Analysis of Energy Intensity of Basic Materials Industry in Japan

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Abstract

Based on various statistics, this paper empirically investigated energy intensity of iron and steel, non-ferrous metals, and cement sectors in Japan. We estimated the production volume, energy intensity, and energy consumption for the three sectors. The results reveal that energy consumption tended to decline, and the decrease in production amount in both three sectors was observed. While the energy intensity of the steel sector was improving, the energy intensity of non-ferrous metals and cement sectors was deteriorating. In the cement sector, expanding the use of wet waste and by-products affected the trend in energy intensity. Capacity factor also had a large impact on energy intensity. Energy intensity is one of the key indicators for climate mitigation and we have to recognize that not only internal efforts but also external factors affect the consequence of energy intensity.

Keywords: Energy intensity, basic materials industry, iron and steel sector, cement sector, non-ferrous metals sector.

1. Introduction

Although climate change is a long-term problem, it is important to understand the current situation in order to respond to the question of what policy measures should be taken now from a shorter-term perspective. It is important to understand how and why the energy consumption has changed in energy-intensive industries.

Based on the above problem awareness, this paper focuses on energy intensity (GJ/t) of basic materials industry in Japan. The subjects of analysis are iron and steel, non-ferrous metals, and cement sectors. The analysis period is mainly from 2000 to 2016. As shown in Fig. 1, the energy consumption of the Japanese industrial sector is on a downward trend. The aim of this paper is to clarify whether the trend is mainly a production factor or an energy intensity factor.

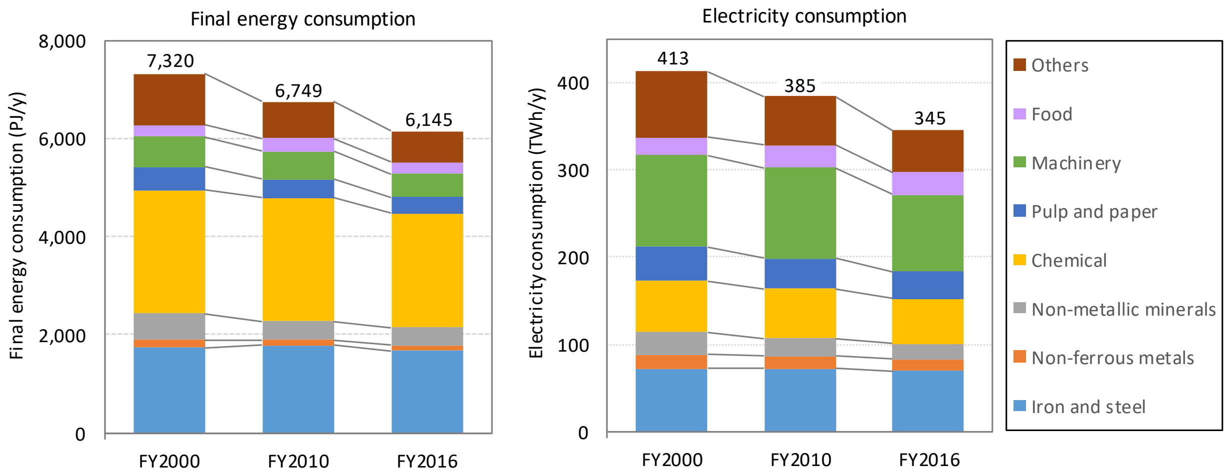

Fig. 1. Industrial sector energy consumption in Japan
Source: METI (2017a)

2. Methods

In terms of energy consumption data, we referred to METI (2017a, b). Energy intensity (GJ/t) is calculated by dividing energy consumption by production volume. In terms of production data, we referred to Japanese government statistics, e.g., METI (2017c), and other domestic statistics e.g., Cement Press (2017), and JISF (2017).

We also estimated yearly capacity factor and its impact on energy intensity in iron and steel, and cement sectors based on Oda et al. (2016).

3. Results

3.1 Iron and steel sector

Fig. 2 shows the results of iron and steel sector in Japan. The estimates (red line) partially explain the primary energy intensity trajectory (black line) from 2000 to 2017. The estimates consist of three factors: hot metal ratio (x_1), steel product mix (x_2), and capacity factor (x_3). Fig. 2 reveals that capacity factor had a large impact on energy intensity in the short term, for example, the change from 2008 to 2009, which makes it more difficult to detect long-term trends in energy intensity.

