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Challenges and Solutions in the Practice of "From Coal to Gas" Transformation in the Foshan Ceramic Industry

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Abstract: This paper focuses on the practice of building ceramics industry in Foshan City in the clean energy transition from coal to gas, and discusses the challenges and solutions in the transition process. As an important base of China's building ceramics industry, Foshan City's energy transformation is of great importance to regional energy security and environmental protection. This paper summarizes the practical background and effect of Foshan's energy transformation and points out the challenges in the process of natural gas supply stability, technological renewal, and market competition. By comparing the experience of coal to gas at home and abroad, the paper summarizes the enlightenment of policy promotion, technological innovation, and upstream and downstream cooperation in the industrial chain. Based on this, the paper puts forward policy suggestions on strengthening policy support and supervision, promoting technological innovation, and research and development. Finally, it emphasizes the importance of promoting energy transformation to Foshan's sustainable development and puts forward practical solutions.

Keywords: Building ceramic industry; Coal to gas; Clean energy; Energy transition; Foshan

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1. Introduction

1.1. Research background

With the increasingly severe problem of global climate change, energy transformation has become the focus of global attention. As one of the world's largest energy consumers, the optimization and transformation of China's energy structure is of great significance to global energy security and environmental protection. Foshan City, one of the most economically developed cities in China, is also the agglomeration area of the building ceramic industry, and its energy transformation practice has important demonstration significance for the energy transformation of the country and even the world [1,2].

The report of the 20th National Congress of the Communist Party of China points out that achieving

peak carbon neutrality is a broad and profound economic and social systemic change. We should base on China's energy and resource endowments, adhere to the principle of building before breaking down, and carry out the carbon peaking action step by step in a planned way. We will improve the regulation of total energy consumption and intensity, with a focus on controlling fossil energy consumption, and gradually shift to a system of dual control over total carbon emissions and intensity. In recent years, Foshan City has actively responded to national environmental protection policies and vigorously promoted energy transformation, especially in the building ceramics industry, where the transition from coal to natural gas has become an important trend. However, there are also many challenges and problems in this transition process. This paper aims to deeply explore the practice of Foshan's energy transformation, analyze the challenges faced, draw on the experience of energy transformation at home and abroad, and put forward policy suggestions to promote Foshan's energy transformation.

1.2. Significance of the research purpose

This paper aims to explore the practice of energy transition from coal to natural gas in Foshan City, analyze the main challenges encountered in the process, and put forward corresponding solutions based on domestic and foreign experience. Through the study of Foshan's energy structure optimization, the key factors in the transition are revealed, which can provide decision-making reference for local governments and enterprises and promote regional clean energy applications. As a center of building ceramics industry, Foshan's energy transformation not only plays an important role in local environmental protection but also provides a demonstration of significance for other high-pollution industries. This study will also explore the role of energy transition in promoting sustainable development from the perspectives of technological innovation, industrial upgrading, and the application of market mechanisms, and provide experience for national energy security and environmental governance [3,4].

2. The practice of energy transformation in Foshan

Foshan's energy consumption structure is dominated by coal, and the proportion of clean energy such as natural gas is relatively low. In recent years, as the government attaches great importance to environmental protection and energy structure adjustment, Foshan has gradually increased the use of clean energy such as natural gas, and the proportion of coal consumption has gradually decreased, while the proportion of natural gas consumption has gradually increased. In 2020, the city's total energy consumption is about 30.3 million tons of standard coal, with an average annual growth rate of 0.5% in the 13th Five-Year Plan period, and the growth rate is 2.6 percentage points lower than that in the 12th Five-Year Plan period. In the "13th Five-Year Plan," the city's energy consumption per unit of Gross Domestic Product (GDP) decreased by 24.34%, exceeding the provincially-mandated energy conservation targets by 5 percentage points, and the energy efficiency level has been significantly improved [5,6].

Foshan's energy transformation practice can be divided into three stages, each stage has its own characteristics of goals and practical effects, and gradually promotes the clean energy transformation of the entire building ceramic industry.

2.1. Start-up stage (2010–2015)

In the initial stage from 2010 to 2015, Foshan's main goal is to explore the application of natural gas in the building ceramics industry. Through policy guidance, some enterprises were encouraged to take the lead in clean energy transformation. At this stage, some large enterprises responded positively and took the lead in completing the initial transformation from coal to natural gas, forming a good demonstration effect. These enterprises have not only reduced pollutant emissions, but also reduced production costs to a certain extent, and promoted more enterprises to participate in the clean energy transformation.

