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The Road of "Coal to Gas" in the Transformation of Energy Structure — Current Status and Strategic Suggestions for Foshan City's Policy Implementation

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Abstract: Under the guidance of national policies, the "coal to gas" project has become one of the important measures to promote the transformation of energy structure in China. Foshan, an important industrial town in Guangdong province, the implementation of the "coal to gas" policy has demonstrated significance for the optimization of the national energy structure. Through the analysis of the change in Foshan's energy consumption structure and the implementation of the policy, this paper found that there were some challenges in the policy implementation process, such as high economic cost, lagging infrastructure, low social acceptance, and lack of technical personnel. To address this, suggestions are put forward, including increasing financial subsidies, improving laws and regulations, promoting technological innovation, and encouraging social inclusion policies. These recommendations aim to provide guidance and reference for the remaining "coal to gas" projects and the development of clean energy.

Keywords: Coal to gas; Energy structure transformation; Foshan City; Clean energy

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1. Introduction

1.1. Research background

China's energy consumption structure has long relied on coal, which produces a large number of pollutants, such as sulfur dioxide, nitrogen oxides, and particulate matter, in the process of mining, transportation, and use, causing serious harm to the environment and human health. In response to this problem, the country has issued a white paper titled "China's Green Development in a New Era," which clearly proposes to accelerate the adjustment of the energy structure and promote the "coal to gas" project [1]. Foshan, as a major energy consumption city, the implementation of its "coal to gas" policy is of great significance to the optimization of the energy structure of

Guangdong province and even the whole country.

1.2. Research purpose and significance

Foshan City, using the current implementation status of the "coal to gas" policy as a starting point, analyzes its application in the industrial sector, identifies challenges, and proposes corresponding countermeasures and suggestions to guide the remaining "coal to gas" efforts. By addressing the issues and solutions encountered during the policy's implementation, this analysis aims to provide a theoretical basis for future policy adjustments and technological innovations.

2. Implementation status and challenges of the "coal to gas" policy in Foshan City

2.1. Foshan's energy consumption structure and progress of "coal to gas" reform

According to the data of the "14th Five-Year Plan" for Foshan's energy development, in 2023, Foshan's energy consumption is dominated by coal, accounting for 21.8% of the total energy consumption. While natural gas accounted for 12.2%. In recent years, Foshan has actively implemented the policy of replacing coal with gas, gradually reducing the proportion of coal in the energy structure and increasing the proportion of clean energy such as natural gas through pipeline network construction, technological transformation, and policy support[2].

Table 1. Comparative data of energy consumption structure in 2015, 2020, and 2023

Type of energy	Share in 2015 (%)	Percentage in 2020 (%)	Share in 2023 (%)
Coal	27.0	24.6	21.8
Oil	15.7	9.0	7.5
Natural gas	5.4	9.5	12.2
Primary electricity and other energy sources	51.9	56.9	58.5

Source: Foshan Statistical Yearbook (2020, 2023)

Table 2. Fund allocation of "coal to gas" projects in Foshan City from 2016 to 2023

Year	Total amount of special funds (ten thousand yuan)	Subsidies for industrial enterprises (%)	Subsidies for residential users (%)	Technology development and promotion (%)
2016	5,000	60	20	20
2017	8,000	65	15	20
2018	12,000	70	10	20
2019	15,000	75	10	15
2020	18,000	80	10	10
2021	20,000	75	15	10
2022	22,000	70	20	10
2023	25,000	75	15	10

Source: Foshan Finance Bureau Special Fund Report on Coal to Gas Reform (2023)

2.2. Challenges existing in the implementation process of "coal to gas" reform

Although Foshan has made some progress in changing "coal to gas," it still faces the following problems during implementation.

(1) Economic cost pressure: "Coal to gas" involves a large initial investment, including pipeline network construction, equipment transformation, and other costs [3]. This is a heavy burden on small and medium-sized enterprises and low-income families. Although the government has provided certain subsidy policies, it is still not enough to cover the renovation costs of most enterprises [4].

