ISSN: 2690- 912X

Research Article

Journal of Genetic Engineering and Biotechnology Research

Application Features of Energy-Efficient Led Lights Powered by Photovoltaic Batteries

Sadullaev Alaviddin Bobakulovich*, Avlakulov Meili and Umirov Asror Pardaevich

[1]*Professor, Qarshi State Technical University Karshi City, Uzbekistan*

[2]*Doctor of Technical Sciences, Professor Qarshi State Technical University Karshi City, Uzbekistan*

[3]*Associate Professor Karshi City, Uzbekistan*

***Corresponding Author**

Sadullaev Alaviddin Bobakulovich, Professor, Qarshi State Technical University Karshi City, Uzbekistan.

Submitted: 2025, May 12; **Accepted:** 2025, May 19; **Published:** 2025, May 25

Citation: Bobakulovich, S. A., Meili, A., Pardaevich, U. A. (2025). Application Features of Energy-Efficient Led Lights Powered by Photovoltaic Batteries. *J Gene Engg Bio Res, 7*(2), 01-04.

Abstract

The article scientifically substantiates the improvement of the system's energy efficiency and efficiency indicators compared to analog systems as a result of the use of renewable alternative energy sources such as power sources, motion sensors, and photosensors installed by LED lamps in electric lighting networks. The authors have developed recommendations for the use of energy-efficient LED lamps in electric lighting networks based on the results of experimental studies and theoretical calculations.

Keywords: High-Pressure and Compact Gas-Discharge Electric Lighting, Led Electric Lighting, Motion Sensors and Photo Sensors, Alternative Renewable Energy Sources, Photovoltaic Batteries, Energy Saving, Economic Efficiency Indicators, Lighting Parameters

1. Introduction

In all countries of the world with developed economies, today the issue of saving energy resources and further improving the economic efficiency of electric lighting networks is considered one of the most urgent, and special attention is being paid to this issue.

In accordance with the Decree of the President of the Republic of Uzbekistan dated 03/04/2024. UP No. 109 "On Amendments to Certain Legislative Acts of the Republic of Uzbekistan on issues identified in the strategy "Uzbekistan-2030" On August 27, 2024, the President of Uzbekistan signed a decree “On measures to expand the use and utilization of energy resources in order to improve energy efficiency.”

Based on these sources, an in-depth analysis of the research work carried out by experts in this field has shown that positive solutions to the issues of increasing energy saving and economic efficiency in electric lighting networks are inextricably linked to the correct choice of types of electric lighting devices in each specific case, the implementation of uninterrupted power supply to consumers through renewable alternative energy sources and the process of automatic control of modes equipment operation. To date, there are topical issues in this area that have not been fully studied [1-9].

Based on the above sources, the outdoor electric lighting networks of the central street of the city of Karshi were selected as the object of research.

1.1 The Purpose, Objectives and Methodology of the Research Work

The purpose of this research work was to scientifically substantiate the improvement of energy efficiency and economic efficiency of the system in accordance with the results of experimental and theoretical calculations due to the correct choice of light sources that provide adequate and high-quality artificial lighting in each specific case, including the central street of the city of Karshi [10,11].

It is known from the results of operation that the important practical significance inherent in electric lighting lies in the fact that the creation of standard and high-quality lighting, defined in each area in accordance with the "rules for the installation of electrical appliances" in a particular case, guarantees the prevention of various technical malfunctions or disasters. Simultaneously with the increase in labor productivity and based on the information described above, this scientific article draws conclusions that scientifically substantiate the increase in energy efficiency and efficiency of the system as a result of the use of LED electric lighting installed in motion and photo sensors that receive energy-efficient, continuous energy supply from renewable alternative energy sources to the electric lighting network as the selected central streets of the city of Karshi.

In order to ensure the simplicity of conducting a comparative in-depth analysis, the tables presented the average values of the experimental study results [12-14]. The work on the technical accounting of light and electricity in the electric lighting network of the central street of the city of Karshi was carried out using methods for calculating the coefficient of traditional comparative power and electricity losses used in practice.

Work on the accounting of the electric lighting network was carried out at the following stages:

- Work on the lighting and electrical technical calculation of the electric lighting network was performed in two cases, namely, the electric lighting network uses high-pressure gas-discharge DRLs, compact gas-discharge and light-emitting LED lighting devices that receive energy-efficient and energy supply from autonomous solar photovoltaic batteries connected to the consumer and the installed capacities $P_{1.o'r}$, $P_{2.o'r}$, $P_{3.o'r}$,$P_{4.o'r}$;
- Based on the "Rules for the installation of electrical appliances" at selected working points on the surface of the illuminated area, the calculation of the electricity required by consumers to provide the standard and high-quality lighting specified in each specific case was carried out.;
- The main parameters of the electric lighting network were determined, which characterize the indicators of energy efficiency and economy.

