

Research on effect of China's energy saving policy of phase-out incandescent lamps

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Abstract. China's energy saving policy of phase-out of incandescent lamps have been introduced and a comprehensive evaluation framework has been put forward. The impact of the implementation of the policy on manufacturing enterprises and places of sale, lighting industry and domestic and foreign markets, as well as the effect of energy conservation and emission reduction have been analyzed from micro, meso and macro layers. The research results show that, under the guidance of the policy, the orderly product mix transformation has been seen in incandescent lamp manufacturing enterprises, incandescent lamps gradually exit the Chinese mainstream lighting product market, and the energy conservation and emission reduction effect is remarkable.

1. Introduction

Since lighting consumption accounted for about 12% of the whole society's total electricity consumption, it is of great significance to phase-out incandescent lamps and promote the implementation of high efficiency lighting products in order to promote the optimization and upgrading of China's lighting electrical appliance industry, implement requirements of energy saving and emission reduction.

On November 4, 2011, the Chinese government issued the China's Roadmap for the Phase-out of Incandescent Lamps^{[1][2]}. (hereinafter referred to as the "roadmap"), announcing the prohibition of the import and sale of incandescent lamps for general lighting services in terms of power step by step from October 1, 2012. Step 1: The period from November 1, 2011 to September 30, 2012 will be reserved as a period of preparation for the transition; Step 2: Prohibition of the sale and import of incandescent lamps ($\geq 100W$) for general lighting services from October 1, 2012; Step 3: Prohibition of the sale and import of incandescent lamps ($\geq 60W$) for general lighting services from October 1, 2014; and Step 4: The period from October 1, 2015 to September 30, 2016 will be reserved for interim evaluation, during which, the previous policies will be evaluated and follow-up ones adjusted.

2. Framework of evaluation

The framework of evaluation from low, middle and upper layers was proposed to analyse and evaluate the implementation of the phase-out incandescent lamps policy's impact on manufacturing enterprises and sales markets, lighting industry and domestic and foreign markets, as well as economic benefit and energy saving and emission reduction, etc.

3. Analysis of effect



3.1. Impact on enterprises

Incandescent lamps enterprises began to adjust their products structure under the guidance of energy saving policy of the phase-out of incandescent lamps.^{[3][4]} Figure 1 shows the share of annual output, export and domestic sales of sample enterprises from 2011 to 2014.

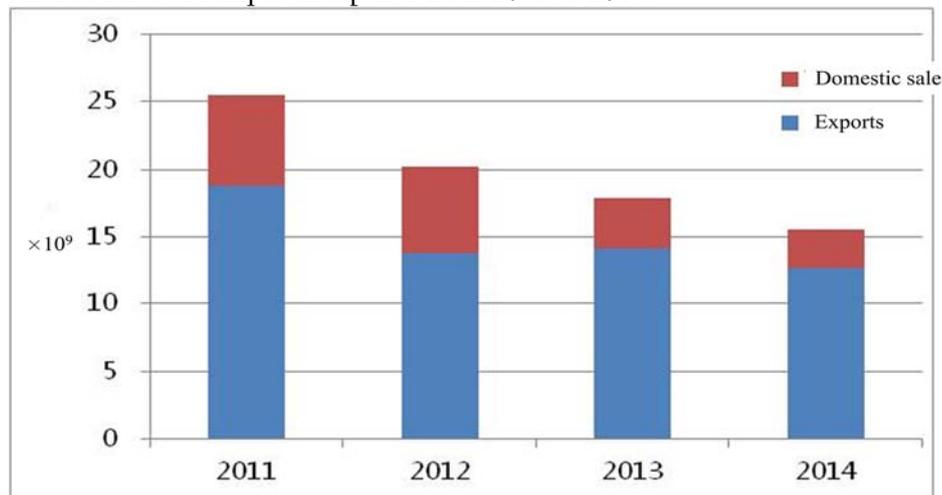


Fig.1 Annual outputs, exports and domestic sales of sample enterprises from 2011 to 2014

As seen in Fig.(1), sample enterprise produced a total of 2.55 billion incandescent lamps in 2011 and 1.55 billion in 2014, with a reduction of 1 billion, falling nearly 39%. Export proportion increased to 81.0% in 2014 from 73.8% in 2011 while domestic proportion decreased to 19.0% in 2014 from 26.2% in 2011. It means that domestic incandescent lamp market has been compressing gradually under the guidance of the policy of the phase-out incandescent lamps and popularizing high efficiency lamps.

