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A projection of future electricity intensity and conservation potential in the Chinese building materials industry

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ABSTRACT

Electricity consumption of the Chinese building materials industry accounted for 8.4% of industrial and 6.2% of national electricity usage in 2011. The purpose of this paper is to estimate the future electricity intensity and conservation potential of the Chinese building materials industry. This paper adopts a cointegration method to establish a long-run equilibrium relationship between electricity intensity and factors including technology, power tariff, enterprise scale and value-added per worker. Electricity conservation potential in the Chinese building materials industry is predicted to be 90.5 billion kW h in 2020 under the moderate scenario, which is more than the total electricity consumption of Malaysia in 2007; and 150.9 billion kW h under the advanced scenario, which is more than the total electricity consumption of Saudi Arabia in 2005. Conserved electricity in building materials industry would account for 1.2% and 2.0% of national electricity consumption under the two scenarios, respectively. More importantly, we find that the electricity intensity gap between Chinese and the world's leading building materials industries could be significantly narrowed by 2020 if aggressive energy conservation policies were implemented. Finally, based on the results of our study, future policy priorities and directions are suggested.

1. Introduction

1.1. The roles of building materials industry in national economy and electricity usage

As one of China's pillar industries, building materials industry is capital-intensive and energy-intensive. Meanwhile, it is remarkably important for the Chinese economy due to its widely used products in various economic sectors and strong support for infrastructure construction in China's urbanization process. Building materials industry, which is classified as the non-metallic mineral products manufacturing in *China's National Economic Statistics*, includes subsectors such as building materials and products industry, non-metallic minerals and products industry, inorganic non-metallic materials industry [1].

The Chinese building materials industry developed rapidly in the past two decades. It was mainly driven by the fast expansion of the Chinese economy. Sales revenue of building materials industry has accounted for over 3% of the industrial sector's since 2000. The average annual growth rate of industrial value-added (IVA) was 20.3%, and the average share of the sectoral IVA in the secondary industry was 3.8%. It is worth noting that the IVA of building materials industry contributes nearly 1 percent annually to the national economic growth [2]. In late 2008, the Chinese government launched a four trillion CNY economic stimulus program, in which, 75% of investment was allocated for infrastructure construction [3], and the pace of development in building materials industry was thereby accelerated further.

The Chinese building materials industry has played an important role in the world market. China is by far the world's largest cement producer as well as consumer. In 2011, China's cement production reached 2000 million tons, 9.5 times that of India (the world's second largest cement producer) and 29.2 times that of the United States (the world's third largest cement producer) [4]. Furthermore, China's productions of other major building materials such as plate glass, sanitary ceramics and stone and wall materials are also top-ranked in the world.

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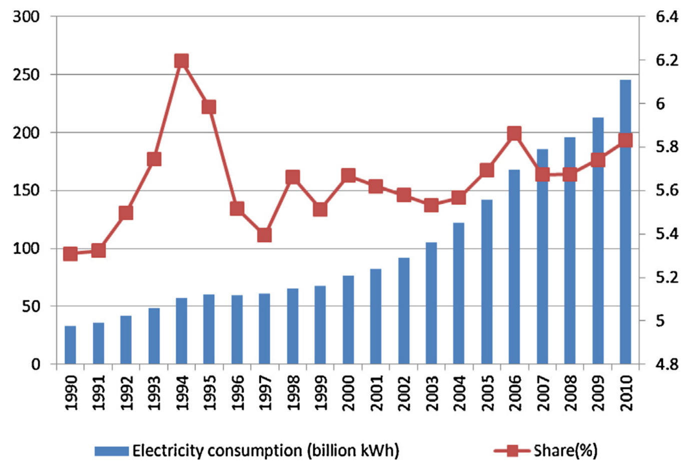

Fig. 1. Electricity consumption of the Chinese building materials industry and its share in national electricity usage (1990–2010). *Source:* CEIC China Database [2].

Similar to the rapid growth in output value, electricity consumption in building materials industry also rose significantly from 22.16 billion kW h in 1985 to 291.79 billion kW h in 2011 [2]; correspondingly, its share in electricity use in manufacturing increased from 7.7% in 1985 to 11.4% in 2011. Fig. 1 shows an increasing trend of electricity consumption in building materials industry. Over the past 20 years, electricity consumption has increased six-fold in building materials industry at an average annual growth rate of over 10 percent. Considering the promotion of urbanization, electricity usage of building materials industry is expected to rise further.

