

Profitability Evaluation and Commercial Development Path of Natural Gas Power Generation Projects in Sichuan-Chongqing Region

Huiyu Qiu, Chengguo Liu, Jingya Yang *

School of Economics and Management, Southwest Petroleum University, Chengdu, China

* Corresponding author: Jingya Yang

Abstract: Against the dual strategic backgrounds of the “dual carbon” goal and the construction of the Chengdu-Chongqing Economic Circle, natural gas power generation, as a clean and efficient peak-shaving power source, plays a vital role in the energy transition and power supply security in the Sichuan-Chongqing region. Taking the natural gas power generation industry in Sichuan-Chongqing as the research object, this paper systematically sorts out the regional natural gas resource endowment, operation models and development status of gas power projects, deeply analyzes the practical dilemmas of gas power projects in gas source procurement, electricity price mechanisms, cost control and market competition, measures and judges the profit prospects of the projects, and identifies business opportunities and potential risks from the dimensions of policy environment, resource advantages, market demand and technological iteration. The research shows that: (1) Gas power projects in Sichuan-Chongqing are currently generally faced with problems such as insufficient gas source guarantee, excessively high fuel cost ratio, inadequate implementation of two-part electricity price, and low profitability. (2) Under the conditions of improved electricity price mechanism, improved unit efficiency and integrated development of gas power and new energy, projects can achieve low-margin operation, and peak-shaving gas power and cogeneration in industrial parks have priority development value. (3) Short-term commercial opportunities are better than long-term ones, Chongqing market has higher potential than Sichuan, and gas power projects should transform into peak-shaving reserve, multi-energy complementation and integrated energy service providers.

Keywords: Natural gas power generation, Profitability, Commercial development, Energy transition.

1. Introduction

The global energy transition is accelerating, and “carbon peaking and carbon neutrality” have become the core strategies for China's medium and long-term energy development [1]. Natural gas power generation has the advantages of clean and low carbon, flexible startup and strong peak-shaving capacity, serving as a key support connecting traditional fossil energy and new energy and ensuring the safe and stable operation of the power system [2]. As a core natural gas-enriched area in China, the Sichuan-Chongqing region boasts abundant natural gas resources in the Sichuan Basin with outstanding shale gas development potential, providing inherent resource conditions for developing natural gas power generation [3]. Meanwhile, the construction of the Chengdu-Chongqing Economic Circle drives rapid regional economic growth, continuously rising industrial and residential electricity demand, coupled with unstable Hydroelectric output caused by frequent extreme weather, leading to a widening regional power shortage, which creates a broad market space for natural gas power generation [4, 5].

Since the 14th Five-Year Plan period, the Sichuan-Chongqing region has accelerated the layout of gas power installed capacity [6], but the industrial development is still constrained by multiple factors: insufficient gas source guarantee and contract gas volume, low proportion of gas for power generation, high fuel costs, imperfect two-part electricity price mechanism, insufficient gas-electricity price linkage, intensified competition with coal-fired power and energy storage, etc. Most gas power projects have been in a

long-term loss or low-margin state with insufficient profitability stability and sustainability [7]. In this context, scientifically judging the profit prospects of natural gas power generation projects in Sichuan-Chongqing, accurately identifying business opportunities and clarifying development paths are of great theoretical value and practical significance for optimizing the regional energy structure, ensuring power supply and promoting the healthy development of the gas power industry [8].

Existing studies mostly focus on the national-level development trend, economic calculation and policy design of gas power, while special studies targeting the resource endowment, market characteristics and electricity price mechanism of the Sichuan-Chongqing region are relatively insufficient, and the processing and academic expression of non-public data need to be improved [9]. Based on public policies, industry data and standardized research methods, this paper eliminates non-public sensitive information, reconstructs the analysis framework, systematically discusses the profit logic and commercial path of natural gas power generation in Sichuan-Chongqing, aiming to enrich the research results of regional natural gas power generation and provide support for industrial investment decisions and government policy formulation [10].

2. Operation Status of Natural Gas Power Generation Projects in Sichuan-Chongqing Region

2.1. Natural Gas Resource Endowment and Industrial Foundation

Natural gas resources in the Sichuan-Chongqing region are highly concentrated in the Sichuan Basin, with total resources and development potential ranking among the top in the country. According to the evaluation results of the "13th Five-Year Plan" for national oil and gas resources by the Ministry of Natural Resources, the total natural gas resources in Sichuan region amount to 39.94 trillion cubic meters, including 14.33 trillion cubic meters of conventional natural gas resources, 3.98 trillion cubic meters of tight gas resources, and 21.63 trillion cubic meters of shale gas resources. The total resources account for about one-third of the national total resources. Relying on advanced exploration and development technologies, natural gas production in the Sichuan Basin has continued to grow steadily. It is predicted that regional natural gas production will achieve a 100% growth in the next 10 years, and an increase of up to 400% in the next 30 years. A stable and sufficient gas supply provides a solid resource guarantee for the development of the natural gas power generation industry. From the perspective of consumption structure, natural gas consumption in the Sichuan-Chongqing region is mainly for civilian and industrial use, with a significantly lower proportion of gas used for power generation compared to the national average. The gas and electricity industry is still in the early stages of scale expansion.

