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The future of natural gas consumption in Beijing, Guangdong and Shanghai: An assessment utilizing MARKAL

BinBin Jiang [a,*], Chen Wenying [b], Yu Yuefeng [c], Zeng Lemin [d], David Victor [e]

[a] Program on Energy and Sustainable Development, Stanford University, CA 94503, USA
[b] Energy, Environment, Economy Institute, Tsinghua University, Beijing 100084, PR China
[c] Department of Mechanical Engineering, Shanghai Jiaotong University, Shanghai 200240, PR China
[d] Guangdong Techno-economic Research and Development Center, Guangzhou 510070, PR China
[e] Program on Energy and Sustainable Development, Stanford University, CA 94305, USA

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ABSTRACT

Natural gas could possibly become a si0gnificant portion of the future fuel mix in China. However, there is still great uncertainty surrounding the size of this potential market and therefore its impact on the global gas trade. In order to identify some of the important factors that might drive natural gas consumption in key demand areas in China, we focus on three regions: Beijing, Guangdong, and Shanghai. Using the economic optimization model MARKAL, we initially assume that the drivers are government mandates of emissions standards, reform of the Chinese financial structure, the price and available supply of natural gas, and the rate of penetration of advanced power generating and end-use. The results from the model show that the level of natural gas consumption is most sensitive to policy scenarios, which strictly limit SO_2 emissions from power plants. The model also revealed that the low cost of capital for power plants in China boosts the economic viability of capital-intensive coal-fired plants. This suggests that reform within the financial sector could be a lever for encouraging increased natural gas use.

1. Introduction

The world's natural gas market is rapidly globalizing. Traditionally, gas supplies have been delivered entirely within regional markets—usually with little geographical distance between the source of gas and its ultimate combustion. However, a significant and growing fraction of world gas is traded longer distances via pipeline and LNG. China is an emerging market for this gas, but its size and potential remains highly uncertain. Today, China's share of the global gas market is tiny, with a natural gas market that is smaller than California's (CEIC Database, 2007), but the future demand for natural gas in China is potentially enormous. With an average Gross Domestic Product (GDP) growth of 9.6% for the last 20 years (China National Bureau of Statistics Database, 2006) and no signs of slowing down, China's demand for energy commodities—coal and oil, notably—has also been expanding rapidly. With this burgeoning demand, along with appropriate policies, natural gas use could grow rapidly (Fig. 1).

The purpose of this study is to better understand the drivers of increased natural gas consumption for the energy systems of three major demand regions of China: Beijing, Shanghai and Guangdong. Analyzing the drivers of gas demand in China is crucially important for three reasons. First, understanding the increasingly global gas market requires assessment of the demand for natural gas in major emerging markets, such as China and India. Second, increased natural gas demand in China will have repercussions for global geopolitics as the state-owned China National Petroleum Company (CNPC) will be under increased pressure to seek out new supplies in politically sensitive regions. Third, fuel displacement of coal by less carbon-intensive natural gas could be a practical option for the government as it strives towards lowering carbon dioxide emissions. This issue has become increasingly pressing for China since it has emerged as top emitter of greenhouse gases for 2007 (Auffhammer and Carson, 2008).

As a starting point for this study, we assumed that the following were some of the major factors that are likely to affect future demand for natural gas:

- Rate at which more efficient end-use technology is made available;
- Stringency of local and regional environmental constraints;
- Financial reforms that affect the cost of capital for different sectors of the economy (i.e., power, industry, residential, commercial, transportation);
- Pricing and availability of gas.

* Corresponding author.
E-mail address: binji@stanford.edu (B. Jiang).

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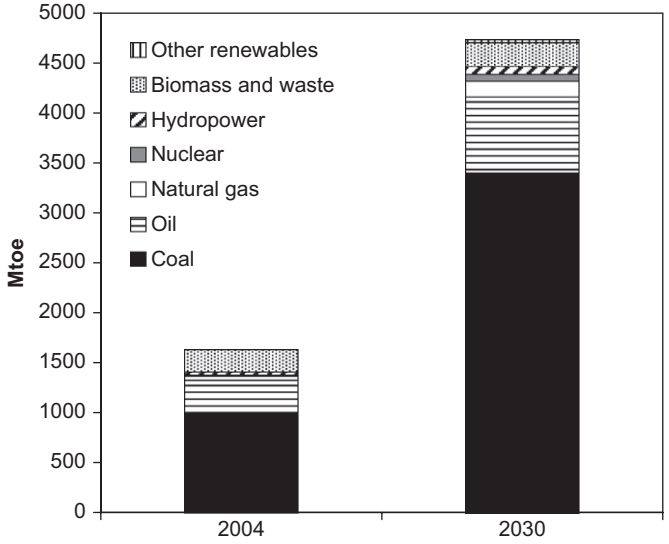

Fig. 1. Primary energy consumption in China for 2005 and 2030. (*Source*: BP Statistics Review 2006, IEA WEO 2007).

