Optoelectronics and optoelectronic devices

Investigation of energy efficiency index for indoor LED lighting units

A.E.H. Gaballah, Alaaeldin Abdelmageed, E.M. El-Moghazy

Photometry and Radiometry Division, National Institute of Standards (NIS), Tersa Str., Al-Haram, 12211 Giza, Egypt
Corresponding author e-mail: ahmed.gaballah@nis.sci.eg

Abstract. The energy efficiency index (EEI) is an important factor used as an indicator either for building energy consumption or electronic device performance; it allows one to select effective devices that save energy. This work studies the performance of different types of LED lamps used in indoor lighting, the lamps currently available in the Egyptian market have been tested according to their photometric and electric parameters, namely: luminous flux, power factor, and EEI. Three different brands E, T, and V have been chosen with the nominal powers 9, 12, and 15 W. The results showed that both 9- and 15-Watt lamps have the same EEI values as 0.14, 0.13, and 0.12 for T, V, and E lamps, respectively, whereas 12-Watt lamps have EEI values of 0.16, 0.13, and 0.13 for T, V, and E lamps, respectively. The experimental testing of these lamps revealed that all the lamps have the same EEI class (A+) regardless of the nominal power. The results also revealed a relationship between the power factor and EEI: as the power factor increases, EEI increases, too. The expanded uncertainty in luminous flux has been calculated.

Keywords: LED lamps, energy efficiency index (EEI), energy consumption, luminous flux.

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1. Introduction

Energy consumption is receiving great attention due to global energy problems, carbon dioxide emissions, and climate change, as it plays a significant role for both energy providers and consumers [1–3]. The governments and concerned individuals are working together to make the use of renewable resources a priority and reduce the irresponsible use of natural supplies by increasing conservation [4–8]. Saving energy can be improved in several attitudes such as using LED lamps instead of traditional light sources, namely, incandescent and high-pressure sodium (HPS) lamps [9–11], depending on daylight illumination as in the case of green buildings [12–14], in addition to that, using good thermal insulation materials plays a key role in improving the energy efficiency of buildings [15–18]. One of the early-developed energy indices that reflect the performance of energy consumption is known as energy efficiency index (EEI) [19–21]. The concept of this index is commonly spread, since it is valuable to have a universal index for energy efficiency activities in buildings [22]. It is most widely used in measuring the performance of electronic devices, since it has a considerable effect on managing the usage of energy, as well as reducing costs. The energy efficiency of LEDs has increased significantly after the first general illumination products came to market [23, 24]. The study introduces EEI for some LED lamps used for indoor lighting to confirm which lamps are the best efficient. Three sets of commercial LED bulbs with nominal power of 9, 12, and 15 W obtained from three different brands labelled E, T, and V were explored in this work. For each lamp, the total luminous flux, current, and power factor were recorded over an aging time of 1000 hr to assess the EEI values. The experimental testing of these lamps showed that all the lamps have the same EEI class (A+), regardless of the nominal power.

2. Theoretical approach

The energy efficiency index (EEI) is calculated using a comparison of its power corrected for any control gear losses with its reference power. The reference power is defined as the useful luminous flux (Φ_{use}) for non-directional lamps, and the flux at 90° or 120° for directional lamps. EEI is calculated in the following manner [25]:

$$\mathrm{EEI} = P_{cor} / P_{ref}. \quad (1)$$

where P_{cor} is the rated power (P_{rated}) for the tested lamps without external control gear, the rated power (P_{rated}) is corrected for models with external control gear.

Conversely, P_{ref} is the reference power that is obtained from the useful luminous flux (Φ_{use}) and calculated according to the following formula [25–27]:

For the models with $\Phi_{use} < 1300$ lm:

$$P_{ref} = 0.88\sqrt{\Phi_{use}} + 0.049\,\Phi_{use}\,. \qquad (2)$$

For the models with $\Phi_{use} \geq 1300$ lm:

$$P_{ref} = 0.0734\,\Phi_{use}\,. \qquad (3)$$

3. Research methods

The total luminous flux of a given source can be expressed as:

$$\Phi_v = K_m \int_{380}^{780} \Phi_{e,\lambda} V(\lambda)\, d\lambda\,, \qquad (4)$$

where $\Phi_{e,\lambda}$ is radiant power in watts and Φ_v is the total flux in lm. The function $V(\lambda)$ is the photopic luminosity which represents the sensitivity of the human eye to light. The constant K_m is a scaling factor called the maximum spectral luminous efficiency for photopic vision and is equal to 683 lm/W [28–31]. The total luminous flux of these lamps was measured using an integrating sphere

