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Abstract. This article through to a large industrial coal boiler replacement for gas boiler engineering design and analysis, the analysis results show that after using distributed energy to replace the original coal boiler, the indicators can reach or exceed the relevant provisions of the state, and the economy is good.

Key Words. Distributed energy resource; "Coal to Gas"; Energy Conservation and Emission Reduction

1. Introduction
In recent years, PM2.5 has attracted more and more attention, and air pollution and governance have become the focus of government and enterprises. According to statistics, coal is the most fundamental cause of air pollution in China. Although burning straw, catering, set off firecrackers at certain times of pollution may also be affected, but they are not the decisive factor for the formation of pollution. “coal to gas” is one of the major measures the central governance haze work, including coal-fired boiler is the key of the reform. A number of large industrial enterprises, including electric power, cement, chemical, pharmaceutical, printing and dyeing, food, food, cars are equipped with large coal-fired boiler, steam supply to the enterprise, heating, most of the coal-fired boiler will gradually be replaced for gas boiler.

Coal-fired boiler replacement for gas boiler, is not an easy task for industrial enterprises, facing many problems, such as the high price of gas, gas supply shortage, environment pollution, air supply distance too far, gas pipe laying, policy support, etc. In recent years, more to take control of coal consumption, promote the "coal to gas" governance fog haze, but the phenomenon of "one size fits all" appeared in the process of policy, all industrial coal-fired projects are strict controls coal index, lead to many industrial production waiting for construction enterprises.

This article through to a large industrial enterprise of coal burning boiler replacement for gas boiler engineering example analysis, it is concluded that natural gas distributed energy is a large industrial enterprise coal-fired boiler replacement for gas boiler engineering of an effective method. Natural gas distributed energy is not only economical, but also effective in energy saving and emission reduction.

2. Economic analysis of natural gas distributed energy
Four ministries and commissions such as the national energy administration issued “on guidance for the development of natural gas distributed energy” basic principles mentioned in comprehensive utilization of natural gas distributed energy supply system average annual energy efficiency should be
higher than the 70% annual comprehensive utilization efficiency is higher than that 70% of the project is qualified gas distributed energy projects. Therefore, the natural gas distributed energy supply system should calculate the annual average energy utilization efficiency in accordance with relevant regulations.

\[ \nu = \frac{3.6W + Q_1 + Q_2}{B \times QL} \times 100\% \]  

WDZJL: \( \nu \) is the annual average energy utilization rate, \%; \( W \) is net annual output, kWh; \( Q_1 \) is the total amount of annual effective residual heat supply, MJ; \( Q_2 \) is the total amount of residual heat supply in the year, MJ; \( B \) is the total annual gas consumption, m³; \( QL \) is the calorific value of low combustion, MJ/m³.

The average annual energy utilization rate of the running natural gas distributed energy project is higher than 70% of the national regulations.

Since 2017, according to the relevant provisions of the Chinese carbon emissions trading market and the energy saving market will be fully opened across the country, in 2016 the domestic carbon emissions trading price of 30 ~ 50 RMB/t, energy saving trading tie for every 500 ~ 800 RMB/t, is far less sellers than buyers, so the natural gas distributed energy, after entering the two market can get extra considerable economic benefits.

It must be pointed out that China's carbon emissions trading market and the energy saving market opening time is shorter, China's carbon emissions and energy saving calculation method still has many problems, in the analysis of energy conservation and emissions reduction should be used when the correct calculation method.

3. Engineering Case Analysis

In order to illustrate that natural gas distributed energy is still an effective solution in the process of “Coal to Gas” in industrial enterprises, this paper analyzes and illustrates a specific project.

3.1. Basic Introduction

A large industrial enterprises, according to the city of “Coal to Gas” unified planning, requires a boiler factory gradually “Coal to Gas” project. The first phase of the plan of the original three coal of 20 t/h boiler retrofit. The second phase will be remaining all converted into gas boiler, coal boiler factory used steam will be supplied by gas steam boiler. In addition the factory existing 35 kV/10 kV step-down station, two lines of 35 kV line into use at the same time, the four sets of 35 kV/10 kV transformer. Enterprise through the investigation and detailed analysis of the economic, if the implementation of “Coal to Gas” plan, the original coal boilers into gas-fired boiler from the requirement of cascade utilization of clean energy, is not reasonable. And use gas distributed energy not only to achieve the basic purpose of “Coal to Gas”, and more to the point of cascade use of clean energy, not only economic benefit is improved greatly, but also in accordance with the existing policy.

