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Study on Profit Prospects and Business Opportunities of Natural Gas Power Generation Projects in Sichuan-Chongqing Region

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Abstract

This study focuses on the profit prospects and business opportunities of natural gas-fired power generation (gas-fired power) projects in the Sichuan-Chongqing region. By analyzing their operational status, existing problems, electricity pricing mechanisms, cost structures, and business environment, it reveals the development potential and challenges of gas-fired power projects. The Sichuan-Chongqing region is rich in natural gas resources, with total reserves reaching 39.94 trillion cubic meters. The annual gas production is expected to reach 78.6-85.6 billion cubic meters by 2030. However, the installed capacity of gas-fired power (1.277 million kilowatts in Sichuan and 979,600 kilowatts in Chongqing at the beginning of the "14th Five-Year Plan") is much lower than that of provinces such as Guangdong and Zhejiang. Currently, gas-fired power projects are mainly of peak-shaving and combined heat and power types, facing issues such as contracted gas volume shortages, low proportion of gas used for power generation (only 1.2%), high fuel costs (accounting for over 80%), imperfect pricing mechanisms (two-part tariff lower than that in eastern regions), and competition from hydropower and coal-fired power. Profit calculations show that with the implementation of the two-part tariff and equipment upgrades (e.g., the gas consumption rate of Unit H in Dazhou Phase II drops to 0.1834 cubic meters per kWh), projects can achieve slight profits. However, to reach an internal rate of return (IRR) of 6%, the capacity tariff needs to increase by 62.88% (to 39.09 yuan per kilowatt per month) or the energy tariff by 16.72% (to 0.5055 yuan per kWh). In terms of business opportunities, policy support, growing demand for clean energy, peak-shaving needs under extreme weather, and demand for combined heat and power in industrial parks are major positives, while challenges include high and volatile gas prices, imperfect market mechanisms, and competition from energy storage technologies. The study suggests improving profitability by integrating gas-fired power with new energy projects (e.g., a 1:1 ratio of green power supporting projects), promoting the optimization of the electricity pricing mechanism, and ensuring gas supply to facilitate the sustainable development of gas-fired power projects in the Sichuan-Chongqing region.

Keywords

Natural Gas Power Generation; Profit Prospects; Business Opportunities.

1. Analysis of the Operating Status of Gas-fired Power Projects in Sichuan and Chongqing Region

1.1. Analysis of the Overall Situation of Gas-fired Power Projects in Sichuan-Chongqing Region

1.1.1. Literature Review

Against the backdrop of the global energy transition, fuel selection and the application of low-carbon technologies in the power sector have become crucial for balancing energy demand and environmental protection goals. The development paths of natural gas, coal, and biomass

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power plants, along with the application of carbon capture and compression technologies, collectively form a vital support for the low-carbon energy system.

Driven by the power demand of various countries, there is a distinct low-carbon trend in energy choices. Natural gas is widely used due to its relatively low emissions and high efficiency. In Turkey, the share of natural gas in power generation reached 48% of total electricity in 2014 and is expected to remain prominent[1]. Despite facing resource and technical challenges, China's natural gas power generation installed capacity is projected to reach 235.7GW by 2030, with an annual growth rate of approximately 10%[2]. Coal, constrained by high carbon emissions, remains a mainstay in some developing regions, but major traditional coal-consuming countries like India and China are promoting the transformation of coal-fired power[1][2].As a renewable energy source, biomass, when combined with carbon capture and storage (CCS) technology, can achieve negative emissions, making it an important alternative to fossil fuels[11].

In terms of energy supply and market demand, natural gas maintains stability in Europe and the Middle East due to the flexibility of its supply chain, but it faces the risk of import dependence[2]. The localized development of biomass energy enhances energy autonomy[11]. Environmental regulations and climate commitments are driving down the market share of coal, and the future energy market will place greater emphasis on low carbonization and sustainability, which is beneficial to natural gas and biomass power generation[1][2].

Among carbon capture and compression technologies, chemical absorption is widely applied. In gas turbine combined cycle power plants, through improved processes (such as lean liquid vapor recovery), the energy consumption of the reboiler can be reduced from 3.74MJ/kgCO_2 to 2.71MJ/kgCO_2, and the net efficiency can be increased to 50.2% (lower heating value)[3].Notably, a comparative study on post-combustion CO_2 capture and compression across natural gas, coal, and biomass fired power plants highlights their varying technical potentials and performance trade-offs, providing a reference for targeted technology deployment[12].

In terms of comprehensive performance optimization, Combined Heat and Power (CHP) systems can improve energy utilization efficiency. For example, lead-tin-tellurium alloy thermoelectric devices in gas-fired power plants can achieve self-power supply[4], and biomass power plants can integrate this module to simultaneously meet power generation and heating needs[11].Moreover, low-carbon optimal planning of integrated energy stations, which consider the combination of power-to-gas technology and gas-fired units equipped with carbon capture systems, further enhances the synergy between energy supply and emission reduction[10].In terms of policies, Section 45Q of the U.S. Federal Tax Code provides tax credits, but the incentive intensity is still insufficient to cover the cost gap[6]; the Emissions Trading System (ETS) and international cooperation can further promote technology deployment[5][7].

Environmental and economic benefit assessments show that natural gas power generation has the problem of methane leakage, with annual emissions of approximately 3.6GtCO_2 equivalent[7];additionally, the health impacts and external costs of natural gas-fired power plants, such as those assessed in the Qom plant case, further highlight the need to address non-CO_2 environmental burdens in their life-cycle[9].biomass power plants need to consider land use and social acceptance[8]. In terms of costs, the average cost of carbon storage exceeds \$38/tCO_2, and its reduction depends on technological innovation[6]. Meanwhile, green electricity price premiums and industrial chain upgrading will provide support for long-term development[5].

In summary, the coordinated development of natural gas, coal, and biomass power plants, combined with the optimized application of carbon capture technologies and supported by

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policy incentives and market mechanisms, will drive the power sector towards a more efficient, low-carbon, and sustainable direction. direction.

1.1.2. Distribution and Development Trend of Natural Gas Resources in Sichuan-Chongqing Region

The Sichuan-Chongqing region is rich in natural gas resources and is one of the three major onshore gas regions in China. The "13th Five-Year Plan" resource evaluation shows that both conventional and unconventional gas resources in the Sichuan Basin rank first in the country.

As the third largest onshore oil and gas basin in China, it covers an area of 18×10^{14} km^2, with total natural gas resources reaching 39.94×10^{12} m^3. Among them, conventional natural gas resources are 14.33×10^{12} m^3, tight gas resources are 3.98×10^{12} m^3, and shale gas resources are 21.63×10^{12} m^3, accounting for 22%, 25%, and 53% of the national total respectively. Currently, the proven rate of the Sichuan Basin is only 9%, with cumulative proven reserves of 6.14×10^{12} m^3, and the discovery rate is only 14%, which is still in the early to middle stage of development. It has huge development potential and is the most promising basin for natural gas exploration and development in China.

The Research Institute of Exploration and Development, PetroChina Southwest Oil & Gasfield Company, has predicted the natural gas production in Sichuan using three forecasting models (Weng's model, Weibull model, Grey model) and their improved versions. It is estimated that Sichuan's annual natural gas production will reach 78.6-85.6 billion cubic meters by 2030, with the peak production period between 2047 and 2051, and the peak production will reach 145.328-175.038 billion cubic meters per year. In other words, Sichuan's natural gas production will double in the next 10 years and quadruple in the next 30 years.

1.1.3. Development Trend of Gas-Fired Power Projects in Sichuan-Chongqing Region

At the beginning of the "14th Five-Year Plan", the installed capacity of gas-fired power in Chongqing was 979,600 kilowatts; in Sichuan, it was approximately 1.277 million kilowatts. There is still a certain gap compared with regions such as Guangdong, Shanghai, and Zhejiang, as shown in Table 1.