Phasing out incandescent lamps by power or luminous flux are two ways usually employed at home and abroad. China's phasing out of incandescent lamps is carried out by power and is divided into three steps. Figure 2 shows changes of incandescent lamp domestic sales of various power of sample enterprises.

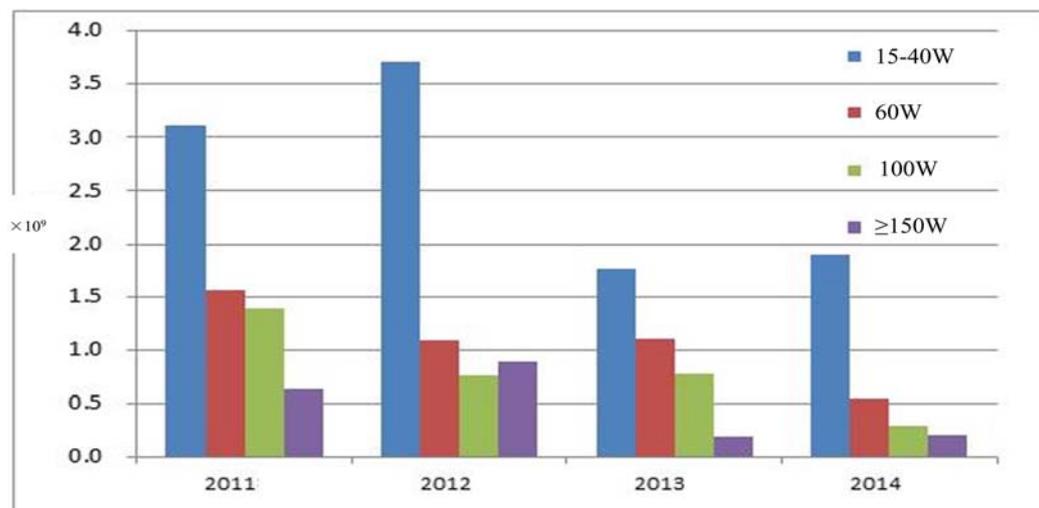


Fig.2 Changes in incandescent lamp domestic sales of various power of sample enterprises

As seen in Figure 2, not only the total output of incandescent lamps of sample enterprises decreased year by year, but also the specification structure changed. The total output of incandescent lamps(<40W) decreased by nearly 39%, incandescent lamps of 60W decreased by nearly 64.7%,

incandescent lamps of 100W decreased by nearly 79% and incandescent lamps($\geq 150W$) decreased by nearly 66.8% in 2011 from 2014.

3.2. Impact on lighting industry

China is a big country of producing lighting appliance in the world whose output can not only meet the domestic market's need, but also export to more than 170 countries.^[3]