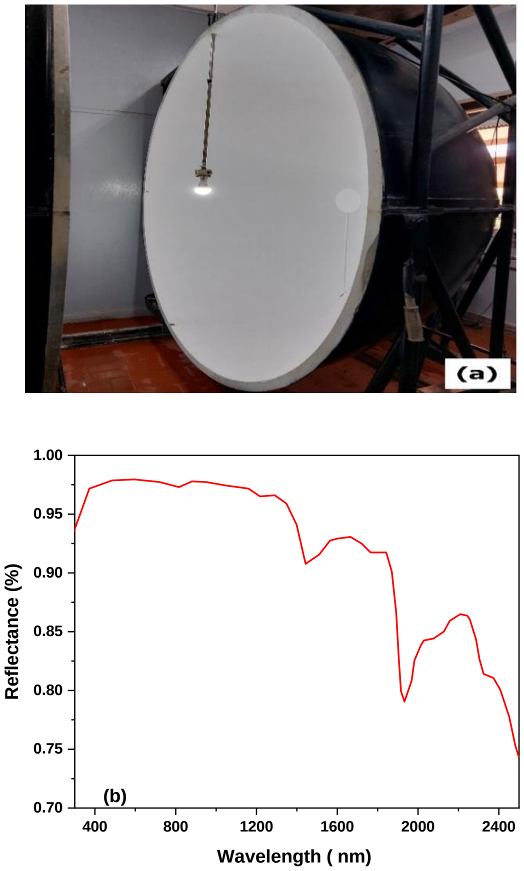

Fig. 1. a) NIS 2.5 m integrating sphere set-up for luminous flux measurements. b) The spectral diffused reflectance of $BaSO_4$.

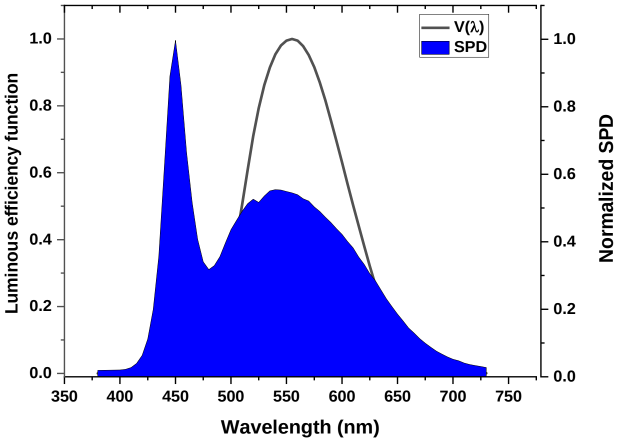

Fig. 2. The spectral responsivity $V(\lambda)$ of the NIS photometer and spectral power distribution (SPD) of the studied LED lamps.

with the diameter of 2.5 m. The sphere is equipped with LMT standard photometer with an opal glass diffuser that serves as the $V(\lambda)$ corrected filter, and the photometer head is connected to the display unit of the model (U1000) for reading the flux. In addition, the sphere is equipped with a baffle screen to prevent first reflections from entering the field of view of the photodetector. A schematic diagram of the integrating sphere is shown in Fig. 1a. The sphere wall is coated with barium sulfate ($BaSO_4$) that has a diffuse reflectance of 0.97, a typical spectral reflectance of $BaSO_4$ is shown in Fig. 1b as that measured on Shimadzu spectrophotometer (model 3101PC).

The lamps operated at the nominal voltage (220 ± 2) V being supplied using an AC power source (model Aglint 6813B). The lamps were normally allowed to steady for approximately 30 min after being turned on. The spectral power distribution (SPD) of these LED lamps as well as the luminous efficiency function $V(\lambda)$ of the standard photometer (LMT) are seen in Fig. 2. The relative power distribution (RPD) at each wavelength was measured using Ocean optics spectroradiometer (HR 20). This curve reveals two characteristics: the height and precise location of the blue peak near 450 nm, as well as the ratio of this peak to the broader emission from the yellow region.

The lamps were tested for flux, current, and power factors after the aging time of 1000 hr [32–34]. Used in the measurements was the 25-W incandescent lamp as a reference standard lamp under controlled environmental conditions corresponding to 240 ± 10 °C [35, 36]. A photograph of LED lamps of different powers used for the experiments is seen in Fig. 3.