Table 1. Development of Gas-Fired Power in Chinese Provinces at the Start of the "14th Five-Year Plan"

Province	2020 Gas-Fired Power Development (10,000 kilowatts)
Guangdong	2680
Shandong	10.75
Zhejiang	1262.33
Chongqing	97.96
Sichuan	127.7
Jilin	1.2
Qinghai	0.5
Fujian	391.4
Shanghai	765.88
Tianjin	381.96

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Table 2. Planned Gas-Fired Power Projects in Sichuan-Chongqing Region

Category	No.	Project Name	Installed Capacity (10,000 kilowatts)	Type	Distribution
Approved Projects	1	Luzhou Gas-Fired Power	95	Peak-shaving	Neijiang, Sichuan
	2	Neijiang Gas-Fired Power	140	Peak-shaving	Luzhou, Sichuan
	3	Deyang Gas-Fired Power	140	Peak-shaving	Deyang, Sichuan
	4	Pengzhou Gas-Fired Power	80	Peak-shaving	Pengzhou, Sichuan
	5	Bazhong Gas-Fired Power	80	Peak-shaving	Bazhong, Sichuan
	6	Dazhou Phase II	140	Peak-shaving	Dazhou, Sichuan
Category	**No.**	**Project Name**	**Installed Capacity (10,000 kilowatts)**	**Type**	**Distribution**
Approved Projects	7	Liangjiang Phase II	140	Peak-shaving	Chongqing
	8	Yubei Gas-Fired Power	70	Peak-shaving	Chongqing
	9	Tongnan Gas-Fired Power	100	Peak-shaving	Chongqing
	10	Jiangjin Gas-Fired Power	100	Peak-shaving	Chongqing
	11	Baitao Gas-Fired Power	49	CHP	Chongqing
Operational Projects	1	Ziyang Gas-Fired Power	140	Peak-shaving	Ziyang, Sichuan
	2	Guangyuan Gas-Fired Power	140	Peak-shaving	Guangyuan, Sichuan
	3	Yongchuan Gas-Fired Power	49	CHP	Chongqing
Total			1463		

So far, only three projects have been put into operation in the Sichuan-Chongqing region, as shown in Table 2. The progress of gas-fired power installation planning during the "14th Five-Year Plan" in the region is relatively lagging. Despite its abundant natural gas resources and huge market demand, the growth of gas-fired power installed capacity in Sichuan-Chongqing has been relatively slow. This is mainly because the region has overly relied on hydropower and other renewable energy sources in the past, with relatively insufficient investment in gas-fired power projects. However, with the frequent occurrence of extreme weather and the increasing instability of renewable energy, the Sichuan-Chongqing region urgently needs to accelerate the development of gas-fired power projects to ensure the stability and security of energy supply. In the future, gas-fired power projects in the region will show an accelerating growth trend to meet the increasing energy demand and ensure energy security.

1.2. Analysis of Typical Modes of Gas-Fired Power Projects in Sichuan-Chongqing Region

1.2.1. Peak-Shaving Type

Peak-shaving gas-fired power refers to natural gas power plants specifically used for power system peak shaving. The main task of peak-shaving gas-fired power plants is to respond to changes in grid load, especially to provide additional power supply during peak periods of electricity demand, to ensure the stable operation of the power grid and the balance between power supply and demand. Such power plants usually have the ability to start up quickly, load up quickly, and reduce load quickly, and can flexibly adjust power generation to adapt to fluctuations in grid load.

1.2.2. Combined Heat and Power (CHP) Type

Combined heat and power (CHP) uses a heat engine or power station to generate both electricity and useful heat. This combined production method is usually more energy-efficient than producing electricity or heat separately. CHP gas-fired power plants (also known as gas-steam combined cycle power plants) mainly use high-temperature exhaust gas generated by

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gas turbines during power generation to heat water in boilers, thereby producing steam, which then drives steam turbines for power generation or heating.

1.2.3. Case Study

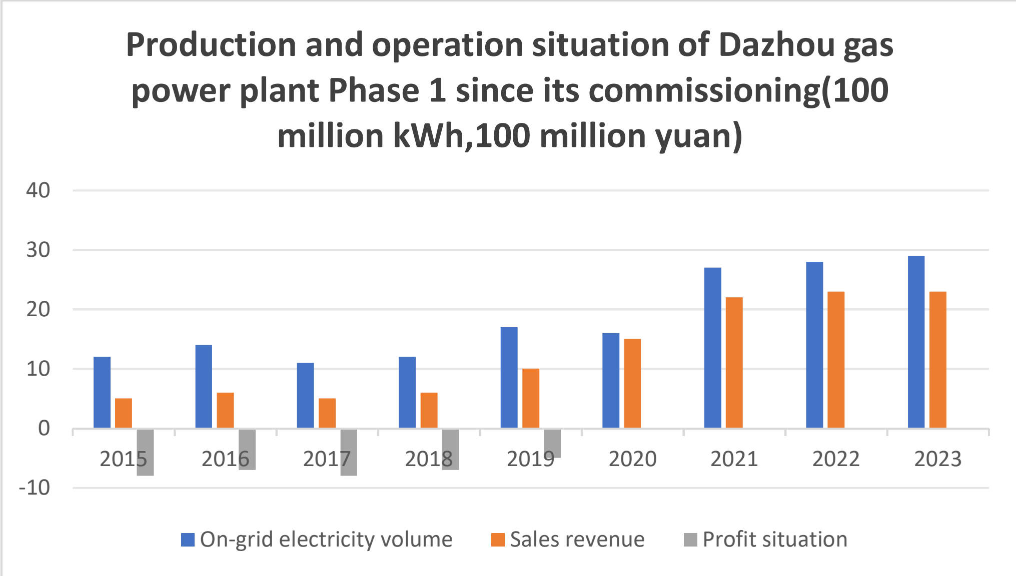

Figure 1. Production and Operation Status of Dazhou Phase I Gas-Fired Power Project Since Commissioning

Taking the Dazhou Phase I gas-fired power project as an example, this section analyzes the revenue structure and cost structure of gas-fired power projects. Dazhou Phase I gas-fired power project has 2×350MW gas-steam combined cycle generating units with a gas consumption rate of 0.202 m^3/kWh. Figure 1 shows the production and operation status of Dazhou Phase I since it was put into operation.

Dazhou Phase I gas-fired power project has been operating at a loss year by year, with only a slight profit in 2019. Despite a significant increase in power generation in the past three years, it still remains in the red. By the end of 2023, Dazhou Gas-Fired Power had accumulated losses of 510 million yuan, with an asset-liability ratio of 102.14%.

(1) Revenue Structure Analysis

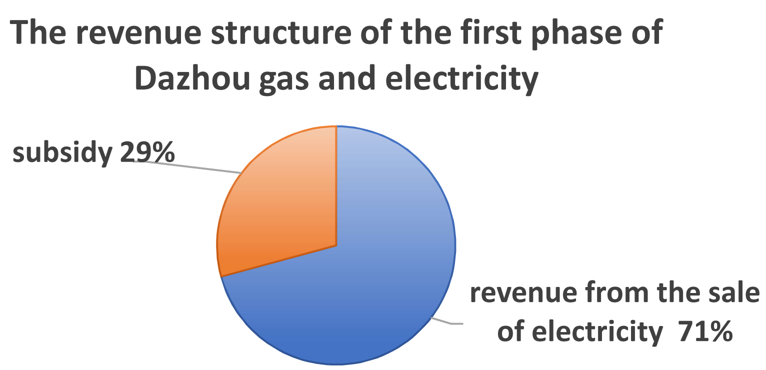

Figure 2. Revenue Structure of Dazhou Phase I Gas-Fired Power Project

As shown in Figure 2, the revenue structure of Dazhou Phase I is characterized by electricity sales revenue as the mainstay and government subsidies as a supplement. Electricity sales revenue accounts for 71%, and government subsidies account for 29%. However, facing the

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severe situation of annual losses, Dazhou Gas-Fired Power needs to further optimize its revenue structure to achieve sustainable profitability and development.