3.2. The plan of “Coal to Gas”

3.2.1. Electrical Load and Thermal Load. (1) Electrical Load

Because the “Coal to Gas” is decided by thermal electricity, 4 sets of distributed energy unit (15 t/h, single steam capacity of 6.5 MW) respectively connected to the factory four 35 kV transformer substations, the installed capacity of 31.84 MW, 26 MW power. That could satisfy the requirement of factory produced steam access campus network pipeline. All production of electricity and steam for private use by the enterprise. Control system gas boiler room access control room for remote control, system in the usual daily electricity peak period of operation to ensure the system economy. The
weighted average power price of the city peak, flat and valley is 0.891 RMB/kWh in summer, and the non-summer weighted average is 0.688 RMB/kWh, and the annual average is 0.88 RMB/kWh.

(2) Thermal Load
Factory run throughout the year, product line almost constantly changes the hourly production steam demand is bigger, but most of the time in more than 60 t/h, up to 280 t/h, only in the morning session time succession 40 t/h steam load. The factory used steam coal boiler by steam supply. All factories use connected to the steam price 342 RMB/t.

3.2.2. Equipment Selection and Operation Instructions. According to the actual can use situation of the factory, the use of “meet the commonly used power load and part of the steam load, thermal balance” of the design principle of “thermal power” to carry on the design. Because of this project is hot is given priority to, so the high exhaust temperature of the gas turbine as prime mover of natural gas distributed energy. Because the factory built distributed energy station need to the factory to provide the required steam throughout the year, as much as possible to reduce gas boiler operating hours, improve the efficiency of the combustion of natural gas, according to the steam and power load analysis and the factory with the capacity of transformer, adopted 47.96 MW gas turbine. As a result of the gas turbine rated conditions (ISO standard conditions) as the inlet temperature of 15°C, 60% relative humidity, and generating capacity, the quantity and temperature of the flue gas and is obviously affected by the outdoor air temperature and decreases with the outdoor dry bulb temperature rise. In the rated condition, the output power of the gas turbine is not considered, and the actual generating capacity is about 4% less than that in the rated condition. At the time of selection and economic analysis, this point has been taken into consideration, and the installed capacity of the generating set of the distributed energy supply system of natural gas with 60 t/h is calculated according to the steam quantity. The system is mainly composed of four gas turbine generators, four customized waste heat boilers, one set of CCHP intelligent control system and other ancillary equipment.

The main equipment of this project is shown in table 1.

| Equipment                  | Reference Quantity/Unit | Quantitative Value |
|----------------------------|-------------------------|--------------------|
| Gas Turbine               | Power Generation/kW     | 7850.32            |
| Gas Turbine               | Generating Efficiency%  | 35.50              |
| Gas Turbine               | Gas Consumption/Nm³/h   | 2388.46            |
| Gas Turbine               | Sets/units              | 4                  |
| Heat Recovery Boiler       | Steam Pressure/MPa      | 1                  |
| Heat Recovery Boiler       | High Pressure Steam Flow/t/h | 15.9             |
| Heat Recovery Boiler       | Sets/units              | 4                  |
| Cooling Tower             | Flow/t/h                | 100                |
| Cooling Tower             | Power/kW                | 5                  |
| Cooling Tower             | Sets/units              | 2                  |
| Cooling Water Pump        | Flow/m³/h               | 100                |
| Cooling Water Pump        | Head/mH2O               | 25                 |
| Cooling Water Pump        | Power/kW                | 92                 |
| Cooling Water Pump        | Sets/units              | 3                  |
| Gas Pressurized Equipment | Inlet Pressure/MPa      | 0.15               |
| Gas Pressurized Equipment | Exhaust Pressure/MPa    | 2.2                |
| Gas Pressurized Equipment | Sets/units              | 1                  |

Economic analysis according to the actual amount of electricity and steam supply quantity computation, considering the influence of the outdoor air temperature throughout the year 93.55% of
the rated capacity of total generating capacity, taking into account the influence of the exhaust pressure loss actual power as the rated 96% of the total generating capacity, a total power generating capacity is 127428 MWh considering the influence of the outdoor air temperature throughout the year for rated 99.5% of the total steam, steam supply steam supply for the whole year of 280092 t gas for the whole year 45279830 m3.