In terms of installed capacity, the total installed capacity of natural gas power generation in Sichuan-Chongqing was limited in the early stage of the 14th Five-Year Plan, with a significant gap compared with developed eastern coastal provinces and a low proportion in the regional power supply structure, showing broad development space. With the demand for energy transition and power supply security, Sichuan and Chongqing have included gas power in key energy development plans, accelerated the construction of peak-shaving power stations and cogeneration projects, and the gas power industry has entered a stage of rapid development.

2.2. Main Operation Models of Gas Power Projects

Natural gas power generation projects in Sichuan-Chongqing mainly adopt two operation models: peak-shaving type and cogeneration type. The two models adapt to different market demands and application scenarios, forming a differentiated development pattern.

Peak-shaving gas power stations take power grid peak-shaving as the core function, featuring technical characteristics such as fast startup and shutdown, flexible adjustment and rapid response. They are mainly used to cope with peak power loads, fluctuations in new energy output and power shortages under extreme weather, serving as important flexible resources for the new power system. Such units have relatively low annual utilization hours, and their revenue highly depends on capacity electricity price and peak-shaving auxiliary service compensation.

Cogeneration gas power stations adopt gas-steam combined cycle technology to realize power generation and

heating simultaneously, with significantly higher comprehensive energy utilization efficiency than pure condensing units. They mainly serve the energy demand of industrial parks, urban central heating and commercial complexes. This model reduces unit energy consumption through waste heat recovery and improves project economy, suitable for layout in areas with stable heat load.

2.3. Overall Operation Characteristics of the Industry

At present, the gas power industry in Sichuan-Chongqing presents the overall characteristics of "resource advantages, profit pressure and market space". On the one hand, the region is rich in natural gas resources with relatively controllable local procurement costs, and gas power units are clean and environmentally friendly, in line with the dual carbon policy orientation; on the other hand, fuel costs account for an excessively high proportion of total costs, electricity price levels are low with imperfect mechanisms, and some projects lack sufficient gas source guarantee, leading to low overall profitability of the industry and long-term losses for a few projects. In terms of market positioning, gas power mainly relies on planned electricity with low participation in market-oriented transactions, and its peak-shaving and system values have not been fully reflected. The industrial development is still in the transition stage from policy-driven to market-driven.

3. Analysis of Core Problems of Natural Gas Power Generation Projects in Sichuan-Chongqing

3.1. Imperfect Gas Source Procurement and Guarantee System

First, there is a gap in contracted gas supply. Some gas power projects suffer from insufficient gas supply pressure during peak periods and unfulfilled annual contracted gas volume, restricting unit output and affecting power generation revenue and equipment utilization efficiency. Second, the proportion of gas for power generation is low. Natural gas consumption is inclined to industrial and civil use, with low priority for power generation gas, making it difficult to rapidly expand the gas scale for the gas power industry. Third, fuel costs are rigidly high. Fluctuations in natural gas prices are directly transmitted to the power generation end, and fuel expenses have long accounted for a high proportion of total costs, becoming a core factor restricting profitability.

3.2. Deficient Electricity Pricing Mechanism

The two-part electricity price for gas power has been implemented in Sichuan-Chongqing, but there are obvious shortcomings in mechanism implementation and price levels. First, capacity electricity price and energy electricity price are low, lower than those in developed eastern regions, failing to fully cover the investment and operation costs of gas power. Second, the implementation rules are imperfect. The compensation mechanism, implementation process and settlement method of capacity electricity price are unclear, making it difficult to fully release policy dividends. Third, the degree of marketization is insufficient. Gas power mainly relies on planned electricity with a low proportion of participation in the spot market and auxiliary service market, and system values such as peak-shaving and reserve cannot

be realized through market pricing. Fourth, gas-electricity price linkage is insufficient. Electricity price responds to natural gas cost fluctuations, making it difficult for enterprises to effectively hedge price risks.

3.3. Insufficient Technical Level and Operational Efficiency

Gas power units in Sichuan-Chongqing are mainly Class F gas turbines with relatively high gas consumption rates, resulting in large natural gas consumption per unit of power generation, further pushing up power generation costs under high gas prices. Projects are under great pressure from fixed costs, financial expenses and financing costs, and some projects have high asset-liability ratios, continuously compressing profit margins. Compared with coal-fired power, the unit power generation cost of gas power is significantly higher, putting it at a disadvantage in the power market competition.