(2) Cost Structure Analysis

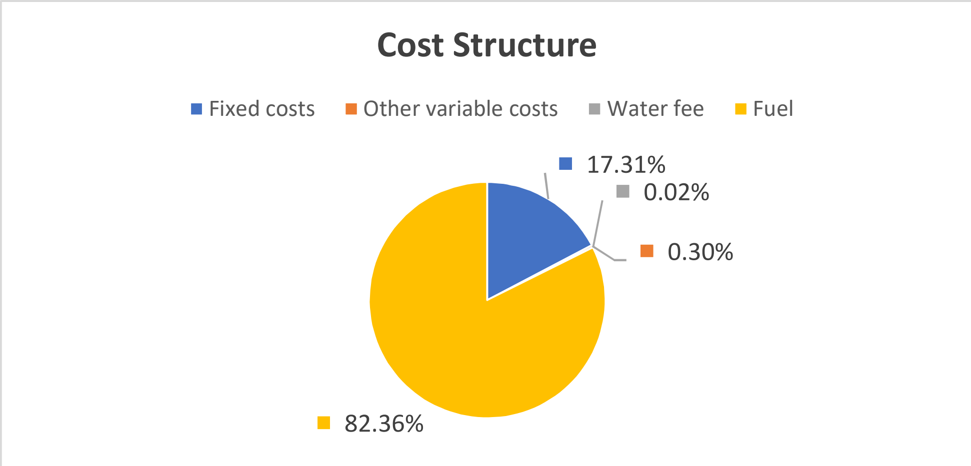

Figure 3. Cost Structure of Dazhou Phase I Gas-Fired Power Project

As shown in Figure 3, the costs of Dazhou Phase I gas-fired power project mainly consist of fuel costs, fixed costs, water fees, and other variable costs. Among them, fuel costs account for a high proportion of 82.36% of the total costs. Fixed costs account for 17.31%, while water fees and other variable costs account for a relatively small proportion of the total costs, at 0.02% and 0.30% respectively.

2. Analysis of Current Problems Faced by Gas-Fired Power Projects in Sichuan-Chongqing Region

2.1. Procurement Issues

(1) Gap in Contracted Gas Volume

The gas supply pressure requirement for the first-phase units in Dazhou is 4.0MPa, while PetroChina's gas supply pressure only maintains at 3.5-4.0MPa. Additionally, the Guangyuan gas-fired power project also has an annual gas volume gap of 60 million cubic meters.

(2) Low Proportion of Gas Used for Power Generation

Domestically, gas used for power generation accounts for 17% of the total national natural gas consumption, but in the Sichuan-Chongqing region, it only accounts for 1.2% of local natural gas consumption.

(3) High Proportion of Power Generation Costs

The cost of gas-fired power generation in the Sichuan-Chongqing region remains high, with fuel costs generally exceeding 70% of the total. With rising gas prices, fuel costs for some gas-fired power projects exceed 80%.

2.2. Sales Issues

(1) Low Two-Part Tariff and Unimplemented Detailed Rules

The capacity price for H-class units is 24 yuan/kW·month (including tax, the same below), and the energy price is 0.2924 yuan/kWh; the capacity price for F-class units is 28 yuan/kW·month, and the energy price is 0.3064 yuan/kWh. This standard is much lower than that in economically developed regions such as Shanghai. In addition, the implementation rules for the

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two-part tariff in the Sichuan-Chongqing region have not been fully implemented, especially with delays in the compensation mechanism and specific implementation of capacity prices.

(2) Difficulties in Marketization

Gas-fired power generation in the Sichuan-Chongqing region is mainly based on planned indicators, with a low degree of participation in market transactions, making it difficult to reflect the value of peak-shaving capacity.

2.3. Competition Issues

(1) Leading Position of Hydropower

As an important area of hydropower resources in China, the Sichuan-Chongqing region has hydropower occupying a leading position in the provincial energy structure. With the advantages of large power generation, low cost, and strong cleanliness, it provides important support for regional economic development and green energy transformation. In 2023, hydropower generation reached 358.33 billion kWh, accounting for 76% of the province's total power generation of 471.26 billion kWh.

In addition, hydropower has obvious cost advantages, with its power generation cost much lower than that of coal-fired and gas-fired power projects, showing excellent economy in long-term operation. As a renewable energy source, hydropower produces almost no greenhouse gas emissions, and its cleanliness advantage is particularly important under the current carbon neutrality goal. These characteristics make hydropower in the Sichuan-Chongqing region an important competitor in the power market.

(2) Strong Economy of Coal-Fired Power

Coal has low costs and abundant resources. According to the 2023 China Coal Market Report, coal market prices generally remained at 500-700 yuan per ton, much lower than other energy sources such as natural gas and oil. According to the China Energy Development Report 2023, China's proven coal reserves are approximately 1.7 trillion tons, accounting for nearly 13% of global coal reserves. Among them, the Sichuan-Chongqing region is a major coal-producing area in southwest China, with coal reserves in Sichuan Province approaching 100 billion tons and in Chongqing Municipality reaching approximately 50 billion tons.

(3) Low-Carbon Development of Coal-Fired Power

With the continuous progress of coal-fired power carbon reduction technologies, the emission reduction potential of the coal-fired power industry is gradually being tapped. According to the "14th Five-Year Plan" and the goals of carbon peak by 2030 and carbon neutrality by 2060, the coal-fired power industry will face strict carbon emission constraints, requiring a 50% reduction in carbon emissions by 2027. Although coal-fired power has high carbon emissions, through the accelerated application of low-carbon technologies, the coal-fired power industry still has great carbon reduction potential. In the future, it can gradually reduce carbon emission intensity by implementing stricter emission standards and optimizing power generation efficiency.

2.4. Case Study

A comparative analysis is conducted between the Huadian Jiangsu gas-fired power project and the Dazhou Phase I gas-fired power project. Huadian International is a gas-fired power enterprise with relatively high profitability and large fluctuations. From 2021 to 2023, it experienced changes from profit to loss and then back to profit.

(1) Profitability of Huadian Jiangsu Gas-Fired Power

The operating conditions of Huadian Jiangsu from 2021 to 2023 are shown in Table 3.

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Table 3. Operating Conditions of Huadian Jiangsu Gas-Fired Power from 2021 to 2023

Indicator	**Unit**	2021	2022	2023
Total Profit	100 million yuan	4.29	-3.77	1.56
Qishuyan Power Plant	100 million yuan	0.63	-2.02	0.11
Kunshan Thermal Power	100 million yuan	1.70	-0.22	0.70
PetroChina Shareholding Income	100 million yuan	0.86	-0.75	0.31
Government Subsidies	100 million yuan	4.86	13.40	19.73
PetroChina Peak-Shaving Discount	100 million yuan	-	-0.60	-0.37
Power Generation	100 million kWh	129.67	139.74	140.22
Annual Utilization Hours	Hour	2074	2235	2242
Heat Supply	10,000 GJ	2069	2121	2060
Gas Consumption for Power Generation	m^3/MWh	185.71	185.92	186.22
Gas Consumption	100 million m^3	29.34	31.39	31.27
Including: PetroChina	100 million m^3	25.70	29.46	29.75
Sinopec	100 million m^3	3.46	1.43	1.00
CNOOC	100 million m^3	0.18	0.49	0.51
Gas Price	yuan/m^3	2.24	2.85	2.89
Including: PetroChina	yuan/m^3	2.20	2.80	2.86
Sinopec	yuan/m^3	2.42	3.61	3.35
CNOOC	yuan/m^3	4.00	4.00	4.20

In 2022, Huadian Jiangsu Gas-Fired Power suffered a loss of 377 million yuan. Although government subsidies increased by 854 million yuan compared with 2021, the natural gas price rose by 0.61 yuan per cubic meter, a relatively large increase. In 2023, Huadian Jiangsu Gas-Fired Power made a profit of 156 million yuan, with little change in gas prices, but government subsidies increased by 633 million yuan compared with 2022. Comparing the changes in the main operating data of Huadian Jiangsu Gas-Fired Power over the three years, it can be seen that government subsidies and fuel costs are the main factors affecting the profitability of gas-fired power enterprises.

