A long-term scenarios analysis on LEDs general lighting in China

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Abstract
Based on survey of China's lighting products market and estimation of trends of LEDs technical innovation of general lighting, the paper has established a model to analyze the impacts on China's future lighting market and energy efficiency potential as LEDs appear to be a next generation of general lighting source. By doing scenarios analysis, the results of this study indicated that only 1 % of LEDS contribution rate to the lighting market will be realized by 2018, while up to nearly 2.5 % by 2020 under the baseline scenarios; for technology-breakthrough scenarios, 1 % of LEDS contribution rate will be realized by 2015, increase to 14 % by 2020; while under the price-breakthrough scenarios, LEDS will constitute 1% contribution rate to the general lighting market by 2013, two years earlier in comparison, due to the decreased price, the market penetration process will speed up and by 2015 and 2020 the contribution rate of LEDs to general lighting market will increase to 9 % and 69 % respectively. Meanwhile, the electricity saving effects of LEDS with regard to general lighting field will show up approximately by 2013, with electricity consumption increase from over 180 billion kilowatt for general lighting of 2002 to 251.3 billion kilowatt in 2020 under baseline scenario; while under the technology-breakthrough scenario, the consumption for lighting of 2020 will be 234.1 billion kilowatt, under price-breakthrough scenario, the figure will drop to 154.2 billion kilowatt instead. Therefore, in 2020 there will be an energy saving possibility of 17.2 billion kilowatt with regard to the technology-breakthrough scenario; meanwhile the price-breakthrough solution in comparison with the baseline has a considerable energy saving potential over 97 billion kilowatt.

Introduction
People are expecting the historical breakthrough of LEDs general lighting technology and wondering where shall LEDs general lighting technology head for in the future? What kind of course shall this historical revolution undergo? What impact shall it bring up on Chinese lighting market and demand? To answer these questions, the author of this paper is going to conduct a systematic analysis of the development of LEDs general lighting technology and the market penetration process of the product by drawing on the experience of foreign countries. By building forecast model, the author will conduct a quantitative analysis and forecast with regard to the impact of the LEDs lighting technology upon the general lighting market of China in the future and the energy saving effect of such lighting technology.

The Development of LEDS General Lighting Technology
By consulting LEDs lighting experts and relevant forecasting data in relation to LEDs lighting technology innovation, the author of this paper selected three LEDs technology development scenarios. The first one is baseline scenario according to which LEDS technology advances slowly without making any substantial breakthrough; while the second is a technology-breakthrough scenario based on the basic solution, assuming that there is a leap in the development of LEDS lighting technology; the third is of a price-breakthrough scenario based

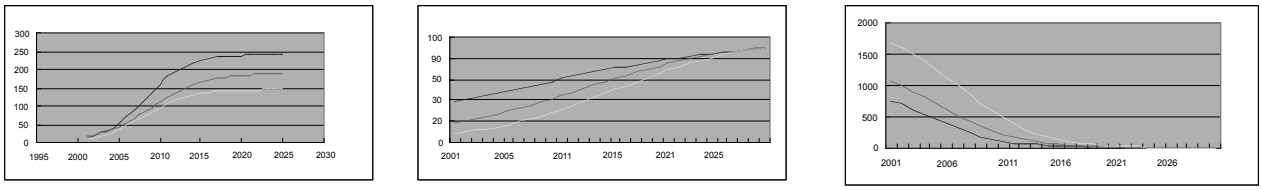

Figure 1. Luminous Efficacy, Lifetime, and per Luminous Price Curves for Baseline Scenarios.

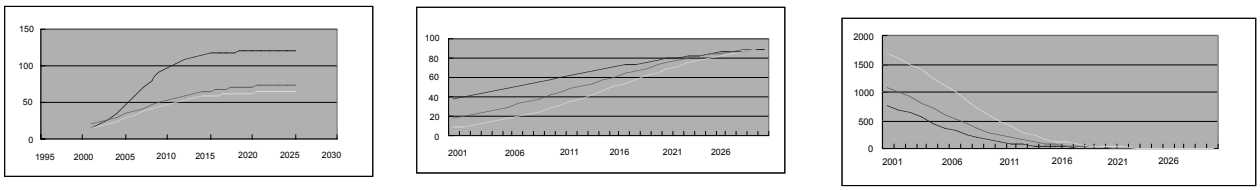

Figure 2. Luminous Efficacy, Lifetime, and per Luminous Price Curves for Tech-breakthrough Scenarios.