Figs 4a and 4b show the variation of flux and power factor with the aging time for different brands of 9-W lamps. The T 9-W lamp has a superior power factor close to unity, which reflects its power efficiency when compared to the other two brands.

Fig. 3. Samples of LED lamps with the powers 15, 12, and 9 W that was chosen for the experiments.

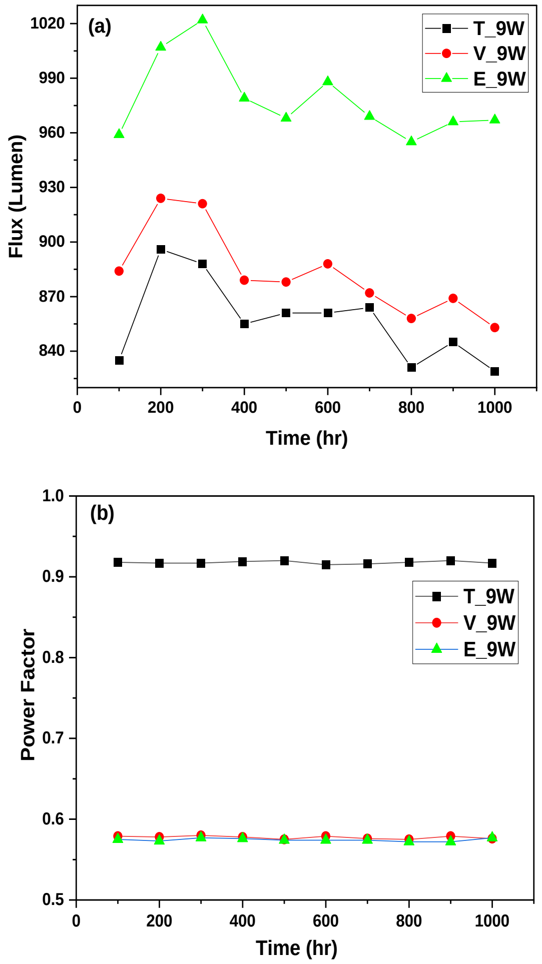

Fig. 4. Variation of the flux (a) and power factor (b) with the aging time for 9-W LED lamps.

Figs 5 and 6 show the variation of flux and power factor with the aging time for various brands of 12- and 15-Watt lamps. Despite the fluctuating luminous flux, the power factor remains constant over time, the T 12-W lamp has a power factor close to unity when compared to the T 15-W lamp. A good power factor is considered to be higher than 0.85, while power factors less than this value require a more efficient power supply, which increases the production and transmission costs of power [37].

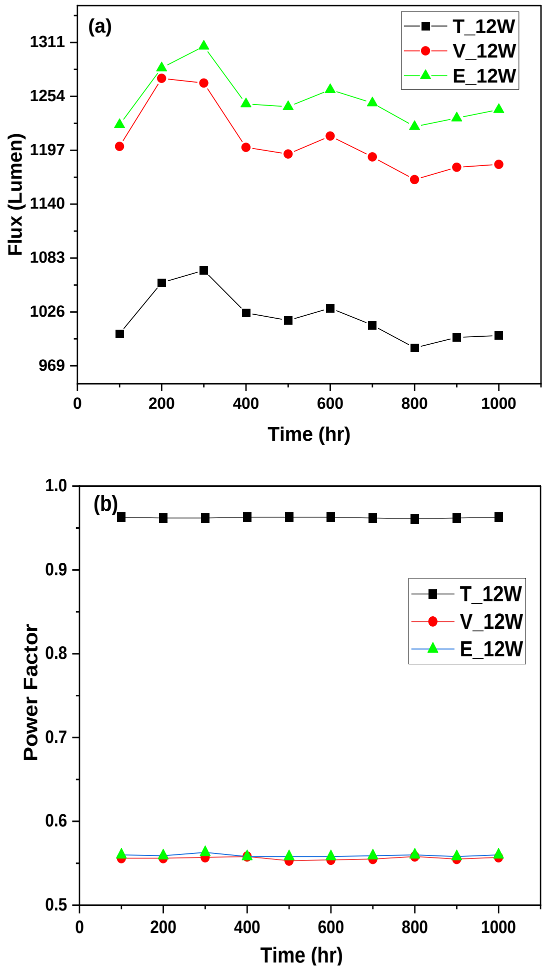

Fig. 5. Variation of the flux (a) and power factor (b) with the aging time for 12-Watt LED lamps.