(2) Infrastructure construction lag: Foshan City natural gas pipe network construction has not completely covered the whole city, especially in some remote areas and industrial clusters, the fuel gas supply is not stable, affecting the transformation of the enterprise.

(3) Low social acceptance: Many enterprises and residents have doubts about the safety and price of natural gas. In addition, the use cost of natural gas is higher than that of coal, which makes the implementation of the "coal to gas" policy more resistant.

(4) Lack of technology and talent: The energy technology and talent structure of Foshan City is still dominated by traditional industries, and the lack of high-end energy technology talents and innovation ability restricts the efficient implementation of the "coal to gas" project [5].

3. Analysis of policy and regulatory framework

3.1. Policy analysis at the national level

Policies at the national level are an important driving force for the "coal to gas" project. China's natural gas industry has developed rapidly since it was included in the national strategy in the "Sixth Five-Year Plan."

To promote the switch from coal to gas, the country has issued a series of policy documents, such as the "Guidance on Deepening the Clean Heating Work of Coal to Gas and Coal to Electricity (2021)," which defines the general requirements and main goals of clean heating, aiming to reduce coal consumption and pollution emissions. In addition, "Several Opinions on Promoting Harmonious and Stable Development of Natural Gas (2023)" were put forward to promote natural gas infrastructure construction, increase the supply capacity, and optimization of the structure of the policies and measures to support the proportion of natural gas in energy consumption.

To encourage enterprises to participate in the conversion of coal to gas, the state has provided preferential tax policies and implemented value-added tax (VAT) refunds on qualified natural gas-distributed energy projects to reduce the burden on enterprises [6]. At the same time, the state has set up special funds to support the research, development, and promotion of "coal to gas" technology, carry out exchanges and cooperation with international advanced technologies, and upgrade domestic technology levels. Laws and regulations, such as the Energy Conservation Law and the Renewable Energy Law of the People's Republic of China, provide legal protection for the "coal to gas" transition. Simultaneously, the National Development and Reform Commission has jointly issued relevant policies to accelerate the development of natural gas infrastructure and optimize the pricing mechanism.

3.2. The policy analysis at the local level

Foshan city government at the provincial and national policy guidance, formulated a concrete implementation plan, to ensure that the "coal to gas" project runs smoothly. For example, the "Notice of the Foshan People's Government on Printing and Issuing the Implementation Plan for Foshan to Accelerate the High-quality

Development of Urban Natural Gas Industry (2021)" and other documents clarify the development objectives and safety management of the natural gas industry. Local governments have also set up special teams to organize and coordinate the work of changing coal to gas to ensure the implementation of the policy.

Foshan has set up a special fund and subsidy mechanism to reduce the burden of transformation on enterprises and residents and support gas subsidies for industrial enterprises above the designated size. The natural gas price adjustment implemented in 2022 has also provided support for enterprises to reduce costs and increase efficiency. Concurrently, the introduction of the "green energy loan for replacing coal with gas in Foshan" further reduces the financing threshold of enterprises and supports the "coal to gas" project of ceramic enterprises.

3.3. Discussion on implementation difficulties

Although national and local policies support conversion from coal to gas, it faces many challenges. Firstly, the economic cost. The initial investment such as pipeline network laying and equipment updating is a big burden for small and medium-sized enterprises and low-income households.

Secondly, the stability of the gas supply needs to be guaranteed at the technical level, while the lag of infrastructure construction in some areas leads to unstable gas supply and affects the process [7]. The lagging update of laws and regulations may not be able to meet the new requirements of coal to gas, such as safety management and price regulation is not perfect, increasing the difficulty of policy implementation [8].

In terms of social acceptance, the change from coal to gas has changed traditional energy use habits, and some people have doubts about the safety and economy of natural gas, which affects the implementation of policies [9]. Finally, strengthening the supervision of coal-to-gas projects to ensure the effective implementation of policies is also an urgent problem to be solved.