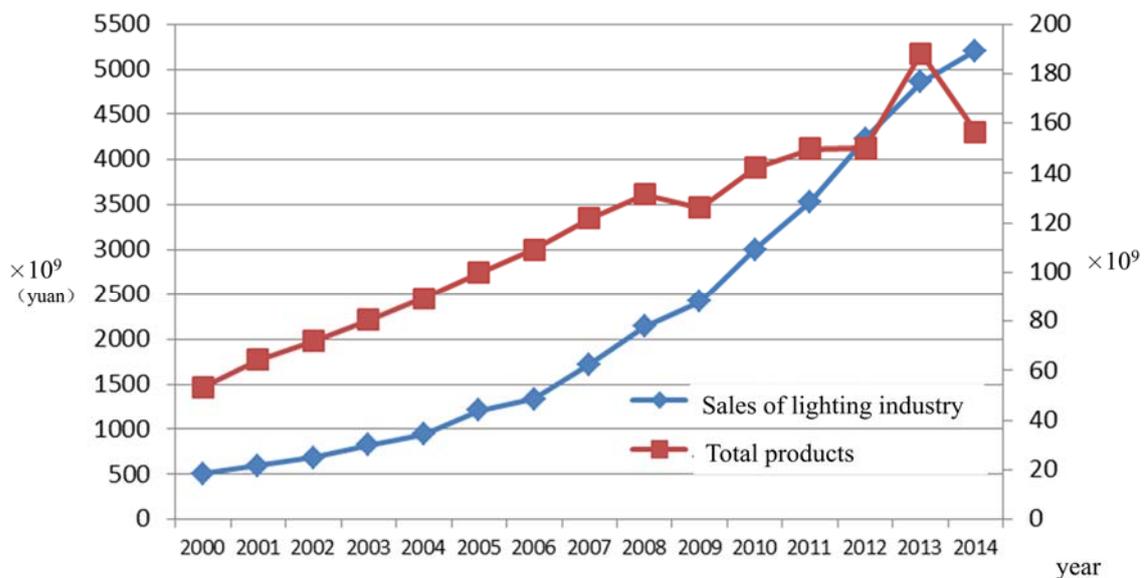


Fig.3 Changes in sales and products of the lighting industry

Figure 3 shows changes of total sales and output of China's lighting appliance industry. As seen in Figure 3, the output of lighting products increased by 192.4% from 2000 to 2014. As the implementation of Roadmap, sales of incandescent lamps decreased sharply, especially in 2014 when total sales volume of lighting industry decreased by nearly 17%, while the value of sales increased by 7.1% from 2013.

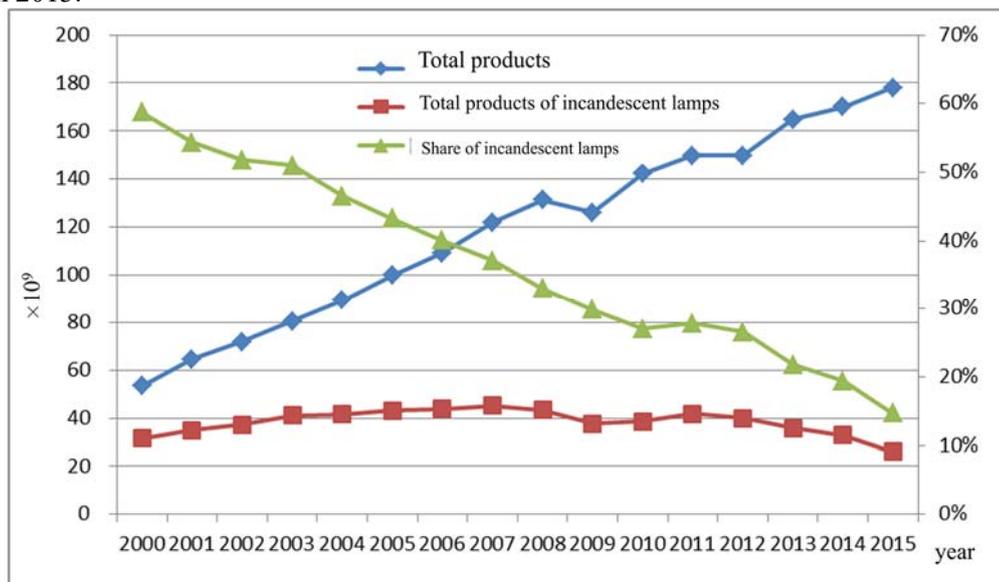


Fig.4 Share of incandescent lamp production in electric light source products

Figure 4 shows the changes of proportion that incandescent lamps occupied of the total output of electric lighting source products. As seen in Figure 4, it was a long course for China to phase out incandescent lamps. The total output of electric lighting products kept a general upward trend since