1.2. The importance of determining energy conservation potential

Determining energy conservation potential is the basis for policy making. A number of studies have evaluated energy conservation potential in economic sectors of different countries or regions. IEA [5] estimated an average potential of 19–32% in industrial energy conservation in 2020 by implementing best available techniques (BAT) globally and an additional potential of 20–30% for new technologies. By taking the technical measures for energy efficiency improvement, Graus et al. [6] showed that the global industrial energy conservation potential would be 84% in 2050, and over half of (the conservation of) the measures were cost-effective. Taking technological/economic restrictions into consideration, Eichhammer et al. [7] estimated energy conservation potential in EU member states in 2030. Results indicated that unit energy consumption of glass and cement production could be reduced by 9% and 5%, respectively. Considering technologies of power-saving and heat production, extra energy conservation of EU's building materials industry could amount to 2500 million tons of oil equivalent (Mtoe). Energy audit is an important means of determining energy-saving potential [8]. Taking the technical and economic potentials into consideration, energy consumption per unit of sales revenue of the US manufacturing industry could drop by approximately 66% in 2035 compared to that in 2010 [9].

1.3. The contribution of this study

China has faced severe problems of energy and resource scarcity, environmental pollution and carbon dioxide emissions. Energy efficiency improvement is potentially one of the most important and cost-effective means for cutting energy consumption and mitigating greenhouse gas emissions in the industrial sector [10]. At present, research on electricity conservation potential in building materials industry is scarce. This paper is the first study that explores the major economic variables affecting the sectoral electricity intensity. The major contributions of our study are: first, to the best of our knowledge, this paper fills the research gap by exploring factors that affect electricity intensity of the Chinese building materials industry; second, the evaluation of sectoral electricity conservation is based on the reduction potential of electricity intensity; third, policy implications are suggested for reducing electricity intensity in the building materials industry. To summarize, this study is not only conducive to promoting the sectoral energy conservation and emissions reduction, but also beneficial for the long-term sustainable development of China's building materials industry.

The remainder of this paper is organized as follows. Section 2 presents the literature. Section 3 investigates major influencing factors and describes the methodology. Section 4 offers the econometric analysis and empirical results. Section 5 summarizes findings and suggests policy recommendations.

2. Literature

Exploring industrial energy conservation potential, a crucial step in forming strategies of industrial sustainable development and national emissions reduction, has recently attracted increasing interest from both scholars and decision makers. In this paper, we review the literature from two aspects: first, recent studies on energy conservation potential; second, major factors that affect energy or electricity intensity.

2.1. Recent research on energy conservation potential

Studies on energy conservation potential in building materials industry are mostly focused on the cement industry. By constructing an energy conservation supply curve, Worrell et al. [11] examined the cost-effective energy saving in the US cement industry. Based on the bottom-up electricity Conservation Supply Curve (CSC) model, Hasanbeigi et al. [12] estimated the cost effective and the total technical electricity-efficiency potential for the Thai cement industry. Using the same methodology, Morrow et al. [13] assessed the cumulative cost-effective electricity savings and cost-effective fuel savings during 2010–2030 in India's cement industry. By performing a cost-effectiveness analysis of some of the best available technologies (BAT), Moya et al. [14] evaluated the potential for improvements in energy efficiency in the EU27 cement industry. Madlool et al. [15] and Madlool et al. [16] reviewed previous studies on energy saving in the cement industry.

Several studies analyzed energy conservation potential in China's building materials industry. For instance, Li et al. [17] evaluated energy conservation potential for glass works in China based on energy audit. Hasanbeigi et al. [18] analyzed energy-efficiency opportunities for the cement industry in Shangdong Province. Results showed that the cost-effective electricity efficiency potential and total technical electricity-saving potential accounted for 16% and 40% of total electricity usage in the investigated plants in 2008, respectively. Using bottom-up CSC models, Hasanbeigi et al. [19] estimated the cumulative cost-effective and technical electricity and fuel saving potentials in the Chinese cement industry for 2010–2030. Lin and Ouyang [20] evaluated electricity demand and conservation potential in the Chinese nonmetallic mineral products industry.

2.2. Main factors affecting energy intensity

Energy conservation potential can be measured by the reduction in energy intensity or the improvement of energy utilization efficiency. The economic indicator measuring energy efficiency is energy consumption per unit of GDP or value added [21]. Technology, industrial structure and energy price are considered as the