



The efficiency improvement potential for coal, oil and electricity in China's manufacturing sectors



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ABSTRACT

This paper introduces an improved total-factor ESTR (energy-saving target ratio) index, which combines the sequence technique and the “energy direction” to a DEA (data envelopment analysis) model, in order to measure the possible energy saving potential of a manufacturing sector. Afterward, the energy saving potentials of four different energy carriers, namely coal, gasoline, diesel oil and electricity, for 27 manufacturing sectors during the period of 1998–2011 in China are calculated. The results and its policy implications are as follows: (1) the average ESTRs of coal, gasoline, diesel oil and electricity are 1.714%, 49.939%, 24.465% and 3.487% respectively. Hence, energy saving of manufacturing sectors should put more emphasis on gasoline and diesel oil. (2) The key sectors for gasoline saving is the energy-intensive sectors, while the key sectors for diesel oil saving is the equipment manufacturing sectors. (3) The manufacture of raw chemical materials and chemical products sector not only consumes a large amount of oil, but also has a low efficiency of oil usage. Therefore, it is the key sector for oil saving. (4) Manufacture of tobacco and manufacture of communication equipment, computers and other electronic equipment are the benchmark for the four major energy carriers of energy-saving ratios.

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1. Introduction

Along with China's economic growth, its energy consumption also increases rapidly. In 2011, China consumed about 348 million ton of coal equivalent (tce), which is about 2.56 times than that in 1998, with an average annual growth of 7.56%. Nowadays, China faces challenges to cope with increasing energy demand, supply restraints, huge environmental costs and backward technology. Hence, the government argues that it is urgent for China to take steps to improve energy efficiency and control the growth rate of energy consumption, thereby creating a resource-conservative and environment-friendly society. It can be said that the core of China's energy strategy is to safeguard national energy security by fully implementing energy-saving policies.

At present, China has entered an accelerated period of the industrialization and urbanization. One of the features of this

period is that the energy-intensive manufacturing sectors, such as petrochemical, iron and steel, are playing key roles in economic growth, thus energy demand is increasing quickly. In 2011, the number of manufacturing enterprises accounts for 92.59% of the total industry enterprises, and its assets is about 75.96% of the total industry assets. The gross industrial output values, taxes and other charges on principal business and the employees of manufacturing sectors account for 86.94%, 82.85% and 87.86% of the whole industrial sectors¹ respectively. At the same year (2011), the industry consumed about 70.82% of whole energy usage; while the manufacturing sectors consumed about 81.32% of industrial energy consumption. Therefore, the manufacturing sectors are the main energy consumers, and they are also the key sectors for implementing energy saving policies.

Fig. 1 shows manufacturing sectors consume about 55%–60% of the total energy consumption. In terms of energy carriers, manufacturing sectors consume about 38% and 52% of the total coal and electricity consumption respectively. But their proportions

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¹ It includes (i) mining and quarrying sectors, (ii) manufacturing sectors, and (iii) electric power, gas and water production and supply sectors.

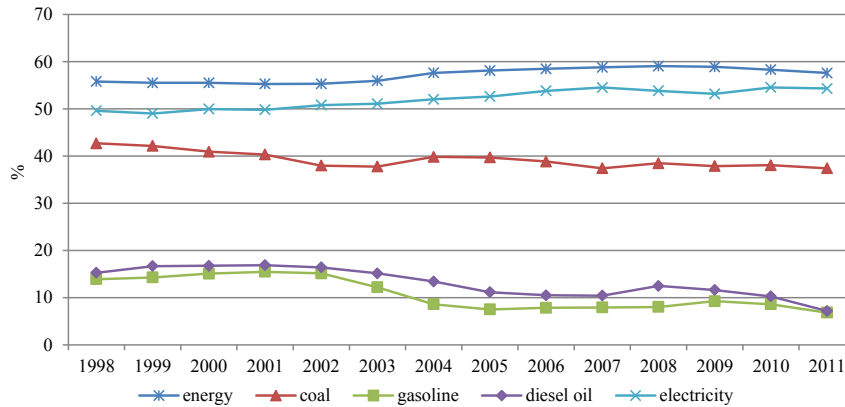


Fig. 1. The proportion of energy usage of manufacturing sectors in China's total energy usage (1998–2011).

