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Energy Saving In Lighting Systems

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Abstract *—The rules of installation of lighting equipment are studied and compared in this paper.*

Keywords — Energy saving; lighting; cost of electricity; rationing; lighting system**.**

Introduction

Energy saving in lighting installations (LI) is a complex task that provides for cost reduction in LI and determines the payback period for a new or refurbished lighting system. Ultimately, the efficiency of the Shelter is determined by the cost of light energy generated over the life of the Shelter and largely dependent on the cost of paying for electrical energy (hereinafter referred to as EE). The structure of the OS cost indicators is formed as follows:

- capital costs for lighting fixtures (hereinafter referred to as LF) and light sources (hereinafter referred to as LS) 10–5%;
- installation and maintenance costs of LF 15%;
- the cost of electricity is 70–75%.

Since the losses from the deterioration of lighting conditions significantly exceed the cost of saved electricity, an effective op-amp should be considered one that creates high-quality lighting and maintains its characteristics over a long period of operation at the lowest capital and operating costs, including minimal power consumption.

Components of LI efficiency:

- luminous efficiency of ICs and their service life;
- lighting and energy parameters of the LF;
- the stability of the parameters of the LF and LS when they work in the lamp;
- EE tariffs;
- number of hours of LI use per year;
- lighting methods and operating modes of LI;
- the cost of lamps and fixtures, installation and maintenance of LI.

Rationing

The most important task is the legislative consolidation of energy-saving requirements for lighting products and installations in standards, norms and rules. The main regulatory documents for the design and execution of LI are building codes and regulations (SNiP 23-05-95) and territorial building codes for lighting (TCL). The new energy-saving standards propose specific installed power (W/m^{2}) as an energy indicator that determines the rational consumption of EE in indoor lighting (IL) systems . The new energy-saving standards will allow, when applied, to reduce the cost of electricity in the LI of buildings by 20-40%, and they should be considered as the basis of the regulatory framework for controlling energy costs in the OS at the stage of project appraisal. According to the new norms, OS that have worked for more than 8 years must be reconstructed. In outdoor lighting systems (NO), the brightness (illuminance) of the carriageway is normalized as a lighting indicator of the LI. The tasks of energy saving in the NO are solved by optimizing the set of characteristics and parameters of the LI.

Brief overview of the regulatory framework in Europe and the USA

In most developed countries, legislative acts have been adopted that establish lighting standards, programs are being developed to carry out energy-saving measures, audits are being carried out, and funds are being created. At the same time, active research and development of modern lighting equipment and lighting technology is being carried out, information work is being carried out for their wide introduction.

The US example shows that active government intervention is required to maximize energy efficiency, despite the fact that the economy operates in a free market.

This is due to the fact that there are many negative factors in the market:

- electricity prices do not reflect its real cost;
- EE tariffs do not include environmental and other non-monetary aspects;
- poor consumer awareness and unavailability of effective technologies;
- lack of investment capital to improve energy efficiency;
- the reluctance of the industry to conduct research and conduct new developments, the potential market for which is not explored and prepared.

The DOE's Federal Energy Management Program (FEMP) has developed the Lighting Expert System (FLEX) to help select efficient lighting technologies. The FEMP program provides training for government building managers, consulting for designers, demonstrations of the latest technologies, and other activities related to energy conservation.

Government organizations are authorized to approve lighting standards, which can be either advisory or directive. They can relate both to individual technologies and to the operation of the power system as a whole. The main document that defines the requirements for all manufactured lighting and products is the US Energy Policy Act (EPAct) introduced in 1992. It contains requirements for individual groups of lighting products, as well as energy efficiency standards for OS in urban planning.

The government strongly supports the development of energy-saving lighting technology through large-scale economic planning campaigns, finances energy audits, and provides information and technical support.

The US National Energy Policy Act (US National Energy Polity Act - EPACT 92), which entered into force in October 1992, affects all aspects of energy efficiency and applies to all consumers and manufacturers of lighting products. In particular, it establishes performance characteristics for LN and LL. As of November 1995, lamps that do not meet these requirements are banned from production and import.

