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Energy efficient lighting as a transition from incandescent lamps to light-emitting diode solutions

Energy efficiency and energy saving are the national objectives set by the President of the Russian Federation Dmitry A. Medvedev. One of the lines of state policy is application of energy saving technologies to lighting. In this regard, the article analyzes the phased measures taken to replace incandescent lamps with energy efficient lamps, including the national development of the energy effective substitutes and the use of technical regulation mechanisms and quality control of the products delivered to the market.

Energy efficiency, energy saving, incandescent lamp, compact fluorescent lamp, light-emitting diodes, marking.

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It is inconceivable that there is no artificial lighting in the life of modern people. A wide range of the optical sources of artificial lighting, developed and manufactured by different companies, helps us to be more independent of natural lighting. In order to achieve ophthalmic comfort it is necessary to sustain a lot of lighting parameters such as optimal luminance, minimal dazzle, specified brightness distribution, good color rendering. Energy efficient healthy light keeps our safety and comfort, preserves our health, improves labour productivity and raises the level of crop yield and livestock products. It also reduces the consumption of natural resources and lowers fatigability and loss of vision. Today energy efficient lighting is a system that produces high-quality lighting and keeps its characteristics over a long period of time at low costs for energy consumption and low capital acquisition expenditures on electrical equipment. At the same time, energy saving shouldn't be pursued by the reduction in lighting standards because the losses caused by the deterioration of light conditions exceed the cost of saving energy.

Nowadays, according to various sources, about 110 billion kW·h of electricity are used for lighting in Russia. They amount to 20% of electricity output. Virtually, lighting is a major single-type consumer of electricity. Light energy unit is produced at the expense of electricity, which is increased by 1.3 – 1.4 times in Russia as compared with advanced nations. The provision of people in Russia with lighting is 3.5 – 4 times lower than in the U.S., Japan and leading European countries. Therefore, energy efficient lighting is an important component of Russian energy saving policy. In Russia, like in many developed countries, the lighting equipment market is moving towards the production of energy saving light sources and replacement of inefficient light sources by them.

In this regard, it will be possible to achieve a great result such as 34 billion kW·h of saving energy per year in 5 – 6 years if a necessary range of modern energy saving light sources corresponding to technical features are used extensively. This will provide an opportunity to increase light energy consumption by 1.5 times and spend 18 kW·h to produce 1 Mlm·h, but not 28 kW·h as today [1].

Industrial and housing premises are the most intensive electric energy consumers in our country. More than 70% of the total light sources are used by them. Primarily, the problem of energy saving in industrial and housing lighting can be solved through the widespread use of new highly efficient light sources. It is necessary to replace incandescent lamps, which efficiency is 3 – 5%, with fluorescent lamps including compact ones, which efficiency is 5 times higher.

The Russian Government has passed a whole number of laws aimed at the improvement of energy efficiency, including the Federal Law No. 261-FL dated November 23, 2009 "On energy saving and improvement of energy efficiency and on amendments to certain legislative acts of the Russian Federation" (hereinafter referred to as the Federal Law "On energy saving"). This law has determined the state regulation in the field of energy saving and energy efficiency of products, providing for the prohibition or restriction of production and turnover of goods with low energy efficiency in the Russian Federation, if there are the similar goods with high energy efficiency in circulation and their amount meets the population's demand. According to this law, energy efficiency includes "the characteristics reflecting the ratio between useful effect of energy resources and the energy expenditures produced in order to obtain such an effect in relation to production and process technology" [3]. The Federal Law "On energy saving" has become a major factor in the development of energy saving lamps market.

According to the law, 100-watt and more incandescent lamps, which can be used in AC circuits for lighting, have been banned since January 1, 2011. Since January 1, 2012 it has been prohibited to order for state and municipal needs 100-watt and more incandescent lamps, which can be used in AC circuits for lighting. In order to implement the requirements to reduce the turnover of electric incandescent lamps sequentially, it could be prohibited to use in the territory of the Russian Federation 75-watt and 25-watt incandescent lamps, which can be used in AC circuits for lighting, since January 1, 2013 and January 1, 2014, respectively [3].

This means that the production of 100-watt and more incandescent lamps have been stopped since January 1, 2011. The producing and sale of 75 watt incandescent lamps could be banned since January 1, 2013. These lamps should have been withdrawn from the production and sale by January 1, 2014.

This law favours the active development of the Russian market of energy saving lamps. In this regard, Russia follows lead of other developed countries, where the similar measures have been taken. According to the assessment of Rusnano (Russian Corporation of Nanotechnologies), in 2010 42% of the world markets were occupied by compact fluorescent lamps, 6 % – by LED lamps and about 52% – by incandescent lamps. The Russian market counted to 6% of compact fluorescent lamps, 4% of LED lamps and about 90% of incandescent bulbs in the same period.