1.2 The Results of the Experiment

To ensure adequate and high-quality lighting in the electric lighting network of the central street of Karshi, high-pressure DRL gas discharge systems and energy-saving systems powered by autonomous solar photovoltaic batteries have been selected. The main parameters describing LED electric lighting with LED backlight installed in motion sensors are shown in Table 1.

№	Model and main parameters of electric lighting	
17.	Model	DPL 250
	Rated voltage and frequency	220 B, 50 Gers
	Capacity	250 W
	The Sokol type	E40
	Service life	10 000 hour
	Luminous flux	1200 Lm
	Light transmission	60 Lm/W
2.	Model	CDM-R111
	Rated voltage and frequency	220 B, 50 Gts
	Capacity	20 W
	The Sokol type	GX8.5
	Service life	9 000 hour
	Luminous flux	750 Lm
	Light transmission	85 Лм/W
3.	Model	ZGSM 150
	Rated voltage	ДС 12/24v
	Capacity	150 W
	The flow of light	14 000 Lm
	Light transmission	165 Lm/W
	Type of management	Motion sensor
	The distance of the motion sensor response	11-12 m
	Average battery charging time	4-5 hour
	Average battery discharge time	24 hour
4.	Model	ZGSM 12
	Rated voltage	ДС 12/24v
	Capacity	12 W
	The flow of light	720 Lm
	Light transmission	192 Lm/W
	Type of management	Motion sensor
	The distance of the motion sensor response	6-7 m.

	Average battery charging time	4-5 hour
	Average battery discharge time	24 hour

Table 1: The Main Parameters of Consumers of the Electric Lighting Network

Since the object studied in the research paper is an urban highway, the standard lighting according to the "Building Codes and Regulations" is determined in the amount of E_M≈**15 Lk**,, for the width of the road for vehicle traffic, E_M≈**4 Lk**, for sidewalks intended for pedestrian traffic [15-18].

The results of measuring the uniform illumination of the track surface using the comparative power method at several selected points were presented in Table 2.

№	The model of electric lamps	Power of electric lampsW	Illuminated surface area- maximum and minimum values Lux.	Average illumination of the field surface Lux.	Required standard illumination of the site surface Lux
Section of highway where vehicles are moving					
1	DRL 250	250 W	E_{max}=17,2 Lux E_{min}=14,7 Lux	$E_{o'rt}$=15,9 Lux	15 Lux
2	ZGSM 150	150 W	E_{max}=16,9 Lux E_{min}=14,3 Lux	$E_{o'rt}$=15,6 Lux	
Pedestrian path area					
3	CDM-R	20 W	E_{max}=5,1 Lux E_{min}=3,6 Lux	$E_{o'rt}$=4,35 Lux	4 Lux
4	ZGSM 12	12 W	E_{max}=5,3 Lux E_{min}=3,2 Lux	$E_{o'rt}$=4,25 Lux	

Table 2: Field Surface Illumination Indicators

Data on the number of luminaires, the height of their installation on supports and voltage losses occurring in operating mode were presented in Table 3 below based on the results of experimental and theoretical calculations obtained for roads intended for traffic and pedestrians on one section of the electric lighting network.

The number of lamps required to ensure the standard illumination of the surface of the site along the width of roads intended for the movement of highways and pedestrians, and their installed capacity in one lighting area, the operating time during the day, and the quantity values calculated under the maximum load of consumed electricity are shown in table 4.

$$P_{1.o'r} = 30 \cdot 0,25 = 7,5 \text{ kW}; \quad P_{2.o'r} = 30 \cdot 0,15 = 4,5 \text{ kW};$$

$$P_{3.o'r} = 30 \cdot 0,02 = 0,6 \text{ kW}; \quad P_{4.o'r} = 30 \cdot 0,012 = 0,36 \text{ kW}.$$

The model of electric lamps	Number of fixtures	Height of installation of lamps (m)	The distance between the lights (m)	ΔU – voltage loss in the electric lighting network
DRL 250	30	8	25	2,3 %
ZGSM 150	30	8	25	1,9 %
CDM-R	30	4,8	16	1,7 %
ZGSM 12	30	4,8	16	1,4 %

Table 3: Lighting and Electrical Parameters of Electric Lighting in the Network

The model of electric lamps	Number of fixtures	Installed capacity (кW)	Average working hours per day (hour)	The amount of electricity consumed (кW• hour)
DRL 250	30	7,5	9	67,5
ZGSM 150	30	4,5	9	40,5
CDM-R	30	0,6	9	5,4
ZGSM 12	30	0,36	9	3,24

Table 4: Lighting and Electrical Parameters of Electric Lighting in the Network

The electricity consumed during one day and one year of moderate use in one section of the road lighting network intended for highway and pedestrian traffic, depending on the geographical latitude at which the city of Karshi is located, was determined from the following equations.