(2) Profitability Comparison Between Dazhou Gas-Fired Power and Huadian Jiangsu Gas-Fired Power

1) Comparison of Capacity Price Revenue

After the implementation of the two-part tariff, since the capacity price in the Sichuan-Chongqing region is the same as that in Jiangsu, both 28 yuan/kW·month, the capacity price revenue of Dazhou Gas-Fired Power is the same as that of Huadian Jiangsu Gas-Fired Power.

2) Comparison of Energy Price Revenue

The energy price in the Sichuan-Chongqing region is lower than that in Jiangsu. With the same power generation, the electricity sales revenue of Dazhou Gas-Fired Power is 13.7% lower than that of Huadian.

3) Comparison of Fuel Costs

As shown in Table 4 and Figure 4, the gas consumption rate of Sichuan Dazhou Phase I is 0.016 m^3/kWh higher than that of Huadian Jiangsu on average, with relatively higher fuel consumption. In terms of gas price, benefiting from abundant natural gas resources in the Sichuan-Chongqing region (accounting for 30% of the national reserves), the average gas price in Dazhou is 23.61% lower than that in Huadian Jiangsu. With the same power generation, the fuel cost of Dazhou Gas-Fired Power is 16.33% lower than that of Huadian Jiangsu.

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Table 4. Fuel Costs of Huadian Jiangsu Gas-Fired Power and Dazhou Phase I Gas-Fired Power

Project	Indicator	Unit	2021	2022	2023	Average
Huadian Jiangsu	Gas Consumption Rate	m^3/kWh	0.1857	0.1859	0.1862	0.19
	Gas Price	yuan/m^3	2.2400	2.8500	2.8900	2.66
	Cost per kWh	yuan/kWh	0.4160	0.5299	0.5382	0.49
Sichuan Dazhou Phase I	Gas Consumption Rate	m^3/kWh	0.2020	0.2020	0.2019	0.20
	Gas Price	yuan/m^3	1.7669	2.0721	2.2565	2.03
	Cost per kWh	yuan/kWh	0.3569	0.4186	0.4556	0.41

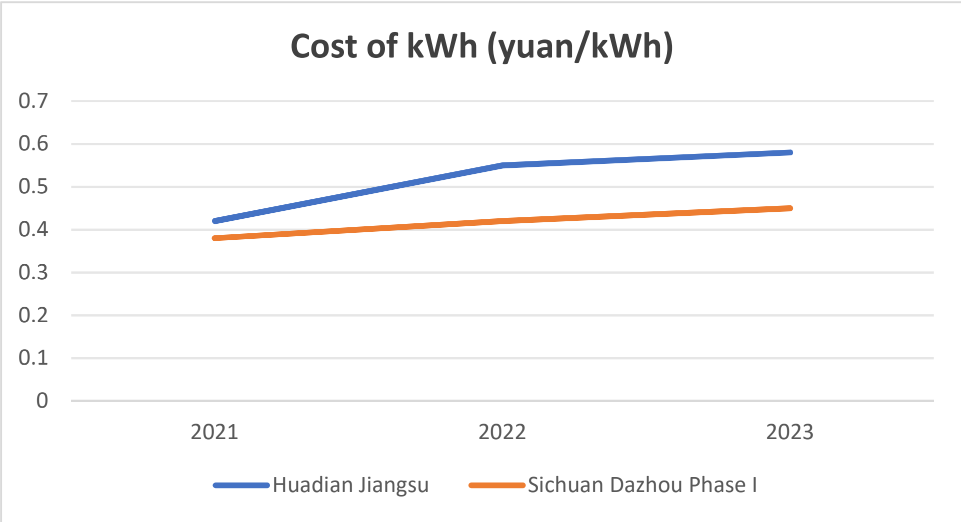

Figure 4. Cost per kWh of Huadian Jiangsu Gas-Fired Power and Dazhou Phase I Gas-Fired Power

3. Analysis of Profit Prospects of Gas-Fired Power Projects in Sichuan-Chongqing Region

3.1. Electricity Pricing Mechanism for Gas-Fired Power in Sichuan-Chongqing Region

(1) Peak-Shaving Generator Sets

The natural gas peak-shaving generator sets in the Sichuan-Chongqing region implement a two-part tariff, consisting of capacity price and energy price. The capacity price is temporarily determined based on the fixed costs plus reasonable returns of technologically advanced units, and will gradually transition to being determined through competitive allocation or formed by the capacity market. The allocation of capacity electricity fees shall be implemented in accordance with relevant national and provincial regulations; the energy price is determined based on fuel costs, gas consumption rate, and other variable costs.

1) Capacity Price

① Capacity Price Standard: The capacity price is determined based on the fixed costs of newly approved natural gas peak-shaving generator sets, considering reasonable returns and related taxes. The capacity price for H-class units is 24 yuan/kW·month (including tax, the same below), and for F-class units is 28 yuan/kW·month.

② Calculation of Capacity Electricity Fees: The capacity electricity fees for gas-fired generator sets are determined based on the capacity price corresponding to each gas-fired generator set and the declared maximum output. Gas-fired generator sets declare monthly, and State Grid

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Sichuan Electric Power Co., Ltd. settles monthly. Capacity electricity fees for gas-fired generator sets = capacity price × declared maximum output of gas-fired generator sets.

③ Allocation of Capacity Electricity Fees: In principle, the capacity electricity fees of gas-fired generator sets are regarded as system operation fees and allocated by industrial and commercial users in the province according to electricity consumption. State Grid Sichuan Electric Power Co., Ltd. measures and announces the allocation standard monthly based on the industrial and commercial electricity consumption in the province. Local power grids (including provincial local power grids) shall, on the basis of the current monthly predicted off-grid electricity structure and scale, additionally report the predicted total industrial and commercial electricity consumption scale data within their supply areas. Promote the fair allocation of capacity electricity fees for gas-fired generator sets in exported electricity.

2) Energy Price

① Benchmark Energy Price: Calculated based on the variable costs of gas-fired generator sets, the benchmark energy price for H-class units is 0.2924 yuan/kWh (including tax, the same below), and for F-class units is 0.3064 yuan/kWh. The natural gas price corresponding to the benchmark energy price is the current benchmark gate price of natural gas in Sichuan Province, which is 1.53 yuan/m^3.

② Gas-Electricity Price Linkage: When the gas purchase price of gas-fired generator sets is between 80% and 120% of the current benchmark gate price of natural gas, the linkage standard is calculated based on the normal rate of return. When the gas purchase price is between 120% and 150% or 50% and 80% of the current benchmark gate price of natural gas, the linkage standard is calculated by appropriately reducing or increasing the rate of return. The part where the gas purchase price is higher than 150% or lower than 50% of the current benchmark gate price of natural gas will no longer be linked. The Sichuan Provincial Development and Reform Commission calculates and announces the linkage standard of energy prices for gas-fired generator sets annually at the beginning of the year based on the annual average gas purchase contract price of gas-fired power projects in the province, and organizes liquidation at the end of the year. Linkage adjustment standard = (annual average contract price of natural gas - 1.53 yuan/m^3) × gas consumption rate ÷ (1 - plant power consumption rate) × tax adjustment factor, where the tax adjustment factor is (1 + power value-added tax rate) ÷ (1 + natural gas value-added tax rate).

