



Contents lists available at ScienceDirect

## Journal of Cleaner Production

journal homepage: [www.elsevier.com/locate/jclepro](http://www.elsevier.com/locate/jclepro)

## Evaluating energy conservation in China's heating industry

Boqiang Lin<sup>a,\*</sup>, Jing Lin<sup>b</sup><sup>a</sup> Collaborative Innovation Center for Energy Economics and Energy Policy, China Institute for Studies in Energy Policy, Xiamen University, Xiamen, Fujian, 361005, PR China<sup>b</sup> College of Energy & School of Energy Research, Xiamen University, Xiamen, Fujian, 361005, PR China

## ARTICLE INFO

## Article history:

Received 30 May 2015

Received in revised form

23 June 2016

Accepted 30 June 2016

Available online xxx

## Keywords:

The heating industry

Energy conservation

Co-integration

Monte Carlo model

Scenario analysis

## ABSTRACT

Energy conservation is a major strategy for China to shift to a low-carbon economy and achieve sustainable development. The heating industry uses coal as its main fuel source in China. Energy consumption of China's heating industry grew at an average annual growth rate of 7.75% over 1980–2011. We use the co-integration method to explore the long-run relationship between energy consumption of the heating industry and the factors including GDP, urban population density, central heating supply areas and fuel price. The results indicate that 1% GDP growth yields 2.24% increase in energy consumption of the heating industry. 1% urban population density growth and 1% central heating areas growth result in 0.56% and 0.36% decline in energy consumption of the heating industry, respectively. Under the BAU scenario, energy consumption of the heating industry will be 157.11 Mtce in 2020. Energy conservation potential is estimated to be 22.16 Mtce under the moderate scenario and 43.6 Mtce under the advanced scenario. Moreover, this paper holds the view that the central heating system can be considered as an effective heating method for cities with dense population, both in the south and north. At last, policy recommendations for energy conservation in the heating industry are provided.

© 2016 Elsevier Ltd. All rights reserved.

## 1. Introduction

## 1.1. The role of the heating industry in China

The heating industry<sup>1</sup> developed rapidly in recent years because it has been preferentially supported by the Chinese government as a key part of China's infrastructure construction. In 2011, industrial heating energy consumption accounted for 70% of China's total heating energy consumption. Although residential heating energy consumption only accounted for 30% of China's total heating energy consumption, the growth rate of residential heating energy consumption was faster than the growth rate of industrial heating energy consumption. Moreover, the proportion of residential heating energy consumption kept rising (CCXI, 2012).

In order to achieve the commitments promised in Copenhagen, the Chinese government has actively implemented energy saving policies. According to China's Twelfth Five-Year (TFY) Plan for

National Economic and Social Development, (hereinafter referred to as "TFY Plan"), China's large-scale industry should realize a 21% decline in energy consumption per unit industrial value-added in 2015 compared with the year 2010. According to the Industrial Twelfth Five-Year Plan (MIIT, 2012), the amount of energy conservation is expected to be 6.7 billion tons of standard coal equivalent (tce) at the end of 2015. It was also clearly mentioned in the "TFY Plan" that the growth rate of building energy consumption should be effectively controlled. In fact, space heating occupies the largest share of building energy consumption in China. In the north of China, energy consumption in space heating accounts for about 40% of China's building energy consumption (Tsinghua University, 2011).

Heating supply is one of the most basic needs of people in Northern China during the winter. But for people in Southern China,<sup>2</sup> the low indoor temperature and lack of heating system in the residential buildings has been increasingly bothersome. In particular, with global climate change, extreme weather

\* Corresponding author.

E-mail addresses: [bqclin@xmu.edu.cn](mailto:bqclin@xmu.edu.cn), [bqclin2004@vip.sina.com](mailto:bqclin2004@vip.sina.com) (B. Lin).<sup>1</sup> In this paper, the heating industry refers to the heating power production and supply industry, which is consistent with the definition of the heating industry in China Statistical Yearbook.<sup>2</sup> Since 1950s, the Qinling Mountain Range and the Huaihe River has been considered as the geographical line dividing China into the north and the south for heating supply by the government. Central heating system is provided in the north, while central heating system is unavailable in the south. However, temperature below 5 °C can last up to 90 days in quite large areas in the South in winter, such as Hunan Province, Hubei Province, Jiangxi Province, Anhui province and etc.

phenomena appear more frequently. For example, a snowstorm hit large areas in the south of China in 2008, and extreme low temperatures lasted for almost the whole winter in most parts of China in early 2013, and so on. In other words, central heating supply is a necessity for people in northern China, while it is needed in the south to make people more comfortable in winter. With economic development, people are seeing increases in income as well as the improvement of their living standard. Thus, improving the habitation environment and keeping comfortable indoor temperature during the winter are becoming a necessity for people's daily life. Therefore, interior central heating supply in winter is required for people in the South. However, various decentralized residential heating methods in service at present in the South are energy inefficient at present. Xiaomei Zhang, a member of the National Committee of Chinese People's Political Consultative Conference, handed in a proposal about promoting central heating system in residential buildings in the south of China to the National People's Congress and the Chinese People's Political Consultative Conference Sessions in 2012. After that, the general public debated fiercely over whether the central heating system fits the South of China from an energy-saving perspective. Debates over whether South China can use central heating attracted more and more attention, even the National Development and Reform Commission (NDRC) set up a special team for further research into this topic.