2.2. Expansion phase (2016–2020)

In the expansion phase from 2016 to 2020, Foshan's clean energy transformation has entered the stage of large-scale promotion. Foshan has vigorously promoted the wide application of natural gas in the building ceramics industry, and more enterprises have completed the transition from coal to natural gas. At the same time, the continuous progress of technology has further improved the efficiency of natural gas use. Through advanced combustion technology, enterprises have achieved improved energy efficiency and reduced production costs and environmental pollution. In addition, the Foshan government has actively promoted the cooperation between enterprises and scientific research institutions to further promote the research and development, and application of clean energy technologies.

2.3. Deepening stage (2021–present)

The deepening phase from 2021 to the present marks the completion of Foshan's clean energy transformation. The vast majority of building ceramics enterprises have realized the transformation of natural gas, and the clean energy in the industry has been realized. At the same time, the government has actively improved the natural gas supply system and ensured the stable supply of natural gas sources by establishing long-term cooperation with upstream suppliers. In addition, Foshan has established a strict supervision system to regularly inspect and evaluate the effect of the renovation to ensure that the policy is effectively implemented. The whole transformation process has provided a strong guarantee for Foshan's environmental protection and economic development [7,8].

3. Challenges faced by Foshan's energy transformation

Although Foshan has made remarkable progress in energy transformation, it still faces many challenges at multiple levels, including policy, technology, market, and industrial chain.

3.1. Insufficient policy support

Although the Foshan Municipal government has introduced a series of relevant policies, the implementation needs to be strengthened. Small and medium-sized enterprises lack sustained and stable policy support during the transformation process, and some enterprises are slow to respond to policies due to poor communication or poor implementation. In addition, the short-term nature of some policies has made enterprises lack long-term confidence, especially subsidies and preferential tax policies have not been sustained for a long time, reducing enterprises' enthusiasm for transformation.

3.2. Technical bottlenecks

In the process of "from coal to gas," Foshan City faces challenges in natural gas supply and combustion technology. Natural gas supply may be in short supply during peak winter, affecting production. At the same time, some enterprises are immature in natural gas combustion technology, with low energy utilization rate and poor control of pollutant emissions. The lack of sufficient research and development funds has also restricted the progress of enterprises in optimizing technology, leading to slow transition.

3.3. Cost pressure

The price of natural gas is higher than that of coal, and it is highly volatile, especially when the international market is unstable, and it is difficult for enterprises to predict the price trend. Large enterprises can afford it to some extent financially, but small and medium-sized enterprises are under greater pressure. Equipment renewal and technology introduction require a lot of capital, while clean energy has a long initial payback cycle, increasing the financial risk of transition.

3.4. Lack of industrial chain synergy

The energy transformation of Foshan ceramic industry requires the cooperation of the entire industrial chain. The number of upstream natural gas suppliers is limited, and the uncertainty of supply has affected production. Downstream customers have been less receptive to clean energy, seeing its high cost and inconvenience as a constraint on market promotion. At the same time, the lack of effective communication among all parties in the industrial chain has led to insufficient synergy and affected the progress of transformation.

3.5. Talent shortage

The clean energy transition relies on talents with professional knowledge, but Foshan's talent reserve in this field is insufficient, and many enterprises lack talents to master the technology, which hinders the introduction and application of technology. Talent mobility is large, outstanding talents are difficult to retain, and enterprises lack a corresponding mechanism in skill training, which further slows down the transformation process.

4. Experience and inspiration of energy transition at home and abroad

The successful experience of energy transition at home and abroad has provided valuable reference for Foshan City.

4.1. International experience

4.1.1. Germany

Germany relies on policy support and market mechanisms to promote the development of renewable energy. The government guides enterprises to transform through long-term policies and financial subsidies and introduces market mechanisms to encourage technological innovation. Foshan can learn from its experience in combining policy continuity with market incentives to ensure that companies actively participate in the transformation.

4.1.2. United States of America (U.S.A.)

The U.S.A. has promoted clean energy use through technological innovation and policy incentives. The

government has set up a special fund to encourage enterprises to cooperate with universities to research and develop new technologies and has promoted the development of clean energy through policies such as carbon tax and financial incentives. Foshan should increase investment in research and development of natural gas combustion technology and combine incentive policies to promote technological progress.

4.2. Local experience

4.2.1. Beijing

Beijing has achieved clean energy transformation of coal-fired boilers through policy support and financial subsidies and implemented strict regulatory measures. Foshan can learn from Beijing's subsidy policy and regulatory system to ensure that enterprises complete the natural gas retrofit.

4.2.2. Shanghai

Shanghai emphasizes the combination of technology research and development and market guidance, promotes technological progress through policies, and encourages enterprises to participate in the energy transition. Foshan can draw on Shanghai's experience to encourage companies to invest in technological innovation and improve energy efficiency.