(2) Combined Heat and Power (CHP) Units

Currently, the electricity generated by CHP units in the Sichuan-Chongqing region is mainly used for self-consumption, with surplus electricity connected to the grid. Natural gas CHP units mainly serve users such as industrial parks and commercial complexes, giving priority to meeting users' heat and electricity needs. The main sources of income for CHP projects are electricity sales revenue and heat sales revenue. They sign electricity purchase contracts and heat use contracts with users in industrial parks, and charge fees according to the prices agreed in the contracts. At the same time, the surplus electricity beyond user demand can participate in power market transactions to form a market-oriented electricity price. If the surplus electricity is not connected to the grid for market transactions, a single on-grid price of 0.3964 yuan/kWh (including tax) shall be implemented.

3.2. Cost Analysis of Gas-Fired Power Projects

(1) Fuel cost refers to the fuel cost for power production. For natural gas power plants, it is generally calculated in standard cubic meters. The standard gas consumption for power generation is based on the design value, considering the annual average operating conditions. The annual fuel cost for gas-fired power plants shall be calculated according to the following formula: Annual fuel cost for gas-fired power plants = annual power generation × standard gas consumption for power generation × unit price of standard cubic meters of natural gas.

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(2) Water cost refers to the cost of purchased water for power production, calculated based on water consumption and water price. It shall be calculated according to the formula: Annual water cost = annual water consumption × water price.

(3) Material cost refers to the cost of various raw materials, materials, spare parts, and low-value consumables used for production operation, maintenance, and accident handling. It shall be calculated according to the formula: Annual material cost = annual power generation × material cost per unit power generation.

(4) Wages and welfare expenses refer to the wages, fees, and welfare expenses of production and management personnel in power plants, including employee wages, bonuses, allowances and subsidies, employee welfare expenses, and social security fees such as medical insurance, pension insurance, unemployment insurance, work-related injury insurance, maternity insurance, and housing provident fund paid by employees. It is calculated based on the total number of employees in the plant and the average annual wage per employee (including fees and welfare expenses). The formula is: Annual wages and welfare expenses = total number of employees in the plant × average annual wage per employee (including fees and welfare expenses).

(5) Depreciation expense refers to the compensation for the wear and tear value of fixed assets during use. It can be calculated according to the formula: Annual depreciation expense = original value of fixed assets × depreciation rate or depreciation rate = (1 - residual value rate of fixed assets) / depreciation period × 100%.

(6) Amortization expense refers to the average amortization of intangible assets and other assets into costs within their effective service life. It shall be calculated according to the formula: Annual amortization expense = intangible assets and other assets / amortization period.

(7) Repair cost refers to the expenses incurred for necessary repairs to maintain the normal operation and use of fixed assets. The repair cost should be calculated using the accrual method. The original value of fixed assets in the calculation of repair costs shall exclude the interest during the construction period included. It shall be calculated according to the formula: Annual repair cost = original value of fixed assets (excluding interest during the construction period included) × repair provision rate.

(8) Financial expenses are the financial expenses incurred by natural gas power generation projects in raising funds during production and operation. Calculated according to the formula: Financial expenses = interest expense + net exchange loss + handling fees related to loans + other expenses incurred in financing. Interest expense is calculated based on the debt funds determined in the financing plan.

(9) Desulfurizer cost refers to the cost of desulfurization raw materials used for unit desulfurization. It shall be calculated according to the formula: Annual desulfurizer cost = annual desulfurizer consumption × unit price of desulfurizer.

(10) Denitration agent cost refers to the cost of denitration raw materials used for unit denitration. It shall be calculated according to the formula: Annual denitration agent cost = annual denitration agent consumption × unit price of denitration agent.

(11) Environmental protection tax refers to the tax levied by local tax authorities on the emission of sulfides, nitrogen oxides, smoke and dust, and noise during the operation of units. It shall be calculated according to the following formula: Annual environmental protection tax = tax payable on taxable atmospheric pollutants + tax payable on taxable water pollutants + tax payable on taxable solid wastes + tax payable on taxable noise; Tax payable on taxable atmospheric pollutants = annual pollution equivalent × corresponding tax rate standard; Tax payable on taxable water pollutants = annual pollution equivalent × corresponding tax rate standard; Tax payable on taxable solid wastes = amount of solid waste emissions ×

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corresponding tax rate standard; Tax payable on taxable noise = decibels exceeding the national standard × corresponding tax rate standard.

(12) Paid use fee for pollutant discharge rights refers to the fee paid to obtain pollutant discharge rights or the cost of purchasing pollutant discharge rights through pollutant discharge rights trading for the emission of sulfides, nitrogen oxides, etc. during the operation of units, as required by the people's government of the province where the project is located. It shall be calculated according to the formula: Paid use fee for pollutant discharge rights = annual pollutant discharge amount × quota transfer price of pollutant discharge rights.

(13) Other expenses refer to other costs that are not included in the above items but should be included in production costs, mainly including company expenses, trade union funds, employee education funds, board of directors' fees, consulting fees, fees for engaging intermediary agencies, litigation fees, business entertainment expenses, property tax, vehicle and vessel use tax, land use tax, stamp tax, research and development fees, and social security fees such as medical insurance, pension insurance, unemployment insurance paid by enterprises, and housing provident fund.

(14) Insurance premium can be calculated by multiplying the net value of fixed assets by the insurance premium rate, or by a fixed annual amount.

3.3. Case Study

(1) Analysis of the Current Economic Benefits of Dazhou Phase II Gas-Fired Power Project

Taking the Dazhou Phase II gas-fired power project as an example, the economic benefits of the gas-fired power project are predicted. During the construction of Dazhou Phase II, H-class equipment was selected, and the gas consumption rate is expected to be reduced to 0.1834 m^3/kWh. The economic benefits are estimated based on the current gas price of 2.2565 yuan/m^3 for Dazhou Phase I, as shown in Table 5.

Table 5. Estimated Economic Benefits of Dazhou Phase II

Indicator	Unit	Parameter Value		
		First Year	Second Year	Third Year
On-grid Hours	Hour	2500	2500	2500
Power Generation	10,000 kWh	376660	376660	376660
On-grid Electricity	10,000 kWh	370000	370000	370000
Gas Consumption Rate	m^3/kWh	0.1834	0.1834	0.1834
Capacity Price (including tax)	yuan/kW·month	24	24	24
Energy Price (including tax)	yuan/kWh	0.4331	0.4331	0.4331
Basic Energy Price	yuan	0.2924	0.2924	0.2924
Linked Energy Price	yuan	0.1407	0.1407	0.1407
Total Investment	10,000 yuan	344000	344000	344000
Income	10,000 yuan	179,528.06	179,528.06	179,528.06
Capacity Price Income	10,000 yuan	37,720.35	37,720.35	37,720.35
Energy Price Income	10,000 yuan	141,807.71	141,807.71	141,807.71
Cost and Expense	10,000 yuan	177,452.54	177,002.54	176,552.54
Including: Fuel	10,000 yuan	140,505.32	140,505.32	140,505.32
Gas Price at Plant Gate	yuan/m^3	2.2565	2.2565	2.2565
Other Costs and Expenses	10,000 yuan	36,947.22	36,497.22	36,047.22
Total Profit	10,000 yuan	2,075.52	2,525.52	2,975.52
Rate of Return		0.6033%	0.7342%	0.8650%

The results show that after the implementation of the two-part tariff and the adoption of relatively new equipment, slight profits are expected, with the expected investment return rate being 0.6033% in the first year, 0.7342% in the second year, and 0.8650% in the third year.