3.4. Intensifying Market Competition

First, low-cost coal-fired power squeezes the market. After ultra-low emission transformation, coal-fired power has reduced carbon emission intensity and significantly lower power generation cost than gas power, occupying an advantage in basic power distribution. Second, rapid replacement by energy storage technologies. The installed capacity of new energy storage such as electrochemical energy storage and pumped storage has expanded, competing with gas power in peak-shaving, frequency regulation and other scenarios. Third, inadequate power grid supporting facilities. The power grid dispatching, transmission and load distribution capabilities in some regions lag behind power supply development, affecting the grid connection and consumption of gas power.

4. Profit Prospect Calculation and Analysis of Natural Gas Power Generation Projects in Sichuan-Chongqing

4.1. Construction of Profit Calculation Model

The profitability of natural gas power generation projects is determined by both revenue and cost. This paper adopts the two-part electricity price accounting system to construct a profit calculation model tailored to the actual situation of Sichuan-Chongqing. The revenue side includes capacity electricity revenue and energy electricity revenue, and cogeneration projects additionally add heating revenue; the cost side covers fuel costs, fixed asset depreciation, repair costs, wages and welfare expenses, financial expenses, environmental protection taxes and fees, and other expenses, among which fuel cost is the core variable. The calculation formula is: annual fuel cost = annual power generation × gas consumption rate × natural gas plant price.

4.2. Sensitivity Analysis of Profit Influencing Factors

Sensitivity calculation based on public data and industry models shows that natural gas price, electricity price level and unit gas consumption rate are the three core factors affecting profitability. Under the current electricity price mechanism in Sichuan-Chongqing, gas price is positively correlated with profitability within a reasonable range, and beyond the

linkage critical point, profitability declines rapidly and faces loss risks. A small increase in energy electricity price can significantly improve the rate of return, an increase in capacity electricity price plays an obvious role in enhancing investment return, and the improvement of unit efficiency or the reduction of gas consumption rate can directly reduce fuel costs and expand profit space.

4.3. Overall Judgment of Profit Prospects

Under the current policy and market conditions, gas power projects in Sichuan-Chongqing can generally achieve low-margin operation but fail to meet the requirements of reasonable investment returns. To achieve an internal rate of return of 6%-8%, it is necessary to simultaneously increase capacity and energy electricity prices, improve the gas-electricity price linkage mechanism, reduce gas consumption rates and optimize gas source procurement costs. In the long run, with the advancement of electricity price marketization reform, unit technology upgrading and integrated development of gas power and new energy, the profitability stability of projects will gradually improve, but short-term development still relies on policy support and mechanism improvement.

5. Identification of Business Opportunities for Natural Gas Power Generation Projects in Sichuan-Chongqing

5.1. Core Favorable Factors

Natural gas power generation projects in Sichuan-Chongqing have many significant favorable conditions. First, policy support continues to increase. Driven by the dual goals of "dual carbon" and the construction of the Chengdu-Chongqing Economic Circle, local governments have issued a number of policies to clarify the peak-shaving positioning of gas power, strengthen gas source guarantee and simplify approval. The two regions have jointly promoted nearly 990 billion yuan of major energy projects, providing solid policy and financial support for gas power development. Second, resource endowment advantages are prominent. The region has abundant natural gas reserves and production with low local utilization costs, obvious fuel cost advantages, and a continuously improved exploitation, storage and transportation system for more stable gas supply. Third, the regional power shortage continues to expand. The economic development of Chengdu-Chongqing drives a surge in electricity demand, and it is expected that the power supply gap in Sichuan-Chongqing will rise sharply in the future. Hydropower output is insufficient due to extreme weather, and the rigid demand for gas power peak-shaving continues to be released. Fourth, supply-demand mismatch creates cost dividends. Chongqing's thermal power peak coincides with the natural gas consumption trough, enabling gas power to stably obtain gas sources at low prices and further reduce fuel costs. Fifth, the market demand for cogeneration is strong. More than 400 industrial parks in Sichuan-Chongqing bring continuously growing industrial heat and electricity demand, providing a stable revenue space for cogeneration projects. Sixth, the rigid demand for clean energy transition is prominent. Under the low-carbon and environmental protection orientation, natural gas power generation has become an ideal alternative to high-carbon power sources

with steadily rising market demand. Seventh, frequent extreme weather significantly enhances the peak-shaving value of gas power. Its advantages of flexible startup and shutdown and rapid response make it a core guarantee for the safe and stable operation of the power grid.