The current standard (ASHRAE/IES-90.1-89 R) is based on the latest advances in artificial lighting technology, lamp specifications and control gear. As a result, in most cases, the permissible energy consumption in the premises and in the building as a whole is significantly reduced.

In the package of regulatory pan-European documents on LI, the most interesting are the standards for lighting workplaces under the title E DIN 5035-2: 1996-06 "Applied lighting engineering-part 2: Lighting workplaces". The lighting design criteria laid down in these standards take into account the requirements of people for safety, ensuring the necessary visual performance and visual comfort, contain requirements for artificial lighting of workplaces in industrial and administrative buildings, for educational institutions and health care institutions, as well as educational institutions of NO .

Requirements are expressed in quantitative form: to the level of illumination at the workplace and in its environment; to limit glare; to the color quality of the IC. Verbal recommendations are given regarding: the distribution of brightness in the field of view; shadow-forming properties of OS; IC emission colors; coefficient of illumination reduction (the reciprocal of the safety factor accepted in domestic practice); natural lighting of the room; OS energy efficiency ; illumination of workplaces with video terminals.

As can be seen from Table. 1 all categories of scales with visual tasks of varying degrees of complexity in domestic standards are lower than in foreign ones and recommended by the International Commission on Illumination (CIE). The Common European Standard, based on German norms, and the CIE recommendations, which coincide with international standards, are very close . The requirements for illumination in domestic SNiP 23-05-95 are one step of the scale lower than the pan-European recommendations.

Table 1

Comparison of requirements for illumination standards (lx) according to domestic and foreign regulatory documents

Requirements for the visual task	SNiP 23-05-95 (Uzbekistan)	CIE Publications No. 29, International Standard ISO 8995, 1989	DIN 5035 (Germany) Common European standard CEN/TC 169WG, 1996	ANSI/IESR PS3 (USA), 1988
Very high	400-500-600	500-750-1000	750	1000-1500-2000
High	200-300-400	300-500-750	500	500-750-1000
Medium	100-150-200	200-300-500	300	200-300-500
Low	-	100-150-200	200	100-150-200
Orientation in interior space	50-75-100	50-100-150	100-150	50-75-100
Orientation in interior areas	20-30-50	20-30-50	20-30-50	20-30-50

In addition to the norms of artificial lighting, in foreign practice (USA, Sweden, the Netherlands) energy saving standards have appeared, where the criterion for assessing rational energy consumption in an LI is the maximum allowable power. Legislative introduction of limits on the maximum values of specific power stimulates the use of the most efficient light sources, lighting fixtures and lighting methods, as well as the control and management of lighting.

Rationing of internal lighting

An effective LI should be considered as one that creates high-quality lighting and retains its characteristics over a long period of operation at the lowest capital and operating costs, including minimal power consumption.

Regulatory data on the use of EE for lighting purposes allow us to calculate the minimum required consumption of EE in order to achieve the rated illumination for a given type of premises and type of visual work and compare with actual costs. Obtaining normative data involves the application of a set of criteria for the rational organization of lighting systems and energy saving, the main of which are normative data on the level of illumination and specific installed power.

Rationing according to the level of illumination of industrial premises and public places is carried out in accordance with the requirements of SNiP 23-05-95, which provide for compliance with sanitary standards when organizing artificial lighting of workplaces.

Newly created and reconstructed LI must comply with the requirements of energy saving standards. The specific installed power (W, W/m ^{2}) of the general artificial lighting of the premises should be used as an energy indicator that determines the rational consumption of EE for the purpose of lighting. The specific installed capacity is the basis of the regulatory framework for controlling energy consumption in the Shelter during the energy inspection of facilities and at the stage of project appraisal.

The specific installed power W of general artificial lighting of public, residential premises, as well as premises of urban facilities should not exceed the maximum allowable values normalized by territorial building codes (TSN).