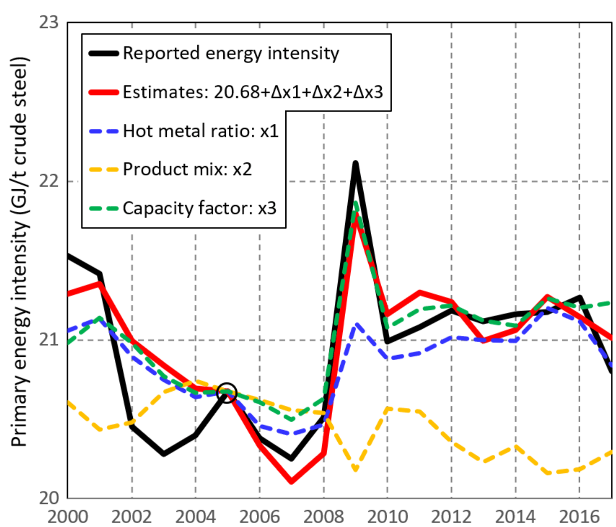

Fig. 2. Results of energy intensity of iron and steel sector in Japan (base year: 2005)

3.2 Cement sector

Fig. 3 indicates the results of cement sector in Japan. The estimates partially explain the primary energy intensity trajectory from 2000 to 2017. The estimates consist of three factors: clinker to cement ratio (y_1), waste and by-products (y_2), and capacity factor (y_3). Expanding the use of (wet) waste and by-products significantly affects the energy intensity, and the energy intensity of cement sector was deteriorating after 2005.

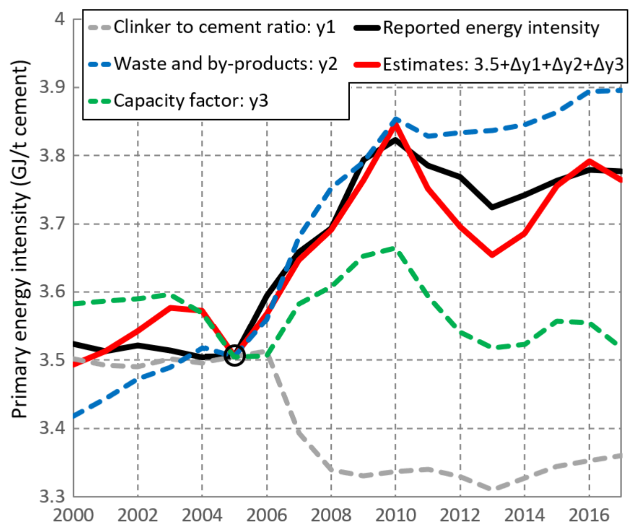

Fig. 3. Results of energy intensity of cement sector in Japan (base year: 2005)

3.3 Non-ferrous metals sector

We are able to collect annual data for the iron and steel and cement sectors, but it is not easy to obtain annual data for the non-ferrous metals sector. We simply compare fiscal 2010 and fiscal 2016 for the non-ferrous metals sector.

Fig. 4 shows the production volumes in the non-ferrous metals sector, which is calculated by METI (2017c). Fig. 5 shows the assumed final energy intensity based on Japan Mining Industry Association (2017), etc. The sum of the product of Fig. 4 and Fig. 5 means the final energy consumption (as a reference value) of the non-ferrous metals sector, which is shown in Table 1. The final energy consumption of FY2016 was -14% of FY2010 level, which means that the production level (weighted average for non-ferrous metals sector by final energy consumption) was -14%. The statistics final energy consumption, listed in Table 1 bottom, was changed by -9%. That implies that the final energy intensity was deteriorating by 5% in in the past 6 years. Capacity factor is decreasing from 100 in FY2010 to 86 in FY2016, that is a factor of the deterioration of energy intensity in non-ferrous metals sector in Japan.