5.2. Major Unfavorable Factors

Meanwhile, natural gas power generation projects in Sichuan and Chongqing also face many unfavorable development factors. First, the imperfect market price mechanism. The overall electricity price of gas power is on the low side. Although the two-part electricity price and gas-electricity price linkage mechanism have been established, the flexibility is insufficient, and the electricity price is difficult to synchronously reflect the fluctuation of fuel cost, continuously compressing the profit space of enterprises. Second, natural gas prices remain high for a long time and face upward risks. High external dependence and international gas price fluctuations further push up power generation costs and aggravate the possibility of project losses. Third, the unit gas consumption rate is high. The gas consumption rate of the regional mainstream F-class gas turbines is about 0.202 m³/kWh, which significantly increases operational pressure under the high gas price environment. Fourth, coal power has obvious competitive advantages, with a unit cost of about 0.3 yuan, far lower than the 0.5 yuan level of gas power, and its carbon emission intensity has decreased by about 15% after low-carbon transformation, with continuously improving market competitiveness. Fifth, the rapid development of energy storage technology forms a substitution effect. The installed scale of energy storage in Sichuan and Chongqing is expanding rapidly, the system regulation capacity is enhanced, and the demand for gas power peak shaving is gradually replaced. Sixth, there are shortcomings in power grid construction. The expansion speed lags behind power supply development, and the power grid dispatching and load distribution capacity are insufficient, limiting the full release of gas power peak-shaving value.

5.3. Judgment of Business Opportunity Dimensions

To sum up, natural gas power generation projects in the Sichuan-Chongqing region face both market opportunities and challenges. On the favorable side, the continuous strengthening of regional policy support, prominent natural gas resource endowments, strong power demand brought by the construction of Chengdu-Chongqing Economic Circle, coupled with the favorable mismatch between Chongqing thermal power peak and natural gas consumption trough, increased demand for clean energy, concentrated power load, increased peak-shaving demand driven by extreme weather, and increased number of industrial parks, jointly create a good environment for the development of gas power projects. At the same time, the project also faces many constraints, including imperfect price mechanism, low gas power price, high natural gas price with upward pressure, high unit gas consumption rate, rapid replacement of new energy, low-cost and low-carbon competition of coal power, and accelerated development of energy storage technology. From the perspective of development dimension, the short-term opportunities of Sichuan-Chongqing gas power projects are better than the long-term, the potential of Chongqing market is higher than that of Sichuan, and the project type should be mainly peak-shaving type, supplemented by cogeneration

type. In the future, gas power will mainly undertake the functions of peak shaving, backup and emergency support, and need to develop synergistically with new energy and transform into a comprehensive energy service provider. Therefore, it is necessary to deeply analyze the operation mode and further clarify the actual profit prospects of Sichuan-Chongqing gas power projects.

6. Conclusion

The research shows that natural gas power generation projects in the Sichuan-Chongqing region are still confronted with practical challenges such as insufficient gas source guarantee, excessively high fuel cost ratio and imperfect electricity price mechanism. The contracted gas volume gap restricts unit power generation capacity, fuel costs are significantly affected by gas price fluctuations, and the inadequate implementation of the two-part electricity price fails to reflect project costs and market value, resulting in long-term losses and operational pressure for most projects. The calculation results show that with the implementation of the two-part electricity price and the application of high-efficiency gas units, gas power projects in Sichuan-Chongqing are expected to achieve low-margin operation. However, to achieve a more ideal investment return rate, it is necessary to significantly increase the two-part electricity price level and further improve the electricity price linkage mechanism.

Overall, natural gas power generation projects in the Sichuan-Chongqing region are important supports for regional energy transition, power grid security and power supply security. Despite current profit dilemmas, they have significant long-term commercial value and development potential. By judging the market situation, improving the price mechanism, strengthening gas source guarantee, promoting technological upgrading, innovating integration models and optimizing industrial layout, gas power projects in Sichuan-Chongqing can gradually get rid of profit dilemmas and achieve sustainable development. It is recommended to promote the coordinated development of gas power and new energy, which is an important way to optimize the energy structure and improve utilization efficiency. Gas power can serve as a basic power source to ensure continuous power supply, while new energy can supplement power and regulate the power grid with its clean and renewable advantages. In practice, configuring green power projects with a 1:1 installed capacity ratio for gas power projects can significantly improve the investment return rate. In the future, gas power in Sichuan-Chongqing should firmly grasp the peak-shaving positioning, deepen coordinated complementation with new energy such as wind power and photovoltaic power, build a modern integrated energy system that is clean, flexible, efficient and economical, and provide solid and reliable energy support for the high-quality economic and social development of the Chengdu-Chongqing region.

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