Characteristics of Energy Consumption in the Process of Regional Economic Integration Development: Beijing-Tianjin-Hebei Economic Belt versus Tokyo-to Metropolitan Area

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Abstract. Energy consumption plays a significant role in the integration process of Beijing-Tianjin-Hebei economic belt. This paper compares energy situation of Beijing-Tianjin-Hebei economic belt and Tokyo-to metropolitan area. The results show there are some differences between Beijing-Tianjin-Hebei economic belt and Tokyo-to metropolitan area: first, the proportion of Beijing-Tianjin-Hebei economic belt in China is lower than the proportion of Tokyo-to metropolitan area in Japan; second, energy intensity of Beijing-Tianjin-Hebei economic belt experiences a trend of descending, while it holds stable in Tokyo-to metropolitan area; third, energy structure of Beijing-Tianjin-Hebei economic belt has a serious reliance on coal, whereas, in Tokyo-to metropolitan area, consumption of oil took the main proportion of energy structure, consumption of renewable energy increasing constantly. Based on our findings, we present some policy implications for energy save in Beijing-Tianjin-Hebei economic belt.

1. Introduction

Regional integration has been a major trend for national scale economies and comparative advantages, both in developed and developing world [1, 2], which tends to have a significant implications for energy consumption [3], such as the work done by Saadi N et al. (2015) [4], proved that under regional cooperation, energy system costs will reduce half. In 2014, China augmented the development of the Beijing-Tianjin-Hebei economic belt and has since been featured it as a national strategy to accelerate and consolidate the country’s economy on a regional basis. A road map is clearly laid out for the programming in the government’s “13th Five-Year Plan” for 2016-2020. Accounting for 10.48% of the national GDP in 2014, the region will play an even greater role in the Chinese economy. At the same time, however, the integration of the regional economy also bear serious consequences on energy consumption, per 10,000 Yuan GDP of Beijing-Tianjin-Hebei economic belt consumed 1.55 Mtce (Million ton coal equivalent) from 1995 to 2013, higher than the national level (1.37Mtce). What would be the energy implications of a fully developed Beijing-Tianjin-Hebei economic belt, which was already responsible for 13.38% of China’s energy use in 2012?

Treating the development of Beijing-Tianjin-Hebei economic belt as a case study, we make reference to the Tokyo-to metropolitan area, an advance regional area in Japan for comparison purposes. Because (1) Tokyo-to metropolitan area, consisted by Tokyo, Saitama, Chiba and Kanagawa, can be treated as the integration region according to its development process [5], meanwhile, Tokyo-to metropolitan area is one of the most developed metropolitan areas in world. (2) Industrial structure of
Tokyo-to metropolitan area is similar to it in Beijing-Tianjin-Hebei economic belt (as shown in table 1). (3) Tokyo-to metropolitan area and Beijing-Tianjin-Hebei economic belt all belong to East Asia, thus they have similar development base and culture in view of their history.

Table 1. Industrial structure inner Beijing-Tianjin-Hebei economic belt and Tokyo-to metropolitan area in 2013(%)

| Area                | Province & Country | Primary Industry | Secondary Industry | Tertiary Industry |
|---------------------|-------------------|------------------|--------------------|-------------------|
| Beijing-Tianjin     | Beijing           | 0.81             | 21.68              | 77.52             |
| Hebei               | Tianjin           | 1.31             | 50.64              | 48.05             |
| Economic belt       | Hebei             | 11.89            | 51.97              | 36.14             |
| Tokyo-to            | Tokyo-to          | 0.06             | 14.14              | 85.80             |
| Metropolitan area   | Chiba             | 1.27             | 41.66              | 57.06             |
|                     | Kanagawa          | 0.23             | 39.11              | 60.66             |
|                     | Saitama           | 0.65             | 42.70              | 56.65             |

There are literatures on energy consumption at the regional integration level, but scholarly attention has been scarce on comparing energy consumption between developing and developed regions. For example, the current research on provincial focus on Beijing, Jiangsu, Guangdong, Tianjin, Yangtze River Delta Region and the 30 provinces of China [6,7]. On national level, the related research focused on developed and developing countries, furthermore, part work paid attention cross multination’s energy consumption, such as the research on South Korean, Mexican, Thailand, Ghana, EU 27countries, east Asia and 186 countries [8, 9, 10]. The research on integration of Japanese only entailed economic development of Shibamoto, other than Tokyo-to metropolitan area and its energy consumption [11].

