt to the needs of low-carbon development.

2.3 Summary

However, China's resource cities still face many problems in the process of low-carbon transformation of the energy industry, such as the complexity of the transformation and upgrading of the traditional energy industry, the limitations of technology and capital in some areas, and the imperfection of the market mechanism. At the same time, there are differences in the degree of application of new digital technology and development level of each city in the development of the industry, which is limited by the level of economic development, geographic location factors, the level of technological development and the perfection of the market mechanism and other factors. China's coastal and first-tier cities are in a leading position in the application of emerging technologies, while some resource cities in central and western China are still facing problems such as technological bottlenecks, low investment and weak infrastructures, etc., and they need to step up their efforts to promote the application of digital technologies in industrial development, so as to enhance the digitization level of the industry, the ability of low-carbon development, competitiveness and sustainable development level.

3. Digital Technology for Low Carbon Transition Paths in Industry

3.1 "Digital technology + energy industry" to accelerate digital intelligent upgrading

Resource-oriented cities should accelerate the construction of digital information infrastructure in the energy sector, promote the digitalization and upgrading of the energy industry, and promote the upgrading of equipment in the energy industry, the innovation of low-carbon processes, and the realization of lean management[3]. The Government should formulate policies and measures related to supporting digitization, automation and intelligence in the energy industry. Energy enterprises should accelerate the in-depth integration with new-generation information technology, accelerate the deployment and research and development of emerging digital technologies such as artificial intelligence, 5G, big data and cloud computing, the Internet of Things, and blockchain, and apply these emerging technological innovations to the entire industrial chain of the research and development, production, sales, and transportation of the products of energy enterprises. By using emerging digital technologies to empower the energy industry, the energy industry can realize all-

round, intelligent and lean effective management, improve the speed of product research and development, quality and production efficiency, thus giving rise to new business forms and new modes and promoting the green and low-carbon development of the energy industry.

By utilizing IoT and big data to establish an energy monitoring and early warning system, it can monitor energy usage in real time, identify and solve energy waste problems in a timely manner, and reduce resource waste. Relying on artificial intelligence and big data technology, real-time collection of operational data enables accurate forecasting of demand, remote monitoring and surveillance of equipment, energy consumption management, predictive maintenance and optimization of equipment operation, which improves the efficiency of energy production scheduling, use and analysis and helps energy companies to carry out long-term planning, rationally arrange energy production and supply, and reduce energy consumption and carbon emissions[4].Artificial intelligence is applied to smart grids and energy management to optimize the production process and achieve interaction and intelligent control between humans and the environment; artificial intelligence robots are used to achieve unmanned mining of energy resources, automation, intelligence and flexibilization of production lines, reduce equipment failures and downtime, lower and reduce labour costs, and improve overall production efficiency. Through the deployment of intelligent perception terminal equipment in energy industrial parks and enterprises, the use of IoT technology and 5G network realizes the monitoring of energy consumption and industrial production processes, aggregates industrial carbon emission basic data, and carries out accurate monitoring and control of carbon emission data. Blockchain technology can be used to implement and manage the carbon emissions trading system, automatically record and verify carbon emission credits and transactions, ensure accuracy and prevent double counting, improve the transparency and traceability of the energy industry supply chain to achieve, efficient management, reduce management costs and improve operational efficiency. Digital twin technology combines carbon emission monitoring and low carbon technology, relying on intelligent terminals, data-based empowerment and information technology support, to build a digital management system, realize the optimization and synergy of the energy system, optimize the asset management, improve the efficiency of energy utilization, coordinate and control the intelligent energy system, inject new kinetic energy for the transformation and development of the energy industry of the resource-based cities, and it is a necessary technical choice for the realization of low-carbon development, which will become a key factor in promoting the transformation, it will become an important hand in promoting the low-carbon transformation of energy industry in resource cities[5].

3.2 Accelerating the digital transformation of energy companies and building smart factories

Energy enterprises are data-driven and can realize automation, intelligence and flexibilization of production lines. Energy companies should accelerate digital transformation, increase investment in intelligent manufacturing technology, realize automation and intelligence of production through the introduction of advanced industrial robots, automated production lines and digital production processes, intelligent equipment, optimize production line processes, reduce equipment failures and downtime, reduce manpower costs, reduce energy consumption, improve production efficiency, and build smart factories. Emerging digital technologies can also promote the synergy and integration between various aspects of production, strengthen inter-industry and inter-enterprise connectivity by creating a data management platform with unified processes, consistent standards, and upstream and downstream data interoperability, break down information silos, and achieve resource sharing and optimized allocation, so as to promote the digital transformation of the entire enterprise and promote the transition to low-carbon transformation. Smart factories achieve a high degree of intelligence, efficiency and sustainability in the production process through the comprehensive use of automated

production lines, Internet of Things, data analysis and artificial intelligence, virtual simulation and other technologies, based on human-machine collaboration. Smart factories bring increased productivity, improved quality, and more flexible and customizable manufacturing capabilities to adapt to the diversified and individualized needs of the market, and should actively promote the transformation of energy enterprises to smart manufacturing[6].

