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Forecast of Energy Saving in Russian Lighting Installations till 2020

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The present paper contains an effort to estimate prospects of energy saving in lighting installations (LI) considering lighting technique development for the next 20 years. The forecast is based on international trends in lighting engineering and its actual state in Russia. Besides it is the first time the evaluations have been made complexly considering the analysis of data about power industry, as well as predictable changes of light sources characteristics (luminous efficacies, life time, average power), correlations of light sources in different lighting installation groups, the number of hours of lighting installations' application per year and the demand factor.

With due account of the required characteristics the electric power consumption for lighting purposes is determined by the parameters of lighting products, on the one hand, and by the structure of the stock of luminaires, on the other. It should be noted that the forecast for 2010, and especially for 2020, is certainly preliminary and is subject to future corrections. At the same time, the term “structure of stock” applies to the ration of lighting points with particular Light Sources of particular power.

Design assessment of the integral characteristics of the whole stock of luminaires presented in the paper were based upon the expert assessment of the weighted mean, for this stock, values of luminous efficacy and service life of lamps produced in Russia (Table 1).

Table 1. Expert assessment of weighted mean values of luminous efficacy and service life of national light sources

Type of lamp	2000		2010		2020	
	Luminous efficacy, lm/W	Service life, h	Luminous efficacy, lm/W	Service life, h	Luminous efficacy, lm/W	Service life, h
IL	12.5	1,000	12.5	1,000	20	1,000
THL	18	2,000	30	4,000	50	6,000
FL	65	12,000	90	15,000	105	20,000
CFL	70	5,500	80	10,000	85	15,000
MHL	75	7,500	80	10,000	90	18,000
HPML	55	15,000	55	20,000	60	24,000
HPSL	100	12,000	110	20,000	120	25,000

In the process of calculations the following issues have been taken into account:

- prediction of change in quantity of lighting points in the main branches of the economy (industry, consumer services, residential sector, and agriculture);
- change in the average power of luminaires in terms of introduction of more effective light sources providing the same light flux at less power;
- increase of luminous efficacy and service life of the light sources;
- redistribution within the stock of luminaires: less effective devices with incandescent lamps (IL) and high-pressure mercury lamps (HPML), in particular, were replaced by more effective devices with compact fluorescent lamps (CFL), fluorescent lamps (FL), high-pressure sodium lamps (HPSL), and metal halide lamps (MHL).
- reduction of the depreciation factor of the mass-production lighting installations due to improvement of lamp and luminaire performances;
- step-by-step introduction of the effective electronic ballasts (EB) and luminaires with the mirror and prismatic optics;
- introduction of automatic lighting control systems.

Table 2. Basic Characteristics of the Lighting Stock for 2002

Branch of the national economy	Type of lamp	Average power of luminaire, $P_{aver.}$, W	Average luminous efficacy of lamp, lm/W	Average service life of lamp, h	Share in the light flux, %
Consumer services T_l= 1.900h	IL FL THL CFL MHL	120 120 50 18 190	12.5 65 18 70 75	1,000 12,000 2,000 5,500 7,500	3.3 96.2 0.06 0.03 0.4
Industry T_l = 2,600 h	IL FL THL CFL MHL CFL	120 150 450 290 440 -	12.5 65.0 55.0 100 75 -	1,000 12,000 15,000 12,000 7,500 -	2.6 36.5 56.3 3.4 1.2 -
Agriculture T_l= 1.250 h	IL FL HPML HPSL CFL	60 60 200 - -	12.5 65 55 - -	1,000 12,000 15,000 - -	9.2 23.8 67.0 - -
Residential sector T_l= 1,500 h	IL FL THL CFL	100 50 35 11	12.5 65 18 70	1,000 12,000 2,000 5,500	97 2.8 0.2 0.03
Others T_l= 2,000 h	IL HPML	100 200	12.5 55	1,000 15,000	34.3 65.7

According to the data of 2000, electric power consumption in Russia is 831.1 billion kWh. An assumption was made in the calculation stating that consumption for lighting is 13% of the total electric power consumption, i.e. 108.1 billion kWh.

To determine energy-saving potential, all design assessments were made for two scenarios of development of the events:

- without energy-saving measures and
- with energy-saving measures.

Basic Characteristics of Lighting Stock for 2000 are presented in the Table 2.