Within one day:

$$W_{1.EE} = 9 \cdot 7{,}5 = 67{,}5 \text{ кW} \cdot hour; \; W_{2.EE} = 9 \cdot 4{,}5 = 40{,}5 \text{ кW} \cdot hour;$$

$$W_{3.EE} = 9 \cdot 0{,}6 = 5{,}4 \text{ кW} \cdot hour; \; W_{4.EE} = 9 \cdot 0{,}36 = 3{,}24 \text{ кW} \cdot hour.$$

Within one year:

$$\mathbf{W_{1.Y} = W_{1.EE} \cdot t = 67,5\ kW} \cdot hour. \cdot \mathbf{365 \approx 24,6\ MW} \cdot hour;$$

$$\mathbf{W_{2.Y} = W_{2.EE} \cdot t = 40,5\ kW} \cdot hour. \cdot \mathbf{365 \approx 14,8\ MW} \cdot hour;$$

$$\mathbf{W_{3.Y} = W_{3.EE} \cdot t = 5,4\ kW} \cdot hour. \cdot \mathbf{365 \approx 1,97\ MW} \cdot hour;$$

$$\mathbf{W_{4.Y} = W_{4.EE} \cdot t = 3,24\ kW} \cdot hour. \cdot \mathbf{365 \approx 1,18\ MW} \cdot hour.$$

An in-depth analysis of the results of the study showed that in the case when high-pressure DRL gas-discharge lamps and compact CDM-R gas-discharge lamps were used on one section of the road lighting network, designed for traffic on motorways and pedestrians in accordance with the "Building Codes and Regulations", the installed electric lighting capacity necessary to ensure regulatory and high-quality lighting, installed in The amount of E_m=15 lux ва E_m=4 lux is $P_{1.o'r}$=**8,1 kW**. In case 2, i.e. with energy efficient, LED lamps are used, their installed power is $P_{2.o'r}$=**4,86 kW**. The results of this study mean that in case 1, 26.6 MW• hours of electricity will be used, and in case 2, 16 MW• hours if the electric lighting network is used throughout the year.

2. Conclusions

Based on the results of experimental studies, it was determined that the lamps selected to provide standard lighting in each specific case for the research object will fully comply with the "Rules for installing electrical appliances" studied by students in terms of their number and configuration.;

the light sources located at the research site and the electric lighting that fully meets the technical requirements were selected, the main parameters of the electric lighting network that characterize one site were determined and analyzed in detail based on a comparison;

as a result of the replacement of gas-discharge lamps, which are also currently used in electric lighting networks, with energy-saving lamps with diode lamps, an improvement in energy efficiency and efficiency of the system has been scientifically substantiated.

References

1. Kneissl, M., Kolbe, T., Chua, C., Kueller, V., Lobo, N., Stellmach, J., & Weyers, M. (2010). Advances in group III-nitride-based deep UV light-emitting diode technology. Semiconductor Science and Technology, 26(1), 014036.
2. Sadullayev, A.B., Bobonazarov, B.A. (2020). Design Solutions of the Mechanism of Energy-Saving Direct and Indirect Drive for Magnetic Starters. International Journal of Innovative Technology and Exploring Engineering (IJITEE). ISSN: 2278-3075, Volume-9 Issue-3.
3. Kozlovskaya, V.B., Radkevich, V.N., Sasukevich, V.N. (2007). Electric lighting. Minsk. Techno perspective, 2007. 255 P.
4. Saadullaev, A.B., Davlonov, H.A. (2023). Physical properties of compacted silicon-based temperature sensors. Alternative energy. Scientific journal. KarIRI. №3, p.78-81.
5. Hayes, K. (2013). Modern approaches to high-quality and inexpensive energy-efficient lighting. Modern lighting technology. No. 6. pp. 59-61.
6. Shashlov, A.B. (2016). Fundamentals of lighting engineering.
7. Yushin, A.M. (2013). Modern LEDs. Moscow: Radiosoft.
8. Shubert, F.E. (2008). LEDs. Moscow: Fizmatlit.
9. Schubert, F. E. (2008). LEDs. A.E. Yunovich, Moscow: Fizmat lit.
10. Arutyunyan, A.A. (2014). Fundamentals of energy saving. Monograph. Moscow: Energoservice.
11. Joost Marchesi, J. (1996). The technique of professional lighting. Allschwil. Switzerland: Bron Elektronik AG.
12. Kazarinov, L. S., Schneider, D. A., Barbasova, T. A., Vystrovskaya, E.V. (2011). Automated control systems for energy-efficient lighting: a monograph. Chelyabinsk: SUSU Publishing Center, publisher T. Lurie.
13. Panfilov, D.I., Polyakov, V.D. (2013). Energy-efficient electric lighting. Moscow: Publishing house of MEI. 288 p.
14. Sergeev, V. A. (2013). Analysis of thermal modes of high-power LEDs as part of LED radiators. Izv. vuzov. Electronics. No. 1. pp. 85-87.
15. Building standards and rules. QMQ 2.04.17-2019. Tashkent, 2019.
16. SNiP 23-05-95. Natural and artificial lighting. Building codes and regulations. Lighting equipment. 2003, No. 2.
17. Road lighting. An electronic resource.
18. LED lighting. An electronic resource.