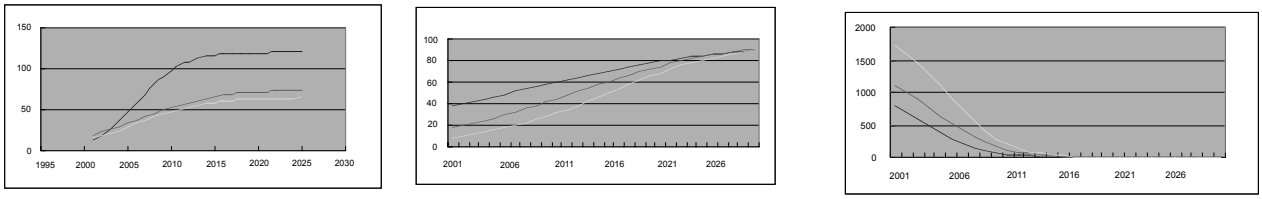

Figure 3. Luminous Efficacy, Lifetime, and per Luminous Price Curves for Price-breakthrough Scenarios.

on the technology-breakthrough solution, indicating besides the tremendous improvement of light efficacy achieved by the LEDs technology, the price of which also goes down significantly. Figure 1 through figure 3 represent the changing curves of LEDs luminous efficacy, lifetime, and per luminous price (US dollar/luminous) in three difference scenarios calculated by application of Pearl-curve of technical innovation analysis. In below three figures, the blue, yellow and pink line is respectively represented low and moderate and high colour rendering LEDs general lighting source.

Simulation Analysis of LEDs Entrance into General Lighting Market

ANALYSIS OF CHINA'S LIGHTING PRODUCT REPLACEMENT PROCESS

In order to understand the inherent development of China's general lighting market and its products replacement process, this study has presented an expectation curve of different customers (see figure 4) in purchasing high-efficient lighting products in accordance with the investigation conducted by virtue of random sampling in China's eight provinces. From the curve we can make sense of the Chinese consumers' preference and consuming behaviours with regard to high efficient lighting products.

HYPOTHESES

This study hypothesizes that the tradition light-source technology has become fully mature with narrowed space for further development, and it is also hypothesized that the market rule of lighting replacement is strictly observing pure economical rules herein, i.e. replacement by minimum overall life-cycle cost, which means the replacement of one product by another will depend on period of investment recovery period (the replacement products with the least investment recovery period will ultimately occupy the market). In accordance with the follow-on investigation of lighting market and lighting product usage conditions in recent years, it is found out that nearly one third of the lighting product stock volume is to be replaced or renewed.

METHODOLOGY OF SIMULATION OF PRODUCT REPLACEMENT

For existing lighting products replacement, we suppose there are two situations, in the first situation, the replacement process is mainly about unitary product, that means there is only one alternative products for replacement. Generally speaking, new lighting products may have a comparatively higher initial cost, but a much lower application cost (lower consumption of energy). Therefore, given equivalent luminous flux, new products are likely stand out with even lower gross cost (initial investment amortization plus operating cost). In this case, the method for replacement simulation is to calculate the investment recovery period in respect of the replacement of traditional products by new ones. According to the length of investment payback period, the corresponding market renewal proportion can be calculated by consulting data of figure 4. In the second situation, when there are many alternative products in the same market segment, as well as many new entrants thereto, the process of products competition and replacement may appear a bit more complex, but the calculation hereof shall still follow the single model based pure economic comparison and replacement principle, except for multiple comparison and replacement process with regard to the products each by each.

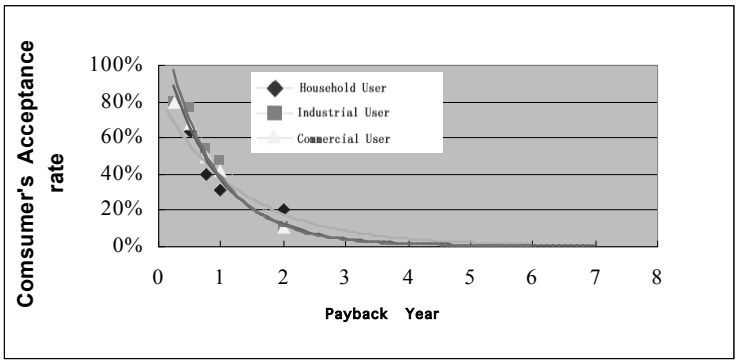

Figure 4. Consumers' Expectation on Investment Payback Period for Lighting Products.