### 1.2. The significance of evaluating energy conservation in the heating industry

The heating industry is a coal-fired energy intensive industry causing serious environment pollution. In 2011, the heating industry consumed 1169.3 million tons of coal accounting for 80% of the total energy consumption of the heating industry. So the pollution is more serious and the environmental quality is worse during heating season than non-heating season in the North of China. For example, concentration of total suspended particles (TSP) is 70% higher during heating-seasons compared with non-heating seasons (Zhang Hang., 2006). Thus, environmental issues brought up by the heating industry cannot be ignored. Efforts to reduce the energy consumption in heating industry and clean up its' negative environmental impacts are of great significance.

Being considered as an important part of China's public utilities, the heating industry gets preferential support from the Chinese government. China's rapid economic growth brings in industrialization and urbanization as well as improvement of people's life quality. People in north China require higher indoor temperature and extension of heating period in winter, while people in the South require heating supply service in winter. In other words, China is a great potential market for the heating industry. As an energy-intensive industry, the heating industry's energy consumption is huge. Therefore, energy conservation in the heating industry is significant for China's energy conservation policies and transition to a low-carbon economy as well as adjustment of industrial structure. It is therefore meaningful to study the energy conservation potential of China's heating industry. However, previous studies on the heating industry's energy conservation issue are almost from technological perspectives. The shortcomings of these studies are that technological measurements of energy conservation have limited influences on the industry because they neglect the driving mechanism within the industry's energy systems. This paper fills this research gap from the perspective of energy economics.

### 1.3. The guiding ideas

In this paper, we study the energy conservation potential of China's heating industry by answering the following questions:

- (1) Is there a long-term relationship between energy consumption and those factors including GDP, urban population density, central heating areas and fuel price?
- (2) If a long-term relationship exists, how will these factors affect each other?
- (3) How to estimate the energy conservation potential of the heating industry in China?

The relevance of this article is also related to another question, can central heating system be widely used by households in the South of China?

Fig. 1 describes the output of the heating industry in China over 1980–2011. Here, the output of the heating industry refers to the output of China's heating power production and supply industry. Data on the output of China's heating industry over 1980–2011 comes from the National Energy Balance Tables in *China Energy Statistical Yearbook* issued by the National Bureau of Statistics.

As shown in Fig. 1, there was a dramatic increase in the output of the heating industry in China from 1980 to 2011. This is due to China's rapid economic development which inevitably brings industrialization and urbanization. The industrial sector is the largest heating power consumer, so the industrialization process can increase heating demand. On the other hand, urbanization leads to urban population increase, urban expansion as well as development of infrastructure construction. As a result, both the heating supply areas and heating demand increases. Above all, economic growth is the essential cause for the growth of energy consumption in the heating industry. The heating supply area affects energy consumption of the heating industry directly. And the central heating system is the dominant heating supply system in China. So we use central heating supply areas as one of explanatory variables. Urban population density not only reflects changes in the urban population, but also reflects changes in urban population per unit area particularly. Urban population per unit area in the central heating supply areas provides us another measurement of efficiency of the central heating system. Therefore, urban population density is chosen as one of explanatory variables.

In order to estimate the energy conservation potential of China's heating industry, we first predict future energy demand in China's heating industry. Four main factors affecting energy consumption

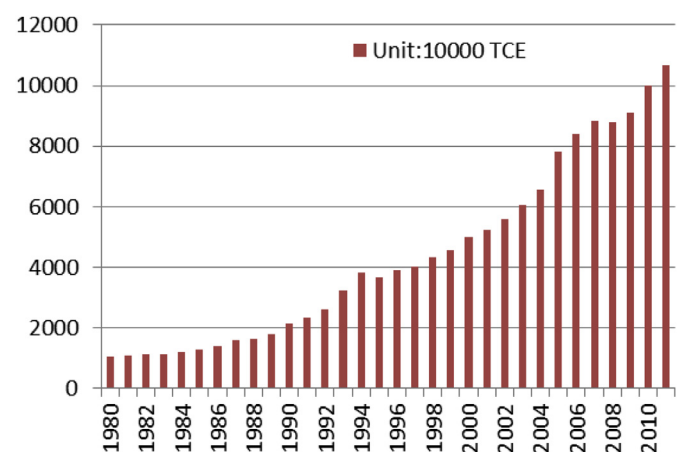


Fig. 1. The output of the heating industry in China over 1980–2011 (Unit:  $10^4$ TCE).

Download English Version:

<https://daneshyari.com/en/article/5481213>

Download Persian Version:

<https://daneshyari.com/article/5481213>

[Daneshyari.com](https://daneshyari.com)