The specific installed power of general artificial lighting of public, administrative and auxiliary premises, as well as premises of communal facilities, when meeting illumination standards, is determined taking into account the requirements of SNiP 23-05-95 "Natural and artificial lighting" (Table 2).

Table 2

Basic values of the specific power of general lighting

Height, m	Room area, m ^{2}	W, W/ m2	Height, m	Room area, m ^{2}	W, W/ m2
one	*2*	*3*	*one*	*2*	*3*
Less than 3	less than 15 from 15 to 25 from 25 to 50 from 50 to 150 from 150 to 300 over 300	4.9 4.1 3.6 3.0 2.7 2.5	4 to 6	from 25 to 35 from 35 to 50 from 50 to 80 from 80 to 150 from 150 to 400 over 400	6.0 4.9 3.8 3.4 2.9 2.4
3 to 4	15 to 20 20 to 30 30 to 50 from 50 to 120 from 120 to 300 over 300	6.0 4.8 3.9 3.5 3.0 2.5	6 to 8	from 50 to 65 from 65 to 90 from 90 to 135 from 135 to 250 from 250 to 500 over 500	6.0 5.0 4.1 3.5 3.1 2.4

The regulatory data obtained as a result of the energy survey and assessment of the level of organization and technical condition of the Shelter, in terms of illumination level and specific installed power, are the main ones for determining the energy efficiency of the Shelter. The calculation of possible EE savings for lighting and recommendations for energy saving in LI are developed according to the following indicators of LI and its constituent components: efficiency of light sources; on the efficiency of ballasts; according to typical design and lighting schemes and operational groups of lighting devices (OP); on lighting systems, the ratio of general and local lighting; on automatic lighting control systems depending on the level of natural light and the area of industrial premises; on compliance with the regulations for the operation of the Shelter.

Sources of light

The energy efficiency and lifetime of light sources vary considerably. For example, during the period of their operation, discharge lamps (RL) produce 50–100 times more light energy per 1 conventional watt of power consumption compared to incandescent lamps. Possible EE savings that can be obtained in the Shelter by replacing inefficient ICs with energy- efficient ones while maintaining normalized illumination levels (EE savings potential) are given in Table. 3.

In new and reconstructed LI, it is advisable to use energy -efficient ICs, the production of which has been mastered in all technically developed countries of the world over the past decade. First of all, it is necessary to consider projects that provide for the replacement of LN in the LI of public and industrial premises with LL, and the use of energy-efficient LL with a power of 18, 36 and 58 W in a flask with a diameter of 26 mm in the LI instead of traditional lamps with a power of 20, 40 and 65 in a flask with a diameter of 38 mm.

Table.3

Possible EE savings when switching to energy -saving ICs

As a result of the replacement:	Average EE savings, %
LN on CFL	60 - 80
LN* on LL	40 - 54
LN *on DRL	41 - 47
LN* on MGL	54 - 65
LN *on NLVD	57-71
LL on MGL	20 - 23
DRL on MGL	30 - 40
DRL on NLVD	38 - 50

The main type of IS, with which hopes and plans for energy saving are associated today in the LI of indoor lighting and, above all, housing, are CFLs.

* *When the normalized illumination for LN is reduced by one step in accordance with* the current *lighting standards.*

more light energy during their service life . CFLs, which have 8-10 times longer service life, 5 times greater luminous efficacy compared to LNs, and satisfactory color rendering quality, are an alternative to incandescent lamps in housing sheds, commercial and public buildings. The small dimensions of CFLs, small-sized electronic ballasts built into the base and a standard threaded base (E14, E14, B22) provide the possibility of direct replacement of 25 to 100 W LNs in existing luminaires. The use of CFLs can be most effective precisely in those types of LI where the most widespread ICs are LNs, for example, in the residential sector.