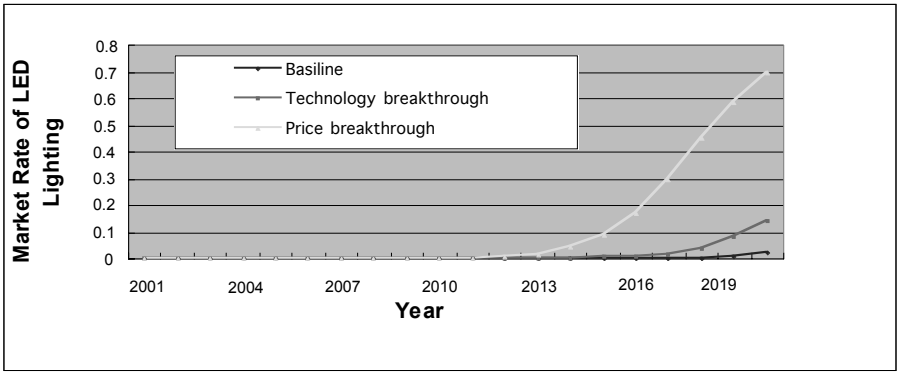

Figure 5. LEDs Market Rate in China's Future Lighting Market.

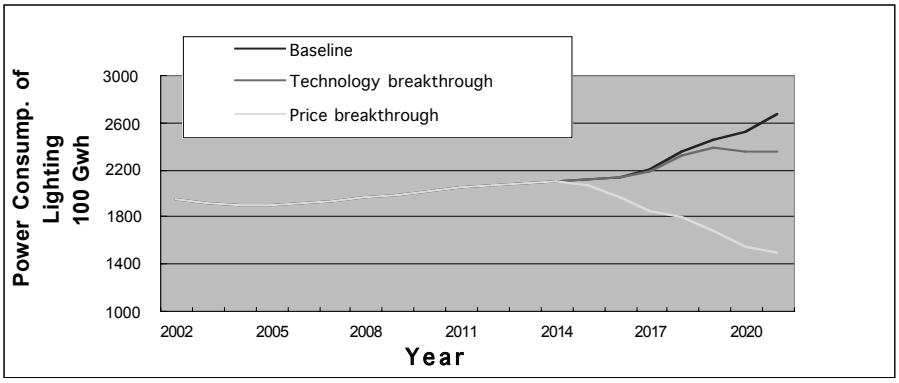

Figure 6. Electricity Saving Potential by LEDs General Lighting in China.

SIMULATION OUTCOME

In accordance with the simulation calculation, here we only present two results of this study; one is the LEDs contribution rate of China's future domestic demand of general lighting sector under three scenarios the other is about the amounts of domestic electricity consumption of lighting of same scenarios (See figure 5 and 6)

Conclusions

Form above two results, this paper will come to the following two conclusions:

The first, if LEDs technology keeps on moving forward in a business as usual way, then it will take a long time for LEDs to enter general lighting market. In this case, it is estimated that only 1 % of LEDs contribution rate to the lighting market will be realized by 2018, while up to nearly 2.5 % by 2020 under the baseline scenarios; for technology-breakthrough scenarios, 1 % of LEDs contribution rate will be realized by 2015, increase to 14 % by 2020; while under the price-breakthrough scenarios,

LEDS will constitute 1% contribution rate to the general lighting market by 2013, two years earlier in comparison, due to the decreased price, the market penetration process will speed up and by 2015 and 2020 the contribution rate of LEDs to general lighting market will increase to 9 % and 69 % respectively.

The second, as it is indicated in the simulation analysis, the electricity saving effects of LEDs with regard to general lighting field will show up approximately by 2013, with electricity consumption increase from over 180 billion kilowatt for general lighting of 2002 to 251.3 billion kilowatt in 2020 under baseline scenario; while under the technology-breakthrough scenario, the consumption for lighting of 2020 will be 234.1 billion kilowatt, under price-breakthrough scenario, the figure will drop to 154.2 billion kilowatt instead. Therefore, in 2020 there will be an energy saving possibility of 17.2 billion kilowatt with regard to the technology-breakthrough scenario; meanwhile the price-breakthrough solution in comparison with the baseline has a considerable energy saving potential over 97 billion kilowatt.

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