Although the brand T exhibits lower flux values, when compared to other brands with different powers, it has an excellent power factor, which reflects its optimal power usage. The power factor of LED lamps shows the actual power ratio that was used to draw apparent power into the circuit of the lamp. The performance of LED

Table 1. Electro-photometric parameters of different types of lamps.

Lamp type	Measured *P*, W	*I*, A	Power factor	Φ, lm
T_{9W}	9.3	0.046	0.917	830
V_{9W}	8.3	0.065	0.576	876
E_{9W}	8.9	0.071	0.577	953
T_{12W}	11.8	0.055	0.963	1003
V_{12W}	10.6	0.087	0.557	1201
E_{12W}	11.5	0.093	0.558	1224
T_{15W}	14.2	0.111	0.580	1432
V_{15W}	12.4	0.105	0.538	1511
E_{15W}	14.8	0.125	0.553	1714

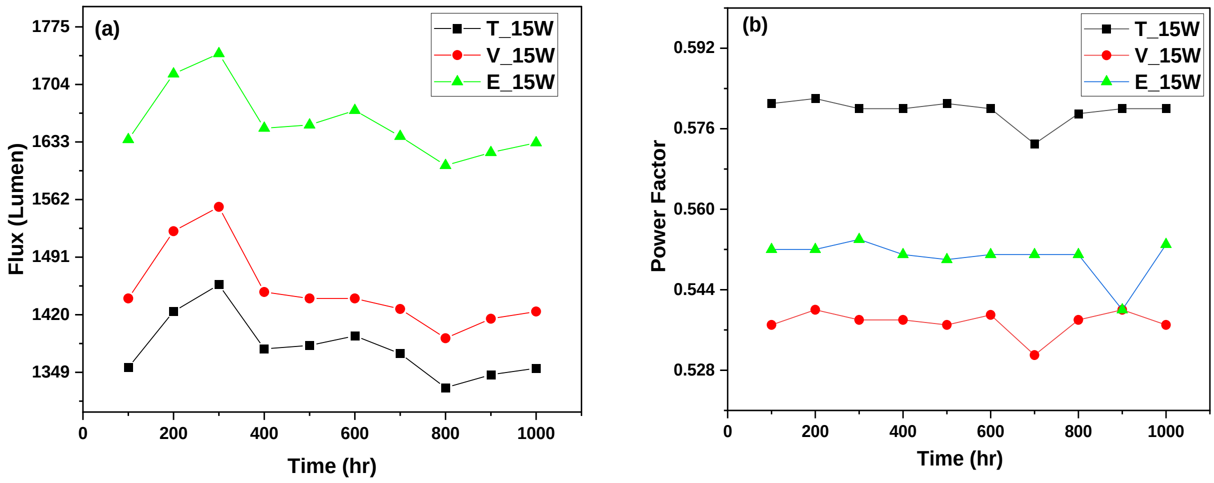

Fig. 6. Variation of the flux (a) and power factor (b) with the aging time for 15-Watt LED lamps.

drivers or electrical components is measured by the power factor rather than the optical components, which represent the LED matrix. As a result, the low quality of LED chips can be blamed for the disparity between the power factor and flux of T lamps.

The electro-photometric parameters for various types of LED lamps are summarized in Table 1 after the aging time of 1000 hr. The tables show the current, power, power factor, and luminous flux for different brands of LED lamps. As can be seen, the lamps labelled with V

Table 2. The calculated EEI for different powers of LED lamps.

Lamps	$P_{rated} = P_{cor}$, W	Φ_{use} , lm	$\sqrt{\Phi_{use}}$, lm	P_{ref}, lm	EEI	Energy efficiency class
T_{9W}	9	830	28.81	66.02	0.14	A+
V_{9W}	9	876	29.60	68.97	0.13	A+
E_{9W}	9	953	30.87	73.86	0.12	A+
T_{12W}	12	1003	31.67	77.02	0.16	A+
V_{12W}	12	1201	34.66	89.35	0.13	A+
E_{12W}	12	1224	34.99	90.76	0.13	A+
T_{15W}	15	1432	37.84	105.12	0.14	A+
V_{15W}	15	1511	38.87	110.92	0.13	A+
E_{15W}	15	1714	41.40	125.83	0.12	A+

Table 3. Energy efficiency classes for directional and non-directional lamps.