Table 3. Summary table

	Calculation options		$P_{inst.}$, mln. kW	$P_{con.}$, mln. kW	$EP_{consumption}$ (inst.), bln. kWh	$EP_{consumption}$ (con.), bln. kWh	Energy saving, bln. kWh	*Mlm. h* / head	kWh(inst.) / head	KWh / Mlm. h
1	2000 (base)		99.6	57.4	175.0	108.1		43	1,200	28
2	2010	Without measures on energy saving	120.0	71.8	204.4	131.5	34.2 (26%)	56	1,450	26
3		With measures	92.1	52.4	159.3	97.3		60	1,090	18
4	2020	Without measures on energy saving	133.4	80,6	242.6	157.8	71.8 (45%)	67	1,661	25
5		With measures	78.8	45.8	137.9	86.0		80	944	12

Figure 1. Evaluation of the luminaires stock structure

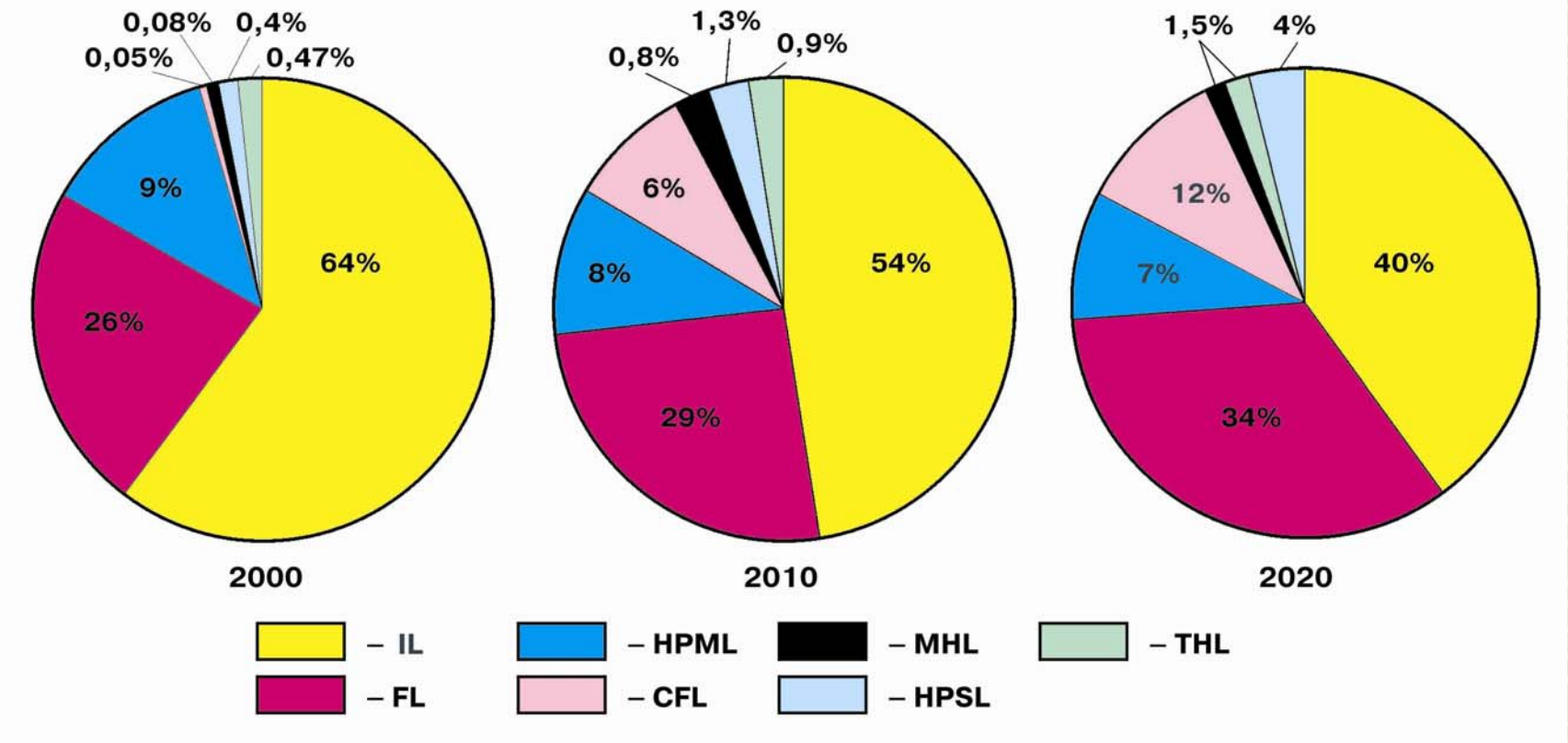

Figure 2. Predicted values of the shares of various LS in generated flux for the consumer services sphere