(2) Analysis Based on Meeting 6% and 8% Internal Rate of Return

Based on the two targets of meeting 6% and 8% internal rate of return, assuming that the gas price at the plant gate and energy price remain unchanged and the annual net cash inflow is the same, the estimation of the increase ratio of capacity price is shown in Table 6.

Table 6. Estimation of Capacity Price Increase in the Next 20 Years

Indicator	**Unit**	**Prediction Table of Dazhou Phase II**	**Year 1-20**	
			Internal Rate of Return 6%	Internal Rate of Return 8%
Capacity Price (including tax)	yuan/kW·month	24	39.09	48.11
Energy Price (including tax)	yuan/kWh	0.4331	0.4331	0.4331
Basic Energy Price	yuan	0.2924	0.2924	0.2924
Linked Energy Price	yuan	0.1407	0.1407	0.1407
Total Investment	10,000 yuan	344000	344000	344000
Income	10,000 yuan	179,528.06	203244.85	217419.88
Capacity Price Income	10,000 yuan	37,720.35	61437.15	75612.17
Energy Price Income	10,000 yuan	141,807.71	141807.71	141,807.71
Cost and Expense	10,000 yuan	176,552.54	176552.54	176,552.54
Total Profit	10,000 yuan	2,975.52	26692.32	40867.34

The results show that after the capacity price increases by 15.09 yuan/kW·month, the internal rate of return can reach 6%, with an increase ratio of 62.88%. After the capacity price increases by 24.11 yuan/kW·month, the internal rate of return can reach 8%, with an increase ratio of 100.45%.

Based on the two targets of meeting 6% and 8% internal rate of return, assuming that the gas price at the plant gate and capacity price remain unchanged, the estimation of the increase ratio of energy price is shown in Table 7.

Table 7. Estimation of Energy Price Increase in the Next 20 Years

Indicator	**Unit**	**Prediction Table of Dazhou Phase II**	**Year 1-20**	
			Internal Rate of Return 6%	Internal Rate of Return 8%
Capacity Price (including tax)	yuan/kW·month	24	24	24
Energy Price (including tax)	yuan/kWh	0.4331	0.5055	0.5488
Basic Energy Price	yuan	0.2924	0.3648	0.4081
Linked Energy Price	yuan	0.1407	0.1407	0.1407
Total Investment	10,000 yuan	344000	344000	344000
Income	10,000 yuan	179,528.06	203244.85	217419.88
Capacity Price Income	10,000 yuan	37,720.35	37,720.35	37,720.35
Energy Price Income	10,000 yuan	141,807.71	165,524.50	179,699.53
Cost and Expense	10,000 yuan	176,552.54	176,552.54	176,552.54
Total Profit	10,000 yuan	2,975.52	26692.32	40867.34

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Table 8. Estimation of Simultaneous Increase Ratio of Capacity Price and Energy Price in the Next 20 Years

Indicator	Unit	Prediction Table of Dazhou Phase II	Year 1-20	
			Internal Rate of Return 6%	Internal Rate of Return 8%
Capacity Price (including tax)	yuan/kW·month	24	27.17	29.06
Energy Price (including tax)	yuan/kWh	0.4331	0.4903	0.5245
Increase Ratio			13.20%	21.10%
Basic Energy Price	yuan	0.2924	0.3496	0.3838
Linked Energy Price	yuan	0.1407	0.1407	0.1407
Total Investment	10,000 yuan	344000	344000	344000
Income	10,000 yuan	179,528.06	203244.85	217419.88
Capacity Price Income	10,000 yuan	37,720.35	42702.55	45680.78
Energy Price Income	10,000 yuan	141,807.71	160542.31	171739.10
Cost and Expense	10,000 yuan	176,552.54	176552.54	176552.54
Total Profit	10,000 yuan	2,975.52	26692.32	40867.34

The results show that after the energy price increases by 0.0724 yuan/kWh, the internal rate of return can reach 6%, with an increase ratio of 16.72%. After the energy price increases by 0.1157 yuan/kWh, the internal rate of return can reach 8%, with an increase ratio of 26.71%.

Based on the two targets of meeting 6% and 8% internal rate of return, assuming that the gas price at the plant gate remains unchanged, the estimation of the simultaneous increase ratio of capacity price and energy price is shown in Table 8.

The results show that with a simultaneous increase of 13.20% in capacity price and energy price, including an increase of 3.17 yuan/kW·month in capacity price and 0.0572 yuan/kWh in energy price, the internal rate of return can reach 6%; with a simultaneous increase of 21.10%, including an increase of 5.06 yuan/kW·month in capacity price and 0.0914 yuan/kWh in energy price, the internal rate of return can reach 8%.

(3) Sensitivity Analysis of Gas Price and Profit

The current benchmark gate price of natural gas in the Sichuan-Chongqing region is 1.53 yuan/m^3. According to the regulations on the two-part tariff in the Sichuan-Chongqing region, when the gas price rises within a certain range, the energy price will rise accordingly; when the gas price rises to a certain extent, the part of the gas purchase price higher than the benchmark gate price will no longer be linked. As shown in Figure 5, the project team conducted a sensitivity analysis on the gas price-profit of gas-fired power projects and found that when the gas price changes within 80%-150%, with the increase of gas price, the profitability of gas-fired power projects will further improve; when the gas price changes exceed 150%, the profitability of gas-fired power projects will decline and face the risk of loss. Currently, the gas price in the Sichuan-Chongqing region is close to the linkage critical point of the two-part tariff. When the gas price exceeds 2.295 yuan/m^3, the profit will decline rapidly, and gas-fired power projects will face great market risks.

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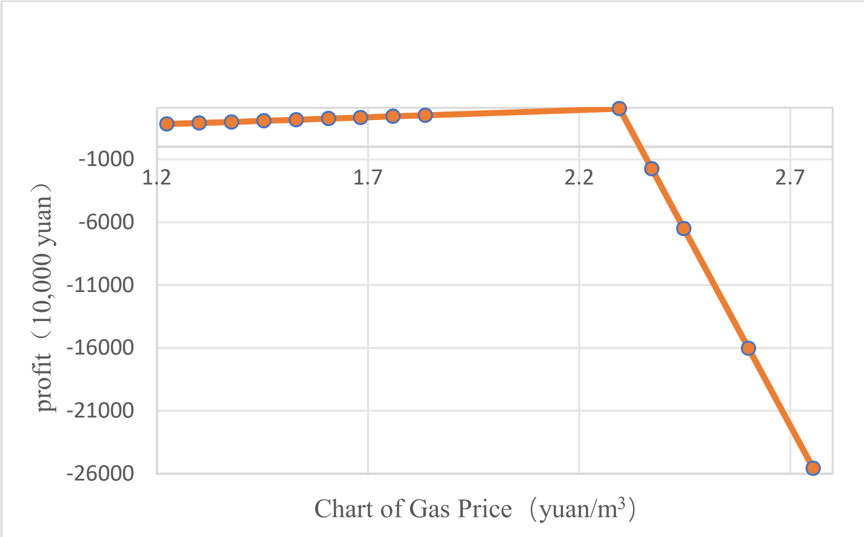

Figure 5. Sensitivity Analysis Chart of Gas Price-Profit

It is worth noting that the adjustment of energy price is based on the annual average gas purchase contract price of gas-fired power projects in the province. If gas-fired power enterprises have a relatively higher gas price at the plant gate, their profitability will further decline.

4. Analysis of Business Opportunities for Gas-Fired Power Projects in Sichuan-Chongqing Region

4.1. Favorable Factors

(1) Increased Policy Support

With the advancement of the dual-carbon goals and the acceleration of energy transformation, the Sichuan-Chongqing region has significantly increased policy support for clean energy, focusing on installed capacity planning, gas source guarantee, and new energy indicator allocation.