3.3 Adjusting the energy structure and accelerating the development of clean energy and other renewable energy sources

Dependence on traditional energy sources such as coal, oil and natural gas for economic development leads to high carbon emissions, and resource-based cities need to adjust their energy structure to realize a low-carbon transition and green transformation; they must increase the development and utilization of new and renewable energy sources that are green, environmentally friendly, safe, low-cost and sustainable, and reduce the proportion of traditional energy sources, gradually decreasing their dependence on traditional energy sources. The development, utilization and investment of clean energy should be increased according to local conditions, and the proportion of new and clean energy should be gradually increased in the large basket of energy supply. Emerging digital technologies such as smart grids and energy storage technologies can increase the utilization rate of green energy and reduce the dependence on traditional fossil energy. Resource-based cities can reduce its dependence on traditional fossil energy by promoting clean energy sources such as solar energy, wind energy, ocean energy, hydrogen energy and biomass energy. At the same time, resource-based cities should actively build new energy innovation demonstration projects to realize large-scale application, thus reducing dependence on traditional coal, oil, natural gas and other high-carbon energy sources, promoting green energy substitution and reducing carbon emissions. Resource-based cities should accelerate the increase of clean energy installed capacity, encourage residents and enterprises to use clean energy, and promote the development of the energy structure in a low-carbon direction. In addition, the efficient utilization of energy and cross-regional energy interaction can be realized through the construction of an energy Internet. Through the construction of renewable energy power projects and smart grids, dependence on traditional fossil energy sources can be reduced and carbon emissions lowered.

3.4 Strengthening resource conservation and recycling and improving resource efficiency

Energy industry in resource cities should rely on the existing industrial base, resource endowment, regional characteristics and industrial base, seize the opportunity of "dual-carbon" development, encourage the development of circular economy and new clean energy-saving and environmental protection industries, and strive to build a green, low-carbon and recycling economic system. By promoting clean energy and energy-saving technologies in traditional energy industries such as electric power and coal, introducing intelligent production processes and energy-saving and environmentally friendly new equipment, promoting digitalization and intelligence in all aspects of energy enterprises, improving production processes, reducing energy consumption and waste generation, enhancing the production efficiency of energy enterprises, promoting clean, efficient, economical and recycling use of resources, and reducing the consumption of fossil fuels, we can reduce carbon emissions. Through the introduction and application of Internet of Things and big data technologies, an intelligent waste treatment system has been established to monitor and track in real time the production and flow of waste and by-products in the production process, which helps to increase the utilization rate of resource recycling. Resource-based cities should encourage enterprises and residents to accelerate the separation of production and living wastes for recycling, treatment, reduction, resourcing and reuse.

3.5 Government develops and introduces policies to support the development of a digital low-carbon transition

The low-carbon transformation of the energy industry in resource cities requires the government to formulate and introduce relevant policies, such as tax incentives, financial subsidies, etc., to encourage and guide energy enterprises to carry out technological transformation and equipment renewal, and to support enterprises to strengthen technological research and development and application, so as to promote technological innovation and value-added industrial transformation and upgrading. First, the government of resource cities can set up special funds to establish a low-carbon transformation development fund, which is used to support the research and development, promotion, and transformation and application of the results of digital technology in the energy industry; secondly, it is to give preferential tax policies to relevant energy enterprises, and to give certain financial subsidies to the projects of low-carbon and digital energy industry, such as the reduction of the enterprise income tax, value-added tax, and tariffs, etc., so as to reduce the cost of the enterprise's digital transformation investment and to speed up the Promote transformation and upgrading; Third, formulate relevant standards and norms to regulate the development, application and management of digital technology in the energy industry of resource cities, and promote the legalization, standardization and standardization of technology. Fourth, to enhance political support to foster and attract ICT professionals, to foster collaboration between universities, research institutions and energy companies, to enhance industrial, academic and research collaboration, to exchange knowledge, to speed up the use of digital technologies, and to push forward low carbon transition. Resource-based cities can promote the green and low-carbon transformation process of the energy sector by formulating appropriate policies to support joint innovation, technology sharing and work sharing between upstream and downstream enterprises.

4. Conclusion

In the context of the "dual-carbon" goal becoming an important national strategy, the development of the energy industry in resource cities towards low-carbon development is an inevitable trend to enhance competitiveness, adapt to social and economic development, and effectively respond to climate change and the environment. Relying on artificial intelligence, big data, Internet of Things, blockchain and other emerging technologies, the energy industry in resource cities can accelerate the development of digital transformation of energy enterprises by carrying out the action of "digital technology + energy industry", actively adjusting the energy structure, developing clean energy, and strengthening the conservation and recycling of resources, etc. At the same time, the government needs to formulate and introduce relevant policies to promote the energy industry's energy conservation, emission reduction and recycling. At the same time, the government needs to formulate and introduce relevant policies to promote energy saving and emission reduction in the energy industry, economic development and power conversion, reduce environmental pollution, improve the efficiency and effectiveness of green transformation development, and help the development of low-carbon transformation.

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