2000 with an average annual growth rate of 8.5%. Output of incandescent lamps increased slowly from 2000 to 2007 with an average annual growth rate of 5.4%, while declined with an average annual growth rate of -6.3%. The share incandescent lamps occupied of electric lighting products dropped continuously with the shape of the total electric source lighting products fell from nearly 58.7% in 2000 to 14.7% in 2015. It suggests that the share of incandescent lamps was occupied by other electric source lighting products rather than increased with the enlarging of electric source lighting market.

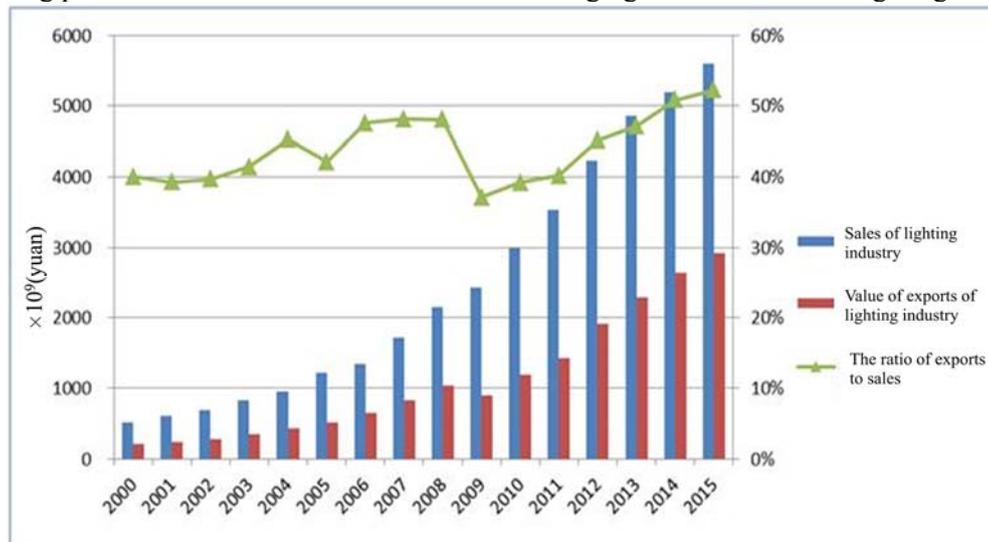


Fig.5 The value of total sale and exports of lighting industry

China is the biggest export country of incandescent lamps and self-ballasted fluorescent lamps owe to the price advantage^[5]. Figure 5 shows the changes of the value of the total sale and exports of lighting industry. As seen in Figure 5, the sale value of China's lighting industry kept a rapid upward trend with an average annual growth rate of 17.5% from 2000 to 2015 except for a little decline of export in 2009. The export sale hit the peak with a proportion of 52.2% of total industry in 2015. Meanwhile, as the implementation of phase out incandescent lamps policy, the shape that the exports of incandescent lamps occupied of the whole lighting industry got smaller and smaller (1.8% in 2011). It suggests that incandescent lamps contributed smaller and smaller to lighting industry. Phasing out incandescent lamps prompt the economic growth of lighting industry significantly since incandescent lamps are generally replaced by self-ballast fluorescent lamps and LED lighting products^[6].

3.3. Effectiveness on energy conservation and emission reduction

The annual average weighted power of incandescent lamps of various specification of sample enterprises shall be calculated by setting the proportion of incandescent lamps of each power occupied of total domestic sales as the weight value. The weighted power is calculated by formula (1).

$$W_q = \sum_{i=1}^n Q_i \times W_i \quad (1)$$

In the formula (1):

W_q--weighted power;

Q_i-- the weighted value of the i-numbered incandescent lamp of domestic sale

W_i--the value of the i-numbered incandescent lamp of domestic sale

The annual average weighted power of incandescent lamps of domestic sale is 63.2W in 2011, 52.4W in 2014 according to formula (1). According to specification standards, incandescent lamps can be divided into 15W, 25W, 40W, 60W, 75W, 100W, 150W, 200W, etc. Figure 6 shows the relationship between the power and luminous flux of incandescent lamps.