Due to the ban on production and turnover of incandescent lamps in Russia, it was reasonable to raise a question about the appearance of high-efficient energy lamps at the light market. They are compact fluorescent lamps with integral starting controller and standard screw caps, which could substitute for incandescent light bulbs. Such lamps save a lot of energy because their light output is 4 – 5 times greater than the light efficiency of incandescent bulbs.

Sales volume of the Russian retail market of compact fluorescent lamps amounted to 16 billion rubles in 2011. Budget institutions of Moscow, St. Petersburg, the Bryansk Oblast, Voronezh, Tyumen and Tomsk switched over to the use of such lamps. It is necessary to emphasize that the Russian lighting equipment market is presented by import compact fluorescent lamps made in China, as a rule. Most Russian companies only assemble compact fluorescent lamps out of Chinese component parts. There is no approved manufacture of component parts for fluorescent lamps in Russia. At the same time, there is a full manufacturing cycle to produce incandescent lamps in electric-bulb plants.

It is also necessary to point out the shortcomings of compact fluorescent lamps. Firstly, they include high cost of these lamps. For comparison, the average price of incandescent lamps in Russia is only about 11.8 rubles; compact fluorescent lamps cost 131.8 rubles. It should be noted that there are a lot of fluorescent lamps of low quality in the lighting equipment market in Russia. Average declared service life of these lamps is 8000 – 10000 hours, but it doesn't exceed 4000 – 4500 hours according to the opinion of consumers. So, it has been overstated by 2 times or more.

The measuring and testing results, founded by the Testing laboratory of the State Unitary Enterprise of the Republic of Mordovia "Centre for Test Run and Implementation of Scientific and Research Institute of Lighting Sources named after A.N. Lodygin" in 2011, proved that Chinese compact fluorescent lamps "Ekola" had lower values of light and luminous efficiency, and therefore they didn't meet the requirements of GOST R 53879-2010 (IEC 60969:1988) and the RF Government Decree № 602 "On approval of requirements for lighting devices and electrical lamps used in AC circuits for lighting" dated 20 July, 2011. There is also an unsolved problem of mercury-containing compact fluorescent lamps recycling.

It should be noted that compact fluorescent lamps are characterized by a stroboscopic effect. It is a pulsating light beam, which can have a negative impact on the human sight. There is an opinion of foreign dermatologists that the people, who have high light sensitivity of their skin, can suffer from compact fluorescent lamps.

In accordance with the global energy saving trends, a major part is assigned to LED light sources and LED lighting systems as the most efficient, economical and safe. The use of light-emitting diodes in illuminating engineering is also developed. According to experts, these products will gradually put traditional light sources out of the market within the next ten years.

The main criteria for the predominant use of LED sources in lighting, even in comparison with promising energy efficient gas-discharge lamps, are the following: low energy consumption during operation; a great service life – up to 50 – 60 thousand hours (it is more by 5 – 10 than service life of fluorescent lamps); the absence of pulsations of light characteristics; the ability to work both at low and high ambient temperatures (from -50 ° C up to +60 ° C), that is especially important for cold and hot regions of our country; resistance to mechanical effects; a high level of security (they don't contain harmful substances, ultraviolet or infrared radiation, mercury, they are not dangerously explosive, etc.) [1]. It is an incomplete list of the advantages of LED light sources.

Our country has begun to develop and use light-emitting diode sources. But unfortunately, this process is too slow. The first samples of Russian LED lamps have come into the market in Moscow and St. Petersburg. The cost of a lamp from the first parcel is about 1 thousand rubles. It is planned that the price will have dropped to 250 rubles by 2014.

The Government of the Russian Federation has approved the document "The procedures for producing efficient light sources "New Light" [2] in order to transform the structure of the lighting market in Russia in favor of energy efficient illumination and protection of the domestic market against energy-intensive unpromising domestic and imported products.

The total investment in the project "New Light" is 12.7 billion rubles, including 6.8 billion rubles of off-budget funds and 4.3 billion rubles of Rusnano. The project "New Light" has found that the introduction of energy efficient light sources and the organization of their production in Russia will be implemented in three phases:

2009 – 2012: Removal of incandescent lamps and introduction of compact fluorescent lamps.

2013 – 2016: Sales peak of compact fluorescent lamps.

2017 – 2020: Active introduction of LED equipment.

The implementation of these activities in the country must ensure a system modernization of lighting products at the expense of domestic production of energy efficient lamps and gradual exclusion of imported products.

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