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# Market Analysis of Natural Gas for Power Generation in China

Ruijie Tian[a], Qi Zhang[a]*, Ge Wang[a]

*a: Academy of Chinese Energy Strategy, China University of Petroleum, Beijing, China 102249*

**Abstract**

The consumption of natural gas (NG) has been increasing at an annual growth rate of more than 10% in China, and it is expected to be used broadly in China to replace coal in downstream sectors to reduce air pollution due to coal burning. However, at present, it is difficult for NG to penetrate power generation market more broadly mainly due to its relatively high cost. In the present study, a market simulation method is proposed to find the marginal conditions and policy to promote NG utilization for power generation. In the proposed method, their impacts of technology improvement, pricing mechanism and carbon on the economic performance of gas power are analyzed. The prerequisite of the market simulation is that the profit of power producers won't decrease when using NG to replace coal. Based on the obtained analysis results, policy analysis is conducted from the points of natural gas pricing reform, electricity pricing reform and carbon tax mechanism. The electricity company will be motivated to generate more NG-fired electricity through higher carbon tax, lower NG fuel cost and higher operation hour of each unit.

## 1. Introduction

China has been the world's third largest consumer of natural gas(NG), and it has been in the rapid-growth stage. China's natural gas consumption and the growth rate between 2000 and 2013 are shown in Fig.1. NG consumption in 2013 increased by 700% compared to the data in 2000, and the annual growth rates is normally between10% and 25%.

| Nomenclature | | |
|---|---|---|
| gas gas-fired generation | coal | coal-fired generation |
| TC total cost of generating electricity(RMB/kWh) | F | fuel cost(RMB/m$^3$ for natural gas or RMB/ton for coal) |

* Corresponding author. Tel.: 86-10-89734752;
E-mail address: zhangqi@cup.edu.cn, zhangqi56@tsinghua.org.cn

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| | | | |
|---|---|---|---|
| FC | fixed cost per year, including investment cost, operations and maintenance cost, human cost(RMB/kWh) | $\eta$ | the efficiency electricity unit(%) |
| | | H | the operation hour of each unit per year(hours) |
| $C_M$ | total capital cost(RMB/kW) | R | payment rate of capital cost per year(%) |
| Q | fuel heat value(kcal/$m^3$ for natural gas or kcal/kg for coal) | t | the lifetime of unit(years) |
| | | $\Phi$ | carbon emission factor(kg/kWh) |
| P | fuel price(RMB/$m^3$ for natural gas or RMB/ton for coal) | $P_C$ | carbon tax(RMB/kg) |
| | | PR | the profit of electricity power enterprise(RMB/kWh) |
| C | capital cost of unit per year(RMB/kW) | | |
| $C_{MO}$ | maintenance and operation cost(RMB/kW) | $P_E$ | the electricity price(RMB/kWh) |
| $C_C$ | the cost of carbon emissions(RMB/kg) | | |
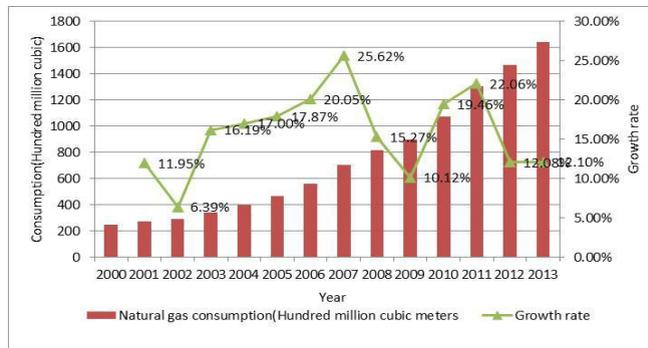


Fig.1 The trend of China's natural gas consumption and the growth rate (2000-2013)( Data source: [1])

In recent years, the domestic production including unconventional gas and importing from overseas by pipeline and LNG increases steadily, enough NG supply will be guaranteed in near future. NG has been widely used in residential sector and industry sector. Although gas-fired power generation has an enormous potential compared with other sectors, it only accounts for a small amount, only 2% [2]. However, the proportion of NG-fired power generation is 42% in Japan, 24.2% in the US, and 22% in the world in average. The main barrier of the development of gas-fired power generation is the cost. In this study, a simulation model is developed to analyse the market natural gas-fired power. Different scenarios are analysed for promoting the development of gas-fired power generation.

## 2. Methodology and Data

As shown in Fig. 2, a market simulation model is proposed. The input includes heat value, capital cost, efficiency of the unit, coal price, lifetime of the unit, carbon emission factor, and coal power price. Sensitive analysis is conducted on carbon tax, fuel cost, operation hours and gas electricity price. Finally, the economic feasible interval of gas power compared to coal power can be deduced and analysed.

The power generation is based on the technology of Combined Cycle Gas Turbine (CCGT). To simplify the model, it is assumed that the cost of power generation is mainly composed of fixed cost, fuel cost and the cost of carbon emissions. When the profit of gas-fired electricity is more than the coal-fired ones, the electricity company will be motivated to shift to the gas-fired power generation. The detailed cost-profit model introduction will be given as follows.