Our analysis will contribute to fresh insights to existing literatures and assist in formulating energy policies to address emerging issues during regional economic integration. The objectives of this paper mainly focused on the following aspects. (1) Recognize the situation of energy consumption in Beijing-Tianjin-Hebei economic belt and Tokyo-to metropolitan area. (2) Give some suggestions on energy conservation in the integrated process of Beijing-Tianjin-Hebei economic belt based on comparisons made above.

The rest of this paper is organized as follows. Section 2 compares energy consumption characteristics between Beijing-Tianjin-Hebei economic belt and Tokyo-to metropolitan area, and Section 3 gives main conclusions and policy implications that benefit to save energy on the integration development of Beijing-Tianjin-Hebei economic belt.

Data of Beijing-Tianjin-Hebei economic belt is from National Bureau of Statistics of China. Data of Tokyo-to metropolitan area is from Agency for Natural Resources and Energy (NRE) of Japan.

2. Compares between Beijing-Tianjin-Hebei economic belt and Tokyo-to metropolitan area

2.1 Energy amount

Figure 1 shows (a) Energy consumption of Beijing-Tianjin-Hebei economic belt increased constantly from 1995 to 2013. Total amount of energy consumption in this region grew from 11,126 Mtce in 1995 to 33,204 Mtce in 2013. (b)Proportion of energy consumption in this area kept stable in China, which proportion ranges from 8.22% to 9.64%, and this means, to some extent, that energy consumption of Beijing-Tianjin-Hebei economic belt has a remarkable impact to China.
Figure 1. Energy consumption of Beijing-Tianjin-Hebei economic belt and China

Figure 2 indicates (a) changing trend of energy consumption in Tokyo-to metropolitan area was unstable comparing to Beijing-Tianjin-Hebei economic belt from 1995 to 2013. For example, energy consumption of this area grew from 3,146,289 TJ (Terajoule) in 1995 to 3,481,372 TJ in 2007, then it dropped down to 3,261,967 TJ in 2010, while it increased to 3,206,931 TJ in 2013. (b) Proportion of energy consumption in Tokyo-to metropolitan area was higher in Japan comparing to the proportion of Beijing-Tianjin-Hebei economic belt in China. Energy consumption of Tokyo-to metropolitan area in Japan ranged from 21% to 24%, while the level of Beijing-Tianjin-Hebei economic belt under 10%.

2.2 Energy intensity

Figure 3 reports following points. (a) Energy intensity of China, Beijing-Tianjin-Hebei economic belt, Beijing, Tianjin and Hebei experienced a sharp decline from 1995 to 2013. Energy intensity of China, Beijing-Tianjin-Hebei economic belt, Beijing, Tianjin and Hebei were 2.18, 2.83, 2.34, 2.76 and 3.12 Tce (per 10,000 Yuan/ ton coal equivalent) in 1995, respectively, however, they dropped to 0.73, 0.71, 0.35, 0.54 and 1.03 Tce in 2013, respectively. (b) Energy intensity of Beijing-Tianjin-Hebei economic belt was higher comparing to the national level from 1995 to 2013.

Figure 4 illustrates (1) Energy intensity of Tokyo-to, Kanagawa, Saitama and Tokyo-to metropolitan area kept stable from 1995 to 2013, but it experienced a decrease in Japan and Chiba. (2) Energy intensity of Tokyo-to and Saitama were lower comparing to Tokyo-to metropolitan area, while energy intensity of Kanagawa and Chiba were the highest among these areas, specially, energy intensity of Chiba was higher than Japanese level. Mean values of energy intensity in Japan, Tokyo-to metropolitan area, Tokyo-to, Chiba, Kanagawa and Saitama were 30.71 Joule/100Yen, 20.09
Joule/100Yen, 8.51 Joule/100Yen, 63.28 Joule/100Yen, 28.57 Joule/100Yen and 19.48 Joule/100Yen, respectively.

Figures 3. Energy intensity of Beijing-Tianjin-Hebei economic belt

Instruction: For the data limitation of Cabinet office, GDP of Japan from 1995 to 2013 is calculated by the fix price of 2005.