Energy efficiency class	EEI for non-directional lamp	EEI for directional lamp
A++ (most efficient)	$EEI \le 0.11$	$EEI \le 0.13$
A+	$0.11 < EEI \le 0.17$	$0.13 < EEI \le 0.18$
A	$0.17 < EEI \le 0.24$	$0.18 < EEI \le 0.40$
B	$0.24 < EEI \le 0.60$	$0.40 < EEI \le 0.95$
C	$0.60 < EEI \le 0.80$	$0.95 < EEI \le 1.2$
D	$0.80 < EEI \le 0.95$	$1.2 < EEI \le 1.75$
E (least efficient)	$EEI > 0.95$	$EEI > 1.75$

Table 4. The combined uncertainty budget for luminous flux measurement.

Uncertainty factor	Relative standard uncertainty (%)		
	Type A	Type B	
Calibration of the standard lamp		✓	0.85
Spatial nonuniformity of the sphere response		✓	0.2
Drift in the recalibration of the sphere photometer	✓		0.006
Spectral mismatch correction of the photometer		✓	0.08
Self-absorption correction from the lamp itself		✓	0.09
Repeatability of the tested lamps	✓		0.50
Photometer readout resolution		✓	0.01
Uncertainty of AC source		✓	0.60
The expanded uncertainty at *k* = 2			**2.36**

typically have moderate behavior, when compared to their counterparts of the same power. Table 2 shows the measured EEI for the same brands of LED lamps.

Table 3 shows the classification of EEI for both directional and non-directional lamps according to the European Commission supplementing Regulation (EU) 2017/1369 [25].

Although these lamps provide high luminous efficacy and high output in lumens they produce the same EEI class despite the discrepancies in their power factor. Fig 7 shows the EEI and the power factor inherent to each lamp, as can be seen from the figure, there is a correlation between the power factor and EEI: as the power factor increases, EEI increases, too. The power factor is defined as the real power used by the load divided by the perceived power drawn into the circuit. A lamp with a low power factor is, therefore, less efficient, since it draws more current into the circuit than it consumes, thus, more current use leads to more energy loss in the form of heat.

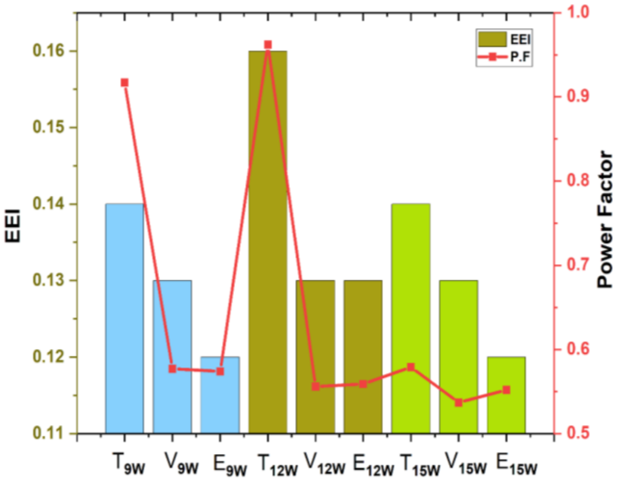

Fig. 7. Variation of EEI and power factor for LED lamps with different powers.

4. Analysis of uncertainties

The analysis of uncertainties was performed using the GUM method, which is adopted and described in detail by the international organization for standardization (ISO) [38]. The standard uncertainty $u(x_i)$ of an input quantity is estimated by the standard deviation of the mean, where:

$$u(x_i)=S(\bar{q}). \qquad (5)$$

The combined standard uncertainty $u_c(x)$ for a set of input quantities $x_1, x_2, \ldots, x_i$ is obtained by the square root of the sum of individual standard uncertainties $u(x_i)$, these can be evaluated as Type A and Type B uncertainties.

$$u_c(x)=\sqrt{u^2(x_1)+u^2(x_2)\ldots u^2(x_i)}. \qquad (6)$$

The uncertainty analysis for luminous flux associated with the measurements is calculated as seen in Table 4.

5. Conclusions

This paper provides an overview of the methods used for measuring EEI to offer useful resources for energy efficiency. Three different brands labelled E, T, and V, with nominal powers of 9, 12, and 15 W, were chosen for the research. The experimental results for these lamps showed that all of them show the same EEI class, despite the difference in powers. The results revealed that 9- and 15-Watt lamps have the same EEI values as 0.14, 0.13, and 0.12 for T, V, and E lamps, respectively, whereas the EEI values for 12-Watt lamps range from 0.13 to 0.16, and then the EEI class for all lamps is A+.