4. Countermeasures and suggestions for the "coal to gas" policy in Foshan City

4.1. Policy level

4.1.1. Increase fiscal subsidies and financial support

The Foshan government should further increase financial support for the "coal to gas" project, provide subsidies for equipment transformation of enterprises and residents, and reduce the initial investment pressure. At the same time, it should cooperate with financial institutions to launch low-interest loans and green finance support policies to provide stable funding sources for "coal to gas" projects [10]. For example, Foshan City, in collaboration with Shanghai Pudong Development Bank, launched the "Foshan Coal to Gas Green Energy Loans," providing an effective model of financial support.

4.1.2. Improve the legal and regulatory system and enhance the transparency of policy implementation

In terms of policy formulation, Foshan City should establish special laws and regulations for coal to gas, and clarify the management and supervision responsibilities in the process of natural gas use [11]. Concurrently, the relevant supporting laws, such as the Energy Conservation Law of the People's Republic of China and the Renewable Energy Law of the People's Republic of China, should be improved to ensure the effective implementation of the policy.

4.2. The technical level

4.2.1. Promote the technological innovation of coal to gas and improve the efficiency of transformation

Foshan City should encourage enterprises to establish cooperation with scientific research institutions and universities to jointly develop efficient and low-cost gas equipment and natural gas purification technology. The government can set up special scientific research funds to support the development and application of technologies related to coal to gas and form an innovative mode of integration of production, education, and research.

4.2.2. Establish demonstration parks for "coal to gas" technology

In Foshan's ceramic and building materials enterprise clusters, establish demonstration parks for "coal to gas" technology. These parks will showcase the latest "coal to gas" technologies and equipment, provide opportunities for other enterprises to visit and learn on-site, and enhance the overall level of coal to gas adoption in the industry through the sharing of technical resources and management expertise [12].

4.3. The management level

4.3.1. Strengthen the stability of the gas supply and optimize the construction of the pipeline network

The government of Foshan City should increase investment in natural gas pipeline network construction, particularly in remote areas of industrial clusters and regions with limited gas network coverage, to enhance the stability of the gas supply [13]. Enterprises should also be encouraged to build their own liquefied natural gas (LNG) point supply facilities to improve gas supply flexibility.

4.3.2. Enhance social publicity and public participation

Strengthen the publicity and promotion of the "coal to gas" policy through media campaigns, special lectures, and seminars to improve enterprises' and residents' understanding of its importance. Introduce incentive mechanisms, such as commendations and rewards for enterprises and individuals who adopt clean energy, to enhance social participation and support.

4.4. Innovative suggestions

4.4.1. Develop intelligent energy management systems

Foshan City can explore and develop an intelligent energy management system based on big data and the Internet of Things. By collecting and analyzing data, the system can enable real-time monitoring and regulation of natural gas consumption and emissions, enhance energy efficiency for enterprises and households, and reduce emissions.

4.4.2. Introduce hydrogen energy and energy storage technology to broaden the application scope of clean energy

Foshan City, building on the foundation of the "coal to gas" transition, should actively explore the application of hydrogen and energy storage technologies, particularly in energy-intensive industries such as ceramics and building materials. This includes implementing hydrogen as an alternative to natural gas and further optimizing the energy structure with solar energy. Foshan City has already built China's first commercially operational hydrogen refueling station and hydrogen-powered bus line and should continue expanding the depth and breadth of hydrogen energy applications.

5. Conclusion

Foshan's "coal to gas" reform has achieved remarkable progress in policy support, technological innovation, and management practices [14], but challenges remain, including lagging infrastructure development and low social acceptance [15]. Moving forward, policy support should be further optimized, research and application of "coal to gas" technology should be promoted, cooperation with natural gas suppliers and financial institutions should be strengthened, the stability and cost-effectiveness of natural gas supply should be improved, and emerging technologies should be introduced. These efforts will provide demonstrations and references for the clean energy development of Foshan City and even the entire country.

Disclosure statement

The authors declare no conflict of interest.

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