

China's fuel gas sector: History, current status, and future prospects



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ABSTRACT

China has a unique urban pipeline network of three types of fuel gases: manufactured gas (coal gas), Liquefied Petroleum Gas (LPG), and natural gas. Manufactured gas, which is often seen as an outdated technology in the western world, is still widely used in Chinese cities. LPG is distributed through community-based pipelines in many Chinese cities, in addition to its distribution in cylinders and canisters in rural areas. Natural gas consumption is increasing throughout China, particularly as a cooking fuel. Expanding the production and supply of natural gas in China faces many challenges. In particular, China's controls on natural gas prices have deterred investment in exploration and natural gas imports. However, recent price decontrols of unconventional natural gas (defined in China as shale gas, coal-bed methane, and coal-to-natural-gas), and recent pricing reforms, appear likely to increase natural gas use. The prospect for increased exploration is promising but will still depend greatly on the future of institutional reforms. In the near term, regulatory reforms toward a more market-driven system will be the most critical issue in the development of China's fuel gas sector.

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1. Introduction

Gaseous fuels comprise a small but growing share of China's energy system. In most countries, household gas from a pipeline is generally synonymous with natural gas. In contrast, China's urban pipeline network of fuel gas is supplied by three major gas types: 1) manufactured gas, mostly hydrogen (H₂), carbon monoxide (CO), methane (CH₄) and other hydrocarbons; 2) natural gas, primarily methane; and 3) petroleum gas, primarily propane (C₃H₈) and butane (C₄H₁₀). Manufactured gas was widely used in U.S. and European cities in the nineteenth and early twentieth century (Tarr, 2004). China deployed manufactured gas extensively during the latter half of the twentieth century, after the western world had started to phase it out. In the United States, for instance, natural gas quickly gained market share and replaced manufactured gas during the 1930s–1950s (Hatheway, 2012). Many other countries converted from manufactured gas sometime in the mid-to-late twentieth century (Wang and Gao, 2008).

China's fuel gas sector was underdeveloped throughout most of the 20th century. From the 1950s to the 1970s, China had a planned economy and endured slow economic development. Unlike the United States, which decontrolled natural gas prices in the 1980s,

China has maintained price controls on natural gas through today. Not surprisingly, artificial price controls have led to chronic shortages and market distortions in China (Rockoff, 2008).

Since U.S. natural gas prices were decontrolled in the 1980s, natural gas has evolved from a resource that was scarce in the United States to one of its most abundant energy resources. Inspired by the U.S. experience, China has recently initiated regulatory reform and partial price decontrols to encourage the development of unconventional gas. Just as it was for the United States in the 1970s–1980s, China's natural reform of natural gas pricing has been a slow and politically difficult process (Zhao, 2011a, b). Although there has been progress in recent years, the prospect of future reform remains uncertain.

To our knowledge there has been no systematic examination of the historical developments and unique regulatory environments of China's fuel gas utilities. The prevalence of manufactured gas use in China and the 20-year deployment of urban LPG pipeline networks with envisioned eventual conversion to natural gas is largely unknown outside of China, as is the evolution of institutional restructuring and price controls for natural gas there. Although China's fuel gas sector is largely controlled by the government, it is gradually moving towards deregulation, a change that will result in the phasing out of some antiquated technologies and the adoption of more advanced ones. By tracing historical developments, and using history to understand the current status and future prospects of fuel gas in China, we analyze the fuel gas sector in a way that

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should benefit energy and environmental policymakers as well as entrepreneurs and technical experts.

Here, we examine the three main types of fuel gases – manufactured gas, LPG, and natural gas – currently supplied in China’s urban gas pipeline networks. Each type has a unique history of development and is encountering different challenges. Manufactured gas is still widely used in hundreds of cities, although many cities are now converting their manufactured gas systems to natural gas. LPG currently serves the most people in China as the most widely accessible cooking fuel in cities and villages. Natural gas is the fastest growing of the three gas types and is the focus of current regulatory reform, a topic we examine in detail. The pace of pricing and regulatory reform will likely determine how quickly China’s fuel gas sector develops.

2. Historical development of fuel gas in China

A number of historical developments have led to China’s current unique structure for its fuel gas sector. This background provides important insights into how China’s fuel gas infrastructure became well established on the demand side but underdeveloped on the supply side. As described above, manufactured gas is still an important part of China’s energy economy. The widespread pipeline networks used for delivering manufactured gas for the retail market can be easily converted to deliver natural gas. Such retail delivery networks are capital intensive to build. Without the existence of the manufactured gas networks, China’s retail demand for natural gas would not be able to expand at such rapid speed.

The natural gas industry is, in our view, the most regulated and least flexible energy sector in China. Price-controls and a national monopoly on natural gas industry and mineral rights have stymied exploration and production for decades. Reform has been slow and unbalanced, focusing primarily on unconventional gas but overlooking the potential of underexplored conventional natural gas.