Declaration of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

1. Ghasemian S., Faridzad A., Abbaszadeh P. *et al.* An overview of global energy scenarios by 2040: Identifying the driving forces using cross-impact analysis method. 2020. *Int. J. Environ. Sci. Technol*. https://doi.org/10.1007/s13762-020-02738-5.
2. Acaroğlu H., Güllü M. Climate change caused by renewable and non-renewable energy consumption and economic growth: A time series ARDL analysis for Turkey. *Renew. Energy*. 2022. **193**. P. 434–447. https://doi.org/10.1016/j.renene.2022.04.138.
3. Chakraborty D., Alam A., Chaudhuri S. *et al.* Scenario-based prediction of climate change impacts on building cooling energy consumption with explainable artificial intelligence. *Appl. Energy*. 2021. **291**. P. 116807. https://doi.org/10.1016/j.apenergy.2021.116807.
4. Gielen D., Boshell F., Saygin D. *et al.* The role of renewable energy in the global energy transformation. *Energy Strateg. Rev*. 2019. **24**. P. 38–50. https://doi.org/10.1016/j.esr.2019.01.006.
5. Xu D., Yuan Z.-L., Bai Z. *et al.* Optimal operation of geothermal-solar-wind renewables for community multi-energy supplies. *Energy*. 2022. **249**. P. 123672. https://doi.org/10.1016/j.energy.2022.123672.
6. Chicherin S., Zhuikov A., Kolosov M. *et al.* Optimizing the renewable and fossil-fired generation capacities: Case study of interconnected district-level systems. *Energy Rep.* 2022. **8**. P. 137–144. https://doi.org/10.1016/j.egyr.2021.11.095.
7. Atsu F., Adams S. Energy consumption, finance, and climate change: Does policy uncertainty matter? *Econ. Anal. Policy*. 2021. **70**. P. 490–501. https://doi.org/10.1016/j.eap.2021.03.013.
8. Rahman A., Farrok O., Haque M.M. Environmental impact of renewable energy source based electrical power plants: Solar, wind, hydroelectric, biomass, geothermal, tidal, ocean, and osmotic. *Renew. Sustain. Energy Rev*. 2022. **161**. P. 112279. https://doi.org/10.1016/j.rser.2022.112279.
9. Kıyak I., Oral B., Topuz V. Smart indoor LED lighting design powered by hybrid renewable energy systems. *Energy Build.* 2017. **148**. P. 342–347. https://doi.org/10.1016/j.enbuild.2017.05.016.
10. Chew I., Kalavally V., Oo N.W., Parkkinen J. Design of an energy-saving controller for an intelligent LED lighting system. *Energy Build*. 2016. **120**. P. 1–9. https://doi.org/10.1016/j.enbuild.2016.03.041.
11. Pekur D.V., Kolomzarov Y.V., Sorokin V.M., Nikolaenko Y.E. Super powerful LED luminaires with a high color rendering index for lighting systems with combined electric power supply. *SPQEO*. 2022. **25**. P. 97–107. https://doi.org/10.15407/spqeo25.01.097.
12. Liu X., Sun Y., Wei S. *et al.* Illumination distribution and daylight glare evaluation within different windows for comfortable lighting. *Results Opt.* 2021. **3**. P. 100080. https://doi.org/10.1016/j.rio.2021.100080.
13. Mayhoub M.S., Rabboh E.H. Daylighting in shopping malls: Customer's perception, preference, and satisfaction. *Energy Build*. 2022. **255**. P. 111691. https://doi.org/10.1016/j.enbuild.2021.111691.
14. Udhwani L., Soni A. Evaluation of daylighting performance in an office building: A case study. *Mater. Today Proc*. 2021. **46**. P. 5626–5631. https://doi.org/10.1016/j.matpr.2020.09.518.
15. Simona P.L., Spiru P., Ion I.V. Increasing the energy efficiency of buildings by thermal insulation. *Energy Procedia*. 2017. **128**. P. 393–399. https://doi.org/10.1016/j.egypro.2017.09.044.
16. Lee L.S.H., Jim C.Y. Transforming thermal-radiative study of a climber green wall to innovative engineering design to enhance building-energy efficiency. *J. Clean. Prod.* 2019. **224**. P. 892–904. https://doi.org/10.1016/j.jclepro.2019.03.278.
17. Paraschiv S., Paraschiv L.S., Serban A. Increasing the energy efficiency of a building by thermal insulation to reduce the thermal load of the micro-combined cooling, heating and power system. *Energy Rep*. 2021. 7. P. 286–298. https://doi.org/10.1016/j.egyr.2021.07.122.
18. Rahman M.M., Mahlia T.M.I., Uddin M.N. Energy efficiency analysis in building walls in tropical climate using thermal insulation system. *Encyclopedia of Renewable and Sustainable Materials*. 2020. **1**. P. 255–261. https://doi.org/10.1016/B978-0-12-803581-8.11114-2.
19. Abu Bakar N.N., Hassan M.Y., Abdullah H. *et al.* Energy efficiency index as an indicator for measuring building energy performance: A review. *Renew. Sustain. Energy Rev.* 2015. **44**. P. 1–11. https://doi.org/10.1016/j.rser.2014.12.018.
20. González A.B.R., Díaz J.J.V., Caamaño A.J., Wilby M.R. Towards a universal energy efficiency index for buildings. *Energy Build*. 2011. **43**. P. 980–987. https://doi.org/10.1016/j.enbuild.2010.12.023.
21. Guo C., Bian C., Liu Q. *et al.* A new method of evaluating energy efficiency of public buildings in China. *J. Build. Eng*. 2022. **46**. P. 103776. https://doi.org/10.1016/j.jobe.2021.103776.
22. Kumar A., Kar P., Warrier R. *et al.* Implementation of smart LED lighting and efficient data management system for buildings. *Energy Procedia*. 2017. **143**. P. 173–178. https://doi.org/10.1016/j.egypro.2017.12.667.
23. Davidovic M., Kostic M. Comparison of energy efficiency and costs related to conventional and LED road lighting installations. *Energy*. 2022. **254**. P. 124299. https://doi.org/10.1016/j.energy.2022.124299.
24. Yoomak S., Jettanasen C., Ngaopitakkul A. *et al.* Comparative study of lighting quality and power quality for LED and HPS luminaires in a roadway lighting system. *Energy Build*. 2018. **159**. P. 542–557. https://doi.org/10.1016/j.enbuild.2017.11.060.