The total 365 days of the year are deducted from the statutory holidays, 27 days and 18 days of winter and summer weekends, and the annual operating time is 320 days, 16 hours per day, and the total amount is 5120 hours.

3.3. Economic Analysis
The main indicators of the financial analysis of this project are shown in table 2 (the unit price in the table is the tax-included price).

| Table 2. Financial Sensitivity Analysis Table |
|---------------------------------------------|
| Project                                      |
| Construction Investment                      |
| Unit                                         |
| Quantitative Value                           |
| Construction Investment                      |
| T RMB                                        |
| 262880                                       |
| Unit Investment                              |
| RMB/kW                                       |
| 8256                                         |
| Electricity Price                            |
| RMB/MWh                                      |
| 73739                                        |
| Hot, Cold Unit Price                         |
| RMB/GJ                                       |
| 119.79                                       |
| Pay Back Period                              |
| year                                         |
| 5.83                                         |
| IRR                                          |
| %                                            |
| 16.21                                        |
| Return on Investment                         |
| %                                            |
| 15.31                                        |
| Net Principal Profit Margin                  |
| %                                            |
| 5.98                                         |
| ROI                                          |
| %                                            |
| 15.31                                        |
| Profit and Tax Investment Ratio              |
| %                                            |
| 21.06                                        |
| Average break-even point                    |
| %                                            |
| 39.94                                        |
| Average annual energy utilization rate       |
| %                                            |
| 77.10                                        |

As can be seen from table 2, 1) project capital internal rate of return is 16.21%, significantly higher than the 8% of the relevant departments of the state regulations of index. 2) Annual average energy comprehensive utilization rate of 77.10%, 70% higher than stipulated by the state.3) the main factors influencing the project economics as the price of natural gas.

3.4. Energy Conservation and Emission Reduction Analysis
Table 3 shows the energy conservation and emission reduction analysis of this project.

| Table 3. Analysis of energy conservation and emission reduction |
|---------------------------------------------------------------|
| Standard coal consumption /t/a                                |
| CO2 discharge /t/a                                            |
| energy saving /t/a                                            |
| emission reductions /t/a                                      |
| Energy trading /T RMB/a                                        |
| carbon emission trading /T RMB/a                              |
| Conventional coal type                                        |
| 75924                                                        |
| 199090                                                       |
| -                                                            |
| -                                                            |
| -                                                            |
| -                                                            |
| Natural gas distribution                                      |
| 53040                                                        |
| 111878                                                       |
| 22879                                                       |
| 87205                                                        |
| 13727.4                                                     |
| 3488.2                                                       |

4. Conclusion
We need to eliminate, halt and build up coal capacity to prevent the risk of overcapacity in coal and electricity production, and improve the efficiency of the coal and electricity industry, so as to make
space for clean energy development. "Coal to Gas" is one of the important measures of the central governance haze work, although the coal boiler is the focus of the reform for the "Coal to Gas" China still exist many different opinions, but facts have proved that many misunderstandings exist in the middle.

As one of the major measures to deal with the haze, coal reform has become an irresistible trend. The key is how to rely on high and new technology, local conditions, careful design, and rigorous construction. In this paper, a case study of "coal modification" in a large industrial enterprise is taken as an example to show that if the original coal boiler is changed to a gas boiler. Although the purpose of "coal modification" is realized, the clean energy is not used in the steps. Not only economically irrational, but also not consistent with the central government's repeated efforts to promote the spirit of distributed energy. Engineering example analysis results show that 60 t/h boiler steam coal into gas cooling and heat power regeneration distributed energy system, investment payback period is 5.83 years, the capital of the internal rate of return of 16.21%, significantly higher than the provisions of the state of the lower limit of 8%, the average annual energy comprehensive utilization rate of 77.10%, higher than the 70% limit set by the state, at the same time can save each year Standard Coal reduce CO 2 emissions of 87205 t, 22879 t economic benefit is obvious. Thus, the distributed energy of natural gas is an effective and effective way for large industrial enterprises to change coal.

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