The findings of the report show that natural gas consumption (apart from polices that directly influence the price of natural gas relative to other fuels) is very sensitive to the implementation of government mandates that limit the amount of SO_2 that is allowed to be emitted. At the same time, we found that financial reforms may play an important role in determining what types of fuel gets consumed. We also find that a side benefit to SO_2 emissions reduction policies is a corresponding decline in CO_2 emissions on the order of 60 million tons CO_2 for some locales (equivalent to about a quarter of the entire stock of Clean Development Mechanism projects in China) (UNEP Riso Centre). This suggests that a leverage point for governments in developing countries like China to start addressing global concerns about climate change is through regulation of local pollutants that yield visible and immediate benefits while also fortuitously limiting growth of CO_2.

2. Background

To provide a context in which the models are operating, the subsections below will explain the natural gas supply and demand conditions in the country as a whole, and for each of the three regions that the study targets.

2.1. Demand

The major off-takers of natural gas in China are the chemical and fertilizer, industrial, power generation, and residential sectors (Fig. 2). IEA predicts that the power sector's share of the overall demand is increasing, consuming 39% of the gas in 2020 compared with 11% in 1997. Residential consumption is also estimated to increase to 25% of total gas off-take in 2020 from 11% in 1997. The consumption of gas by the chemicals and fertilizer sector is predicted to fall from 43% to 16%. Although these numbers describe the national market, regional demand can look quite different. Most noticeably, the chemical/fertilizer natural gas demand is non-existent for the fairly urbanized areas in and around Beijing, Guangdong, and Shanghai.

2.1.1. Beijing

In Beijing, end-use consumption of gas is dominated by space heating (60%), residential use (22%), commercial use (14%), industry (3%), and automobiles (1%) (Chen, 2007). Because space heating is such a large component of the consumption needs, one of the challenges for the system is how to accommodate the seasonality of the demand and how to deal with the extra supply in the summer. However, because Beijing is particularly motivated to rid the air of pollutants such as sulfur dioxide (SO_2), nitrogen oxides (NO_x), and total suspended particulate matter (TSP) before the 2008 Olympics, the government is likely to support policies that encourage the use of natural gas. The Beijing government has forecasted optimistic future natural gas consumption levels (12% of end-use energy mix by 2020; the current level is 7%) (Chen, 2007).

2.1.2. Guangdong

Guangdong's situation is especially affected by the scarcity of local coal resources. This province is thus poised to become the biggest natural gas demand center in China. It faces high costs and unreliability associated with the transportation of coal from remote areas. Consequently, Guangdong is often the first among the provinces to explore alternative energy supply options. China's first LNG terminal, Guangdong Dapeng, was completed in 2006. Guangdong has also initiated several nuclear power plant projects. The major consumers of natural gas in this region include peaking power plants that would otherwise be run by expensive diesel generators (Zeng et al., 2007) (Table 1).

Industrial and residential/commercial demand is also projected to increase. The high level of development and income in the region means that its residents and officials have the financial and infrastructural capacity to put a premium on environmental protection. Natural gas is a more attractive fuel option for this region than in other parts of China due to these factors.

2.1.3. Shanghai

About 32% of the natural gas demand in Shanghai comes from six energy-intensive industries (Yu et al., 2007).[1] Industry is therefore poised to be the largest user of natural gas in this region, although some construction of natural gas-fired power plants is under way. Shanghai experienced a rapid increase in residential and commercial natural gas consumption in recent years due to the fact that much of the infrastructure that is needed to bring gas to each household was already in place. (The network of pipes originally enabled the distribution of synthetic gas, also known as town gas, produced by burning coal.) Shanghai also has one of the most comprehensive policies in support of natural gas market development in China. For example, the municipal government was the first in the country to subsidize the cost of natural gas conversion. Simultaneously, fees for SO_2 emissions have tripled from 0.20 to 0.60 RMB/kg in 2005 (Yu et al., 2007). However, with its cheaper fuel prices and entrenched infrastructure, coal remains dominant in the energy sector.

2.2. Supply

Most of the onshore gas supplies are controlled by PetroChina, a listed subsidiary of China National Petroleum Company (CNPC), China's largest state-owned enterprise (The offshore supplies are controlled by the China National Offshore Oil Company, CNOOC—another state-owned company.) Most of the gas that is being utilized in China today comes from the domestic gas fields controlled by one of these companies. Production levels in existing fields are declining, however, while the discovery of

[1] Figure calculated from data from Yu Yuefeng, Zhang Shurong, and Hu Jianyi using the total natural gas demand, percentage of natural gas in total gas use (including town and other gas types), and the total gas consumed in industry.