It is also important to note the environmental significance of CFLs, since one such lamp with a power of 18 W during its service life can reduce emissions of carbon dioxide into the atmosphere by 2 times and by 7.5 kg of sulfur dioxide. The intrinsic content of mercury in CFLs poses practically no threat to the environment. It is also important that the CFL should not be changed every 8-10 months, but once every 9-10 years.

According to prospective assessments on the scale of Western European countries, the replacement of LN in 10% of the OS of residential and 25% of administrative premises with economical LL will provide energy efficiency savings of 15 10^6 kW/h per year, which is equivalent to saving 4 10^9 m^{3} of natural gas, or 3 10^6 tons of oil, or 4 10^6 tons of coal. In rooms with difficult environmental conditions, it is advisable to use high-pressure discharge lamps instead of LN, for example , lamps of the MGL or NLVD type.

Ballasts

The cost-effectiveness of the LI must be considered taking into account the characteristics of the control gear (ballast). The power consumption of the LI with discharge lamps is the sum of the power consumed by the lamp itself $R_{l\ \mathrm{and}}$ the power lost in the ballast (ballast) R_b :

$$R_{OU} \backslash u003d\ R_l + R_b .$$

In this regard, the power lost in the ballast can be considered as a reserve for increasing the efficiency of the LI. Active losses in standard electromagnetic ballasts can reach 25% of the power consumed by the LI, losses in electronic high-frequency ballasts (electronic ballasts) do not exceed 10%.

Conventional electromagnetic ballasts, which are widely used at the present time, have high heating and large power losses. An alternative to them are high-frequency electronic ballasts, with the use of which in the OP the quality indicators of lighting increase: the pulsation of the light flux of the LL is excluded; the occurrence of a stroboscopic effect is prevented ; a favorable ignition mode of the LL is created and its service life is increased; in the starting mode, there are no LL flashes and acoustic noises; lamps are automatically switched off at the end of their service life, as well as defective lamps.

It is economically feasible to use standard electromagnetic ballasts in relatively inexpensive lamps, in LI with a short operating time during the year. In LI with an annual operating time of more than 2000 hours, equipped with relatively expensive lamps, mainly with mirror optical elements, it is economically feasible to use electromagnetic ballasts with reduced losses and electronic ballasts. The use of electronic ballasts is effective in LI equipped with automatic lighting control systems.

The reduction in EE consumption when using economical ballasts in luminaires with standard LL and CFL is: for ballasts with reduced losses - 6-26%; Electronic ballast - 14-55%.

Lighting

The choice of the type of lighting device (LD) should be made according to typical design and lighting schemes and operational groups. As one of the main lighting parameters of the OP are luminous intensity curves (CLCs), characterizing the distribution of the luminous flux of the OP in space.

The efficiency of using one or another CCC is determined by the possibility of achieving the required level of illumination with a normalized unevenness and depends on the ratio L / H, where L is the distance between the OP, H is the height of the OP above the calculated surface. The optimal choice of OP allows you to save energy efficiency while providing high-quality lighting at the level of 14-40%.

Increasing attention to the efficiency of lighting is accompanied by an increase in requirements for luminaires. Luminaires with shielding gratings and mirror reflectors, which provide high efficiency (up to 95%) and visual comfort, are widely used. The use of milk diffusers leads to a significant reduction in the efficiency of the lamp. Therefore, luminaires with shielding gratings are widely used. Their efficiency reaches 70% and above. It is interesting to note that the differences in the efficiency values of luminaires with white and mirror gratings are small. For example, 2×36 W luminaires with a white grille have an efficiency of 64%, with a matte grille - 68%, and a luminaire with a parabolic mirror grille for rooms where they work with computers - 60%. Therefore, luminaires with a special mirror aluminum grille, due to their higher cost, should be used only in cases where they are provided for by the standards: in rooms where there are computers; in installations where direct glare must be eliminated.

The use of a control system can provide EE savings of up to 70%. Such large EE savings can be due to both the high efficiency with which the lamp operates , and minimal power lses in the electronic components of the system, dimming the IC depending on the level of natural light and the use of presence sensors.