In contrast to the tightly controlled natural gas industry, LPG in China is a more market-driven commodity. The commercial success of pipelined LPG provides a showcase for what a deregulated natural gas market could be. The market-driven LPG systems provide sufficient supply at market prices that are higher than the controlled manufactured gas and natural gas, but the higher prices have proven to be commercially viable. The on-going pilot pricing reforms on imported LNG is increasing the supply of natural gas and allows many coastal cities to convert from pipelined LPG to cheaper imported natural gas.

2.1. Manufactured gas

Manufactured gas, also known as coal gas or town gas, was widely used in the United States and Europe before the mid-twentieth century. Today, China still employs manufactured gas in hundreds of cities. China’s national standard on manufactured gas (GB 13612–2006) classifies two types of manufactured gas. Type 1 is made from the pyrolysis of coal, while Type 2 is made by reacting steam with diverse fossil fuel sources, including coal, oil, LPG, or natural gas. Manufactured gas contains a mixture of hydrogen, carbon monoxide, methane, and other volatile hydrocarbons. The proportion of these component gases varies depending on the specific technology and feedstock materials used locally.

British entrepreneurs built China’s first manufactured gas factory and pipeline delivery system in 1865 in the Shanghai International Settlement, a joint colony of European countries and the United States (Shanghai Gas, 2008). The Japanese South Manchuria Railway Company then built manufactured gas systems in eight cities in Japanese-controlled Manchuria (Northeastern China) between 1907 and 1934 (Dalian Gas, 2002). By the end of WWII,

Shanghai and the eight northeastern Chinese cities were the only cities in China with pipeline gas supplies (Gu, 1998).

After the People’s Republic of China (PRC) was established in 1949, the PRC government nationalized the manufactured gas facilities and continued their operation. We were able to find little information on the development of manufactured gas from 1949 to 1978 in China, the era of PRC’s strictly planned economy. One article indicated that deploying urban manufactured gas had been included in the economic plans since the first five-year plan (1952–1957) (Li, 1994).

Between 1949 and 1978, manufactured gas use expanded rapidly under the planned economy, despite a Chinese economy that was largely isolated from the western world and whose economic growth rates were low. The total supply of manufactured gas in China grew from 0.34 million cubic meters in 1949 to 1725 million cubic meters in 1978 (Li, 1994; MOHURD, 2011).

In 1984, the State Council, China’s chief administrative authority, decided to promote urban fuel gas systems to replace coal burned for cooking (Wang, 1996). The use of gaseous cooking fuels greatly reduces indoor air pollution and improves public health. Cooking with pipelined manufactured gas was also more convenient and energy efficient than conventional solid cooking fuels such as biomass and coal briquettes (Edwards et al., 2004). The 7th Five-Year Plan (1986–1990) therefore stipulated that cities should actively deploy manufactured gas. By 1994, 147 cities had manufactured-gas pipelines, while only 51 cities used natural gas (Zhang, 1996). Manufactured gas continued to be the most popular gas fuel used for cooking in Chinese cities throughout the 1990s. Fig. 1 show the length of pipeline networks for manufactured gas, LPG, and natural gas in major Chinese cities and county seats (small towns that serve as administrative centers of rural counties) (MOHURD, 2011).

Manufactured gas production continued to grow throughout the 1990s and up to 2009. However, some cities had already started to convert manufactured-gas networks to natural-gas ones (Wang and Gao, 2008). In 2006, for instance, Beijing completed its transition from manufactured to natural gas. Shanghai is expected to complete its conversion by 2015.

Manufactured gas systems are typically locally-owned public utilities. Local governments’ pricing bureaus set the prices of manufactured gas according to a cost-based principle. However, local policymakers sometimes prioritize political over fiscal concerns and set the retail price below the cost of production (Hou, 2009). That tendency, coupled with volatile coal prices in recent

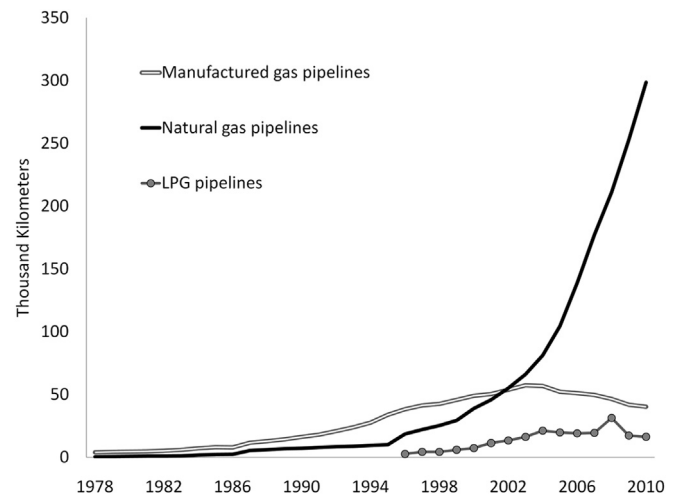


Fig. 1. Urban fuel gas pipelines in China (MOHURD, 2011).

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