2.3 Energy structure

Figure 5 shows energy structure in China, Beijing-Tianjin-Hebei economic belt, Beijing, Tianjin and Hebei in 1995 and 2013. By comparison, we found (a) fuel structure of Beijing-Tianjin-Hebei economic belt is superior than Chinese level, and fuel structure of above two areas are becoming more and more reasonable during this period. Proportions of coal, petroleum, natural gas, electricity and others in Beijing-Tianjin-Hebei economic belt were 62.5%, 19.8%, 1.4%, 10.9% and 5.5% in 1995, respectively, while the proportion of China was 74.6%, 17.5%, 1.8%, 6.1% and 6.1% in 1995, respectively. In 2013, energy mix of Beijing-Tianjin-Hebei economic belt changed to 38.2%, 25.2%, 7.9%, 18.3% and 10.4%, respectively, while the level of China was 67.4%, 17.1%, 5.3%, 7.7% and 10.2%, respectively. (b) There exists a giant difference inner Beijing-Tianjin-Hebei economic belt on fuel consumption, especially, fuel structure of Beijing is superior than it in Tianjin and Hebei. In 2013, proportions of coal, petroleum and natural gas in Beijing were 12.6%, 40.4% and 13.9%, respectively; while, in Tianjin, they were 34.3%, 26.8% and 8.1%; in Hebei, the proportions were 67.7%, 8.5% and 1.6%, respectively.
Figures 5. Energy structure of Beijing-Tianjin-Hebei economic belt

Figure 6 indicates (a) energy structure of Tokyo-to, Chiba, Saitama, Kanagawa, Tokyo-to metropolitan area and Japan is mainly consisted of oil, electricity and town gas from 1995 to 2013. In 1995, the proportion of above three fuels accounted 98.77% in Tokyo-to, 78.09% in Chiba, 92.09% in Saitama, 88.91% in Kanagawa, 87.65% in Tokyo-to metropolitan area and 80.77% in Japan; In 2013, the proportion occupied 97.97% in Tokyo-to, 76.47% in Chiba, 95.96% in Saitama, 89.68 in Kanagawa, 87.99% in Tokyo-to metropolitan area and 81.40% in Japan. (b) Fuel structure of Tokyo-to is the most reasonable one comparing to Chiba. Do the proportions of coal and natural gas as the samples to explain, the proportions of coal and natural gas in Tokyo-to were 0.03% and 37.16% in 2013, respectively; but in Chiba the proportions were 16.96% and 13.92% in 2013, respectively.

Figures 6. Energy structure of Tokyo-to metropolitan area

3. Conclusions and policy implications

3.1 Conclusions

Energy consumption plays a significant role in the integration process of Beijing-Tianjin-Hebei economic belt. This paper compares energy situation of Beijing-Tianjin-Hebei economic belt and Tokyo-to metropolitan area from 1995 to 2013. Based on above analysis, we can draw some conclusions:

(1) Energy consumption in above two regions all keeps a stable proportion in either national levels, respectively, but the proportion of Beijing-Tianjin-Hebei economic belt in China is lower than the proportion of Tokyo-to metropolitan area in Japan.

(2) Energy intensity of Beijing-Tianjin-Hebei economic belt experiences a trend of descending, while it holds stable in Tokyo-to metropolitan area.

(3) Energy structure of Beijing-Tianjin-Hebei economic belt has a serious reliance on coal, and renewable energy was not used in large-scale; whereas, in Tokyo-to metropolitan area, consumption of
oil took the main proportion of energy structure, the consumption of renewable energy is increasing constantly, and consumption of coal was little.

3.2 Policy implications

Based on our findings, we present following policy implications for energy save in Beijing-Tianjin-Hebei economic belt.

(1) Practice of Tokyo-to metropolitan area vividly explains industrial structure adjustment can reduce energy consumption powerfully. So Beijing-Tianjin-Hebei economic belt, especially, Tianjin and Hebei could develop tertiary industry to substitute the dependence of secondary industry. Development of Tokyo-to metropolitan area illustrates energy consumption caused by tertiary industry cannot be neglected, so Beijing should optimize tertiary industry, such as develop green-tour route, and encourage public transportation.

(2) The experience of Tokyo-to metropolitan area tells that Beijing-Tianjin-Hebei economic belt can reduce energy intensity of secondary industry as the break through on reducing energy consumption.

(3) Comparing to Tokyo-to metropolitan area, fuel structure of Beijing-Tianjin-Hebei economic belt is unreasonable. So in the future, cleaner energy should be encouraged in order to reduce dependence on coal in the region, especially in Hebei.

Acknowledgments
This study is supported by Beijing Natural Science Foundation (9172001) and "18 connotation development -resource, environment and circular economy" project (033000514118003).

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