25. The European commission, Energy labelling of household dishwashers and repealing Commission Delegated Regulation (EU) No 1059/2010. *Off. J. Eur. Union*. 2019. P. 134–154. http://data.europa.eu/eli/reg_del/2019/2017/oj.
26. Ding Q., Liang X., Zhao Y. *et al*. Study on Chinese and U.S. Energy Efficiency Regulations and Standards for Efficient Lighting Products. *E3S Web Conf.* 2018. **53**. P. 02010. https://doi.org/10.1051/e3sconf/20185302010.
27. Pekur D.V., Sorokin V.M., Nikolaenko Y.E. Features of wall-mounted luminaires with different types of light sources. *Electrica*. 2021. **21**. P. 32–40. https://doi.org/10.5152/electrica.2020.20017.
28. Fujiwara K. Photonmetric quantities and their application, in: *Plant Factory Basics, Applications and Advances*. T. Kozai, G. Niu, J.G. Masabni (Eds). Academic Press, 2021. P. 83–99. https://doi.org/10.1016/B978-0-323-85152-7.00004-5.
29. Martinsons C., Hlayhel R. A method to measure the spectral responsivity of a photometer using optical excitations with arbitrary spectral distributions. *Light. Res. Technol*. 2021. **54**, Issue 4. P. 1–18. https://doi.org/10.1177/14771535211026322.
30. Nikolaenko Y.E., Pekur D.V., Sorokin V.M. Light characteristics of high-power LED luminaire with a cooling system based on heat pipe. *SPQEO*. 2019. **22**. P. 366–371. https://doi.org/10.15407/spqeo22.03.366.
31. Cusumano P., Garraffa G., Stivala S. A simple method for the photometric characterization of organic light-emitting diodes. *Solid. State. Electron*. 2022. **195**. P. 108394. https://doi.org/10.1016/j.sse.2022.108394.
32. Qian C., Fan X.J., Fan J.J., Yuan C.A., Zhang G.Q. An accelerated test method of luminous flux depreciation for LED luminaires and lamps. *Reliab. Eng. Syst. Saf.* 2016. **147**. P. 84–92. https://doi.org/10.1016/j.ress.2015.11.009.
33. Yan J., Liu H., Zhao W., Su Y. Long-term stability of LED filament standard lamps for total luminous flux. *Proc.* 2021. **11899**, *Opt. Metrol. Insp. Ind. Appl*. VIII. P. 1189918. https://doi.org/10.1117/12.2602256.
34. Park S., Kim Y.-W., Lee D.-H., Park S.-N. Preparation of a standard light-emitting diode (LED) for photometric measurements by functional seasoning. *Metrologia*. 2006. **43**. P. 299–305. https://doi.org/10.1088/0026-1394/43/3/013.
35. El-Moghazy E.M., Gaballah A.E.H. Uncertainty estimation of luminous flux for LED lamps due to the control of electric power. *ECS J. Solid State Sci. Technol*. 2022. **11**. P. 066005. https://doi.org/10.1149/2162-8777/ac7ad4.
36. Pekur D.V., Sorokin V.M., Nikolaenko Y.E. *et al.* Electro-optical characteristics of an innovative LED luminaire with an LED matrix cooling system based on heat pipes. *SPQEO*. 2020. **23**. P. 415–423. https://doi.org/10.15407/spqeo23.04.415.
37. Uddin S., Shareef H., Mohamed A. Power quality performance of energy-efficient low-wattage LED lamps. *Measurement*. 2013. **46**. P. 3783–3795. https://doi.org/10.1016/j.measurement.2013.07.022.
38. Williams J.H. Guide to the Expression of Uncertainty in Measurement (the GUM), in: *Quantifying Measurement: The Tyranny of Numbers*. IOP Publ., 2016. P. 6–9. https://doi.org/10.1088/978-1-6817-4433-9ch6.