References

References

[1] Mirzaev, Uchkun and Abdullaev, Elnur, Mathematical Description of Asynchronous Motors (April 15, 2020). International Journal of Academic and Applied Research (IJAAR), 2020, Available at SSRN: https://ssrn.com/abstract=3593185 or http://dx.doi.org/10.2139/ssrn.3593185

[2] Mirzaev, Uchkun and Abdullaev, Elnur, Experiment of Open-circuit Voltage in 'EPH 2 Advanced Photovoltaics Trainer' Laboratory and Types of PV Cell (April 30, 2020). International Journal of Engineering and Information Systems (IJEAIS) Vol. 4, Issue 4, April – 2020, Pages: 41-46; ISSN: 2643-640X, Available at SSRN: https://ssrn.com/abstract=3623014

[3] Mirzaev, Uchkun and Abdullaev, Elnur, Study of the Electrical Characteristics of a Solar Panel for Multi-Residential Apartments Using a Computerized Measuring Stand 'Eph 2 Advanced Photovoltaic Trainer' (2020). International Journal of Academic Engineering Research (IJAER) ISSN: 2643-9085 Vol. 4, Issue 4, April – 2020, Pages: 59-61 , Available at SSRN: https://ssrn.com/abstract=3622045

[4] Mirzayev, U. "THE MODERN METHODS OF USING ALTERNATIVE ENERGY SOURCES." Central Asian Problems of Modern Science and Education 4.2 (2019): 19-29.

[5] Mirzaev Uchkun. Choice For Electric Power Unit Smoke Exhausts №1 Tolimarjon Thermal Electric Power Plant (April 30, 2020). International Journal of Engineering and Information Systems (IJEAIS), 2020, Available at SSRN: https://ssrn.com/abstract=3593125

[6] Mirzaev Uchkun and Elnur Abdullaev. "Study of the Electrical Characteristics of a Solar Panel for Multi-Residential Apartments Using a Computerized Measuring Stand 'Eph 2 Advanced Photovoltaic Trainer'." International Journal of Academic Engineering Research (IJAER) ISSN (2020): 2643-9085.

[7] Mirzaev Uchkun and Axmedov Abdurauf. "Mathematical Model Of An Asynchronous Motor In Full-Phase Operation." International Journal of Engineering and Information Systems (IJEAIS) ISSN (2021): 10-14.

[8] Mirzaev Uchkun and Nurullaev Orzikul. "Scientific and Economic Basis of Use of Wind Energies in Uzbekistan." International Journal of Engineering and Information Systems (IJEAIS) ISSN (2020): 57-59.

[9] Alisher Boliev, and Uchkun Mirzaev. "Technical and Economic Indicators of a Microhydroelectric Power Station in Agriculture." International Journal of Engineering and Information Systems (IJEAIS) ISSN (2020): 51-56.

[10] Mirzaev, Uchkun and Davron, Uktamov and Abdurauf, Axmedov, The Structure Of The Energy Passport Of Industrial Consumers (2021). International Journal of Engineering and Information Systems (IJEAIS) ISSN: 2643-640X Vol. 5 Issue 3, March - 2021, Pages: 207-209, Available at SSRN: https://ssrn.com/abstract=3820385

[11] Mirzaev, Uchkun and Diyor, Hiloliddinov, Methodology Of Energy Audit In Uzbekistan (2021). International Journal of Engineering and Information Systems (IJEAIS) ISSN: 2643-640X Vol. 5 Issue 3, March - 2021, Pages: 197-199, Available at SSRN: https://ssrn.com/abstract=3820392

[12] Mirzaev, Uchkun and Ashraf, Davirov and Akbarbek, Abirov, Energy Audit Basics, Energy Audit Tasks And Energy Audit Methods (2021). International Journal of Engineering and Information Systems (IJEAIS) ISSN: 2643-640X Vol. 5 Issue 3, March - 2021, Pages: 185-188, Available at SSRN: https://ssrn.com/abstract=3820389