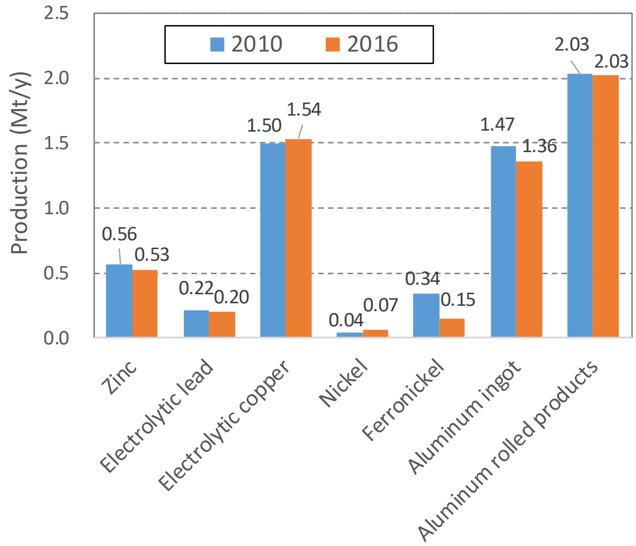

Fig. 4. Production of non-ferrous metals in Japan

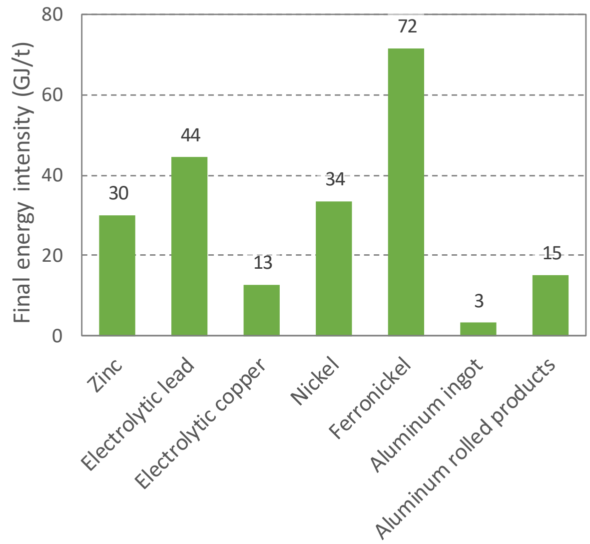

Fig. 5. Assumed energy intensity of non-ferrous metals in Japan

Table 1. Final energy consumption in non-ferrous metals sector in Japan

	FY2010	FY2016	(FY2016/FY2010)-1
Sum of the product of Fig. 4 and Fig. 5	107 PJ	92 PJ	-14%
Statistics (METI, 2017a)	116 PJ	106 PJ	-9%

4. Conclusions

Based on various statistics, this paper empirically investigated energy intensity of iron and steel, non-ferrous metals, and cement sectors in Japan, and quantitatively and qualitatively examined the fluctuation factors of energy consumption. Table 2 summarizes the production volume, energy intensity, and energy consumption for the three sectors. As shown in Fig. 1, energy consumption tended to decline, and the decrease in production amount in both three sectors was observed. While the energy intensity of the steel sector was improving, the energy intensity of non-ferrous metals and cement sectors was deteriorating. In the cement sector, expanding the use of wet waste and by-products affected the trend in energy intensity. Capacity factor also had a large impact on energy intensity.

Table 2. Summary of iron and steel, non-ferrous metals, and cement sectors in Japan

	Production volume	Energy intensity	Energy consumption
Iron and steel (from 2000 to 2016)	-1.6%	-1.2%	-2.8%
Non-ferrous metals (from 2010 to 2016)	-14%	+5%	-9%
Cement (from 2000 to 2016)	-29.2%	+7.2%	-24.1%

Note) In non-ferrous metals sector, production volume and energy intensity mean a weighted average of the final energy consumption of each product (zinc, electrolytic lead, electrolytic copper, nickel, ferronickel, aluminum ingot, and aluminum rolled products).

The results obtained above would be valuable basic information for discussion of further energy intensity improvement and CO_2 emissions reduction in these sectors. Energy intensity is one of the key indicators for climate mitigation and we have to recognize that not only internal efforts but also external factors affect the consequence of energy intensity. Further analysis including other sectors, and international comparisons remains as future work.

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