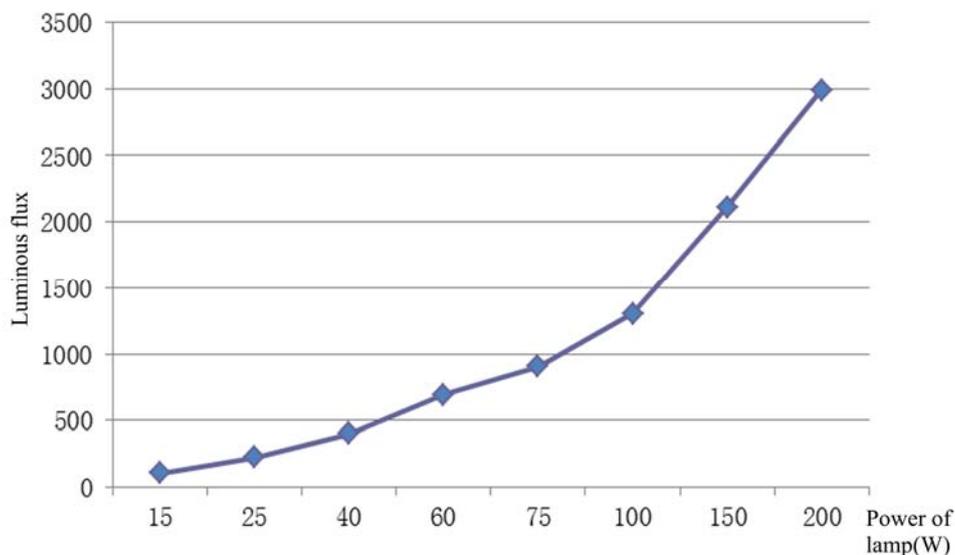


Fig.6 The power and luminous flux of incandescent lamps

The annual average weighted power of incandescent lamps are between 60W and 75W in 2011, while between 40W and 60W in 2014. The luminous flux of those two incandescent lamps of the weighted power are calculated through difference value method. The results are: luminous flux is 747.2lm when weighted power is 63.2W, luminous flux is 581.9lm when weighted power is 52.4W. Incandescent lamps of 63.2W and 52.4W (weighted power) can be replaced by self-ballasted fluorescent lamps of 12W and 10W separately, according to luminous efficacy of self-ballasted fluorescent lamp of energy efficiency grade 2^[7-9].

51.2W could be saved by replacing an incandescent lamp using a self-ballasted fluorescent lamp in 2011, and 42.4W in 2014. The domestic sales decreased by 81 million from 2010 to 2011, 50 million from 2011 to 2014. Energy saving of 5.18 billion kWh and power cost saving of 3.108 billion yuan have been realized in 2011, and energy saving of 26.46million kWh and power cost saving of 15.88 billion yuan in 2014. It was calculated that 2.912 million tonnes of carbon dioxide emission reductions, 6 thousand tonnes of sulphur dioxide emission reductions, 6 thousand tonnes of nitrogen oxide emission reduction have been realized in 2011, and 14.851million tonnes of carbon dioxide emission reductions, 31 thousand tonnes of sulphur dioxide emission reductions, 31 thousand tonnes of nitrogen oxide emission reduction in 2014.

4. Conclusion

Evaluation framework of effect of Roadmap has been put forward, according to which impact on enterprises, industry as well as effect of energy saving and emission reduction have been evaluated. It's suggested to encourage the usage and production of high efficiency lighting products to achieve the goal of phase out incandescent lamps policy through the guidance and implementation of policies, laws and regulations.

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