In terms of installed capacity planning, the Sichuan-Chongqing region optimizes its energy structure based on resource endowments. Sichuan maintains a high level of hydropower installed capacity relying on its water resource advantages, while accelerating the layout of wind power and photovoltaic power generation; Chongqing focuses on increasing the proportion of natural gas power generation installed capacity by 2030 to ensure urban electricity demand. The two regions have clarified goals through joint planning, refined energy installation scales, and laid the foundation for energy structure adjustment and stable supply.

In terms of gas source guarantee, as a region rich in natural gas resources, the Sichuan-Chongqing region strengthens exploitation, transportation, and storage to ensure stable gas supply. The two regions have established a coordination mechanism, and the governments of the two places have signed energy cooperation agreements to jointly promote 20 major energy projects to improve gas supply capacity, providing reliable guarantees for industrial and civil use, involving energy networks, energy supply, reserve peak-shaving, etc., with a total investment of nearly 990 billion yuan. Among them, more than 400 billion yuan will be invested during the "14th Five-Year Plan" period, including the Sichuan-Chongqing power grid integration project and natural gas base construction.

In terms of new energy indicator allocation, the Sichuan-Chongqing region promotes the rapid development of clean energy through scientific allocation of wind power and photovoltaic power generation indicators. The government formulates goals and introduces preferential

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policies to reduce project approval thresholds, optimize subsidy mechanisms, and attract enterprise investment. At the same time, reasonable allocation of indicators promotes grid optimization and transformation, improving the grid-connected consumption capacity of renewable energy.

(2) Obvious Resource Advantages

The Sichuan-Chongqing region is rich in natural gas resources. The total natural gas resources in the Sichuan Basin are 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, providing sufficient gas source guarantee for gas-fired power projects.

The Sichuan-Chongqing region has significant fuel cost advantages in the development of gas-fired power projects. The progress of natural gas exploitation technology and the characteristics of local utilization of regional resources make the natural gas price in the Sichuan-Chongqing region relatively low, greatly reducing the operating costs of gas-fired power projects and creating favorable conditions for the development of the gas-fired power industry. The two regions of Sichuan and Chongqing have actively promoted the improvement of the natural gas industry chain, including the improvement of exploitation, storage, transportation, and allocation capabilities, providing reliable support for efficient resource utilization. The collaborative development model of resources and industries has enhanced the energy guarantee capacity of the Sichuan-Chongqing region.

(3) Strategic Position as a Future Economic Center

With the advancement of the construction of the Chengdu-Chongqing twin-city economic circle, the economy of the Sichuan-Chongqing region has developed rapidly, and the demand for industrial and residential electricity has continued to grow. It is estimated that by 2025, the maximum power supply gap in Chengdu will reach 5 million kilowatts, and the power gap in Chongqing will expand from 1.37 million kilowatts to 10 million kilowatts, making the problem of power demand gap increasingly prominent. This provides a broad market space for the development of gas-fired power projects. Gas-fired power projects can not only effectively fill this power supply gap but also provide efficient and stable power support for industrial production and residents' lives.

(4) Overlap of Chongqing's Coal-Fired Power Peak and Natural Gas Consumption Trough

Chongqing's coal-fired power generation peak coincides with the natural gas consumption trough in summer. For gas-fired power projects, they will face less competitive pressure in obtaining natural gas as power generation fuel, can more reliably obtain sufficient gas supply, reduce the risk of power generation interruption or instability due to gas source shortage, and thus ensure the continuous and stable operation of gas-fired power projects. The pressure on the natural gas transmission and distribution system is relatively small during the trough period, and the load on pipelines and related facilities is reduced, which helps improve transmission and distribution efficiency, reduce possible problems in the transmission and distribution process, and further ensure the stability of natural gas supply for gas-fired power projects.

Due to the low market demand, natural gas prices tend to be low during the consumption trough period. For gas-fired power projects, their fuel procurement costs can be effectively controlled, reducing power generation costs and improving project economic benefits. Low-cost natural gas makes gas-fired power more competitive compared with other types of power sources, helping it gain more power generation share in the power market.

The cost advantage is obvious, and the gas price is relatively low. Due to the low market demand, natural gas prices tend to be low during the consumption trough period. For gas-fired power projects, their fuel procurement costs can be effectively controlled, reducing power generation

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costs and improving project economic benefits. Low-cost natural gas makes gas-fired power more competitive compared with other types of power sources, helping it gain more power generation share in the power market.

(5) Increased Demand for Clean Energy from Enterprises and the Public

As a clean and efficient energy form, natural gas power generation has significant advantages in carbon reduction and has become an important path to achieve carbon peak and carbon neutrality goals. In recent years, driven by policies and environmental protection needs, China's natural gas power generation installed capacity has continued to grow, providing strong support for clean energy transformation.

Under the "dual-carbon" policy, enterprises are actively adopting low-carbon solutions such as natural gas power generation in the face of increasingly strict carbon footprint management requirements. It has effectively promoted enterprises to reduce carbon emissions, driven the rapid expansion of natural gas power generation installed capacity, brought new development opportunities to the upstream and downstream of the industrial chain, and helped China achieve green and sustainable development.

(6) Trend of Concentrated Power Demand

The trend of concentrated power demand provides a broad market space for gas-fired power, intensifies the dependence on power supply stability, increases the load pressure on regional power grids, and promotes the optimization of gas-fired power project layout. The urbanization process has driven the rapid growth of industrial, commercial, and residential electricity demand, prompting gas-fired power projects to further improve their supply capacity. In the Sichuan-Chongqing region, gas-fired power projects will tend to be built close to load centers or power transmission and distribution hubs to shorten the power supply radius, improve energy efficiency, and reduce transmission and distribution losses.

(7) Increased Extreme Weather and Growing Demand for Power Peak-Shaving

In recent years, extreme weather has increased in the Sichuan-Chongqing region, and the gap in peak power demand has been obvious. In the summer of 2022, Sichuan Province suffered from extreme high temperatures and continuous drought, resulting in a significant decline in hydropower generation capacity, and the province's power supply gap once exceeded 10 million kilowatts. At the same time, Chongqing's summer peak electricity load increased by nearly 15%, putting great pressure on the grid's regulation capacity, and traditional baseload power sources have been difficult to fully meet the demand. With the advantages of rapid start-stop and sensitive response, gas-fired power has played an irreplaceable role in ensuring power supply stability, alleviating power shortages, and supporting new energy consumption.

(8) Increasing Industrial Parks and Growing Demand for CHP Mode

By 2023, more than 400 industrial parks have been built and planned in the Sichuan-Chongqing region, most of which are concentrated in the two major metropolitan circles of Chengdu and Chongqing. These parks gather high-energy-consuming industries such as electronic information, equipment manufacturing, and new materials, which have high requirements for the quality, stability, and economy of energy supply. According to statistics, the annual growth rate of industrial electricity consumption in the Sichuan-Chongqing region exceeds 8%, and the demand for heating has also increased significantly. The CHP type is characterized by efficient energy utilization. While generating electricity, gas-fired units can recover waste heat for heating and cooling in industrial parks, achieving an overall energy utilization efficiency of over 80% and significantly reducing the total energy consumption cost of the parks.

4.2. Unfavorable Factors

(1) Imperfect Market Price Mechanism and Low Gas-Fired Power Price

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Against the background of high natural gas prices, the gas-fired power price mechanism in the Sichuan-Chongqing region is still imperfect, and the profitability of gas-fired power is low. Although the Sichuan-Chongqing region has proposed mechanisms such as the two-part tariff and gas-electricity price linkage, it still lacks sufficient flexibility and market orientation, failing to effectively solve the profitability difficulties and price fluctuation problems faced by the gas-fired power industry. Under the current price mechanism, gas-fired power projects usually face high operating costs. The current two-part tariff in the Sichuan-Chongqing region cannot effectively reflect fluctuations in natural gas costs, making it impossible for electricity prices to adjust synchronously with fuel costs, thereby affecting the profit margin of gas-fired power enterprises.