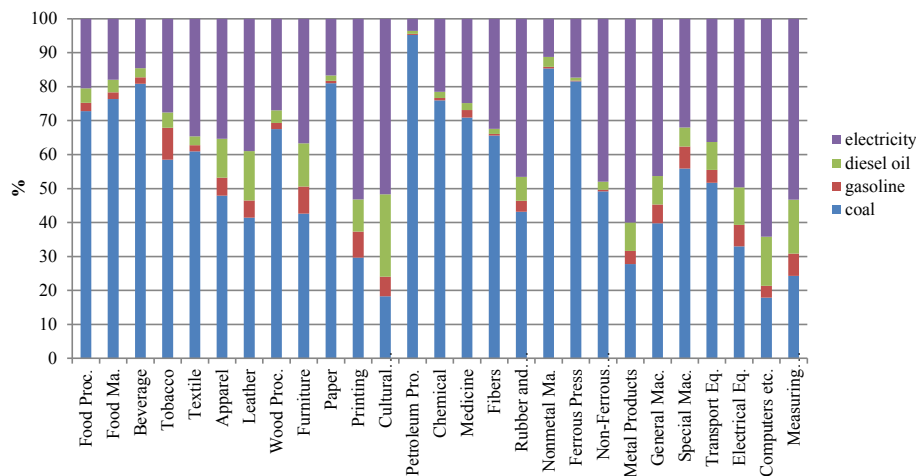


Fig. 2. The average structural of four main energy carriers of China's manufacturing sectors during the period of 1998–2011. Note: The consumption of each energy carrier is transformed to 10^4 tce.

show downward and upward trends respectively. Gasoline and diesel oil consumption in manufacturing sectors account for a small proportion of the total consumption, and both show downward trends.

Fig. 2 shows the average structural of four main energy carriers (coal, gasoline, diesel oil and electricity) of China's manufacturing sectors during the period of 1998–2011. According to it, there are 15 sectors' energy consumption are dominated by coal (it account for more than 50% of four main energy carriers), with the highest is *petroleum pro.*²(95.29%). In addition, four sectors, including *cultural articles*, *metal products*, *computers etc.* and *measuring inst.*, are dominated by electricity.

For energy-saving policy, the Chinese government has put the declining targets of energy intensity (it is defined as energy consumption per unit of Gross Domestic Product) in the national economic development plan, and has adopted the TRS (target responsibility system) for provinces, industries and even energy-intensive units since 2006. Energy intensity has become a core index for China's energy saving policy, and the government expects sustainable development by keeping it at a downward trend.

As a single factor index, changes in the national energy intensity can be attributed to changes in economic structural and energy

intensities of sectors [1]. Energy substitution will also lead to energy intensity changes. Accordingly, in the context of measures designing, the Chinese government pays more attention to technological progress to bring down the energy intensities of energy-intensive sectors/products. Furthermore, the government also accelerates the adjustment and upgrades of the industrial structure in order to improve energy efficiency.

It seems that the Chinese government faces two contradictory targets, namely to maintain economic growth and reduce the growth rate of energy consumption, or even further, to control total energy consumption. In this sense, optimizing the energy consumption structure is conducive to maintaining economic growth under the constraint of total energy consumption control. More importantly, the environmental deterioration is directly related with the massive usage of coal. Thus, it is not enough to only analyze the changes in energy intensity.

According to Figs. 1 and 2, the Chinese government should pay more attention to energy-saving of the manufacturing sectors, but the sectors have different energy consumption structure. Hence, it is important and meaningful to investigate the energy-saving potential of different energy carriers across sectors.

The remainder of this paper is organized as follows. Section 2 is literature review and the main contribution of the current study. Section 3 introduces an improved DEA (data envelopment analysis) model to compute the energy-saving targets. Section 4 cites the empirical results, and section 5 is discussion. The final section concludes the research findings and presents policy implications.

² We use the abbreviated name in italic type to make the text clear and concise. The full name and its abbreviation of each manufacturing sector are provided in Appendix.

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