4.3. Inspiration

Domestic and international experience shows that the combination of policy support and market mechanisms is the key to promoting energy transition. At the same time, technological innovation is the core driving force of the transformation, and Foshan should increase its technological research and development efforts. In addition, industrial chain collaboration and upstream and downstream cooperation are crucial to securing energy supply and improving the efficiency of the transformation [9–11].

5. Policy suggestions and solutions for promoting energy transformation of the Foshan ceramic industry

In order to effectively respond to the above challenges and promote the "coal to gas" energy transformation of Foshan ceramic industry, the government and enterprises should start from many aspects such as policy, technology, market and talent, and formulate a systematic solution path.

5.1. Strengthen policy support and supervision

The government should further improve the policy support system for the clean energy transition to ensure the continuity and long-term nature of the policies. First of all, the government should formulate special support policies for small and medium-sized enterprises, providing financial subsidies, low-interest loans, and tax incentives to help enterprises ease the financial pressure in the early stages of the transition. Simultaneously, policies should have a long-term plan and clearly define the transformation goals at different stages, so that enterprises have a clear direction in the transformation process. In addition, the government should strengthen supervision over the implementation of policies by enterprises, ensure that clean energy transformation projects are promoted as planned, and carry out regular inspections and evaluations to help enterprises solve difficulties encountered during the implementation of policies [12,13].

5.2. Promote technological innovation and research and development

Technology is at the heart of driving the energy transition. The Foshan municipal government should set up a special research and development fund to support cooperation between enterprises and scientific research institutions, and promote the research and development and promotion of natural gas combustion technology and clean energy application technology. A clean energy solution suitable for Foshan's ceramic industry can be developed by introducing advanced foreign technologies while combining with the actual needs of local enterprises. The government can also provide technical consulting and training services to enterprises to help them quickly master new technologies. Moreover, enterprises are encouraged to adopt intelligent equipment and digital management means to improve the efficiency of natural gas use, optimize energy management and reduce production costs through technologies such as the Internet of Things and big data.

5.3. Ensure the stability of the natural gas supply chain

To ensure the stability of natural gas supply for enterprises, the government should strengthen cooperation with domestic and foreign natural gas suppliers, expand natural gas import channels, and build more natural gas storage facilities to improve storage capacity. At the same time, the government should speed up the construction of natural gas transmission networks to ensure that natural gas can be supplied to enterprises in a timely and stable manner. On this basis, an early warning mechanism for natural gas supply can also be established to deal with possible supply shortages in advance. Furthermore, the government should encourage enterprises to sign long-term contracts with natural gas suppliers to stabilize the supply of natural gas sources and reduce supply risks.

5.4. Promote coordinated development of upstream and downstream industrial chains

Energy transformation is not only a matter within enterprises, but also requires collaboration between the upstream and downstream industrial chains. The government should actively encourage all parties in the industrial chain to strengthen cooperation, and promote communication and collaboration between upstream gas suppliers and downstream customers through policy guidance and market incentives. For example, it can improve the acceptance of clean energy by downstream customers by reducing the cost of clean energy use and encouraging enterprises to share experience in clean energy application. Additionally, the government can build a communication platform by holding activities such as industrial chain cooperation forums or exhibitions to promote in-depth cooperation between upstream and downstream enterprises in the use of clean energy, forming synergies and promoting the smooth implementation of energy transformation [14–16].

5.5. Strengthen talent training and introduction

Talent is an important driving force for energy transition. The Foshan municipal government should formulate a talent introduction and training plan for the clean energy industry, cooperate with universities and scientific research institutions, set up relevant courses and majors, and cultivate compound talents with clean energy technology and management capabilities. Concurrently, the government should also introduce policies to attract high-level clean energy technology experts and management talents to Foshan for development. For small and medium-sized enterprises, training subsidies provided by the government can be used to upgrade the skills of internal talents to ensure that enterprises have a sufficient talent reserve during the energy transition process.

6. Conclusion

The "from coal to gas" energy transformation of Foshan building ceramics industry has provided a model for other high-pollution industries in the country. By analyzing the challenges in policy, technology, market and industry chain, this paper puts forward a targeted solution path. Promoting the energy transition requires not only policy and financial support, but also technological innovation and upstream and downstream collaboration. Foshan should combine domestic and foreign experience to strengthen policy support, technology research and development and talent introduction to ensure the sustainability of the transformation results. In the future, Foshan should continue to deepen the promotion of clean energy and make greater contributions to regional environmental protection and industrial upgrading.

Disclosure statement

The authors declare no conflict of interest.

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