(2) High Overall Natural Gas Price and Risk of Increase

China's natural gas supply mainly relies on imports, with a high degree of external dependence, resulting in large price volatility. Fluctuations in international market natural gas prices and domestic demand growth have further exacerbated this trend. High natural gas costs directly push up the fuel costs of gas-fired power projects, reduce their profitability, and lead to the risk of losses in some gas-fired power projects.

(3) High Gas Consumption Rate

Currently, most gas-fired power projects in the Sichuan-Chongqing region use F-class gas turbines, with a gas consumption rate of about 0.202 kWh/m^3, that is, about 0.202 cubic meters of natural gas is consumed per kilowatt-hour of electricity generated. The level of gas consumption rate directly affects the fuel cost and profitability of gas-fired power projects. Against the background of persistently high natural gas prices, the high gas consumption rate of F-class gas turbines has brought greater economic pressure to the projects.

(4) Low Coal-Fired Power Costs and Improved Carbon Reduction Level

The cost of coal-fired power in the Sichuan-Chongqing region is relatively low. In 2023, the on-grid price of coal-fired power projects in the Sichuan-Chongqing region was generally lower than that of gas-fired power, with the power generation cost of coal-fired power being about 0.3 yuan/kWh, while that of gas-fired power was about 0.5 yuan/kWh, showing an obvious gap in fuel costs. The low-cost advantage of coal-fired power makes it highly competitive in the power market.

The environmental protection facilities in the coal-fired power industry have been gradually upgraded, and the carbon reduction capacity of coal-fired power generation has been continuously improved. According to the data released by the National Energy Administration in 2023, the carbon dioxide emissions per unit of coal-fired power in the Sichuan-Chongqing region have decreased by about 15% compared with five years ago. Through technological improvement and ultra-low emission transformation, coal-fired power projects have significantly reduced carbon emissions, making their emission quota utilization in the carbon market more efficient.

(5) Rapid Development of Energy Storage Technology

In 2023, the energy storage installed capacity in the Sichuan-Chongqing region reached 1.5 million kilowatts, and by 2025, the total energy storage installed capacity is expected to exceed 5 million kilowatts. Large-scale battery energy storage projects have improved the regulation capacity of the power system, enabling it to more effectively balance the volatility of renewable energy such as wind power and photovoltaic power generation. In 2023, during the peak power demand in the Sichuan-Chongqing region, energy storage systems were able to provide up to 20% of the power supply. The progress of energy storage technology has made the power market's demand for gas-fired power gradually decrease.

In summary, the gas-fired power projects in the Sichuan-Chongqing region face both favorable and unfavorable factors in terms of market opportunities. On the favorable side, the Sichuan-

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Chongqing region has increased policy support, obvious resource advantages, strategic position as a future economic center, overlap of Chongqing's coal-fired power peak and natural gas consumption trough, increased demand for clean energy from enterprises and the public, trend of concentrated power demand, increased extreme weather and growing demand for power peak-shaving, and increasing industrial parks, all of which provide good conditions for the development of gas-fired power projects. However, there are also unfavorable factors such as imperfect market price mechanism, low gas-fired power price, high overall natural gas price and risk of increase, high cost pressure on gas-fired power projects, high gas consumption rate, continuous increase in new energy installed capacity, low coal-fired power costs, improved carbon reduction level, and rapid development of energy storage technology.

From a time perspective, short-term opportunities for gas-fired power projects are better than long-term ones. From a regional perspective, market opportunities in Chongqing are better than in Sichuan. In terms of type, the Sichuan-Chongqing region should focus on peak-shaving type, supplemented by CHP type. Looking to the future, gas-fired power projects will mainly focus on peak-shaving, standby, and emergency, and should appropriately transform into comprehensive energy enterprises in conjunction with the development of new energy.

5. Conclusion and Recommendations

5.1. Conclusion

The Sichuan-Chongqing region is renowned for its extremely rich natural gas resources, being one of the three major onshore gas regions in China, with total natural gas resources reaching 39.94×10^{12} m^3, accounting for a significant proportion of the national total. However, despite such advantageous resource conditions, the development of gas-fired power projects in the Sichuan-Chongqing region has been relatively lagging. Currently, gas-fired power projects in the region mainly adopt CHP and peak-shaving operation modes to adapt to different power demands and market environments.

Gas-fired power projects in the Sichuan-Chongqing region face many challenges. Firstly, the gap in contracted gas volume is a prominent problem, as many projects struggle to obtain sufficient natural gas supply during peak periods, limiting their power generation capacity. Secondly, fuel costs account for an extremely high proportion of the total costs of gas-fired power projects, and fluctuations in natural gas prices directly affect project profitability. Finally, the current electricity pricing mechanism, especially the two-part tariff policy, is still imperfect in implementation, failing to fully reflect the costs and market value of gas-fired power projects, leading some gas-fired power projects to be in long-term losses and operational difficulties.

Through calculations, it is found that with the gradual implementation of the two-part tariff and continuous optimization and upgrading of gas turbine equipment, gas-fired power projects in the Sichuan-Chongqing region are expected to achieve small profits. However, to achieve a more ideal investment return rate (such as 6% or 8%), it is necessary to significantly increase the two-part tariff level and further improve the price linkage mechanism.

As an important growth pole of China's economy, the Sichuan-Chongqing region has a continuously growing power market demand, especially during the peak electricity consumption periods in summer and winter, where the supply-demand gap is particularly obvious. With the advancement of the construction of the Chengdu-Chongqing twin-city economic circle, the demand for industrial, commercial, and residential electricity will further increase, providing a broad market space for gas-fired power projects.

In terms of policy environment, the state's support for clean energy has been increasing. The implementation of the two-part tariff provides a more reasonable cost recovery mechanism for gas-fired power projects, and the allocation of new energy indicators also encourages the integration of gas-fired power with renewable energy. However, the competitive pressure from

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alternative energy sources such as hydropower, new energy, and coal-fired power cannot be ignored, as they pose challenges to gas-fired power projects to varying degrees.

In summary, gas-fired power projects in the Sichuan-Chongqing region face many challenges while also having development opportunities. By in-depth analysis of the current situation, grasping market opportunities, optimizing operation modes, and formulating effective risk response strategies, gas-fired power projects are expected to achieve sustainable development and make greater contributions to regional economic and social development.

5.2. Recommendations

The integrated development of gas-fired power and new energy is an important way to promote energy structure optimization and improve energy utilization efficiency. By constructing gas-fired power projects and configuring corresponding new energy projects, multi-energy complementarity and coordinated development can be achieved. Specifically, gas-fired power projects can serve as stable base power sources to provide continuous power supply to the grid; while new energy projects can use their clean and renewable characteristics to provide flexible power regulation and supplementation to the grid.

If gas-fired power projects are configured with green power projects at a 1:1 installed capacity ratio, the investment return rate of gas-fired power projects can be significantly improved. Taking the Dazhou Phase II project as an example, at the current level, if corresponding new energy projects are configured, the expected investment return rate can increase from 0.86% to 5.64%, as shown in Table 9. This increase fully demonstrates the huge potential of the integrated development of gas-fired power and new energy.

Table 9. Comprehensive Return Rate of Gas-Fired Power Combined with New Energy Supporting Investment

Investment Type	Investment Return Rate	Unit Investment (yuan/kWh)	Comprehensive Supporting Investment Return Rate
Gas-Fired Power	0.865%	2285	5.64%
Green Power	7%	7000	

In practice, gas-fired power projects can be combined with new energy projects in various ways. For example, gas-fired power projects can be co-constructed and operated jointly with new energy projects such as wind power and photovoltaics; or gas-fired power projects can provide peak-shaving and frequency modulation auxiliary services for new energy projects to ensure the stable output of new energy power.

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