Authors and CV

Ahmed Gaballah is Senior Researcher at the Photometry Metrology Department, National Institutes of Standards (NIS), Egypt since 2012. He defended his Doctoral Dissertation in Information Engineering from the University of Padova, Italy, and University College Dublin, Ireland. His research areas are image analysis, lighting metrology, optical materials, and optoelectronic engineering.

https://orcid.org/0000-0002-7837-8404

Alaaeldin Abdelmageed, Associate Professor, Head of the Radiometry Department at the National Institute of Standards (NIS), Egypt. He received his PhD degree in detector responsivity from the Braunschweig University as well as PTB metrology institute, Germany in 2011. The area of his research interests include optics, photometry and radiometric metrology.

E-mail: alaa.abdelmageed@nis.sci.eg,
https://orcid.org/0000-0002-7279-2786

Essam El-Moghazy, Associate Professor at the Photometry Metrology Department, National Institute of Standards (NIS), Egypt. He received his PhD degree in photometry from Ain Shams University, Egypt in 2012. His research interests include optical metrology, lighting measurements and astronomy.

E-mail: essam.elmoghazy@nis.sci.eg,
https://orcid.org/0000-0002-4875-8983

Authors' contributions

Ahmed Gaballah: carried out the experimental part, data analysis, and wrote the paper.

Alaaeldin Abdelmageed: data analysis, contributed to the final version of the manuscript (review and revision).

Essam El-Moghazy: designed and performed the experiments with **Ahmed Gaballah**.

Дослідження індекса енергоефективності для внутрішніх світлодіодних освітлювальних приладів

A.E.H. Gaballah, Alaaeldin Abdelmageed, E.M. El-Moghazy

Анотація. Індекс енергоефективності (EEI) є важливим фактором, який використовується як показник споживання енергії будівлею або показник продуктивності електронних пристроїв; він дозволяє нам вибирати ефективні пристрої, які заощаджують енергію. У цій роботі вивчається ефективність різних типів світлодіодних ламп, які використовуються у внутрішньому освітленні. Лампи, які зараз доступні на ринку Єгипту, були протестовані відповідно до їхніх фотометричних та електричних параметрів, таких як світловий потік, коефіцієнт потужності та EEI. Було вибрано три різні марки E, T і V з номінальною потужністю 9, 12 і 15 Вт. Результати показали, що лампи на 9 і 15 Вт мають однакові значення EEI як 0,14, 0,13 і 0,12 для T, V і E ламп відповідно, тоді як 12-ватні лампи мають значення EEI 0,16, 0,13 і 0,13 для ламп T, V і E відповідно. Експериментальне тестування таких ламп показало, що всі вони мають однаковий клас енергетичної ефективності (A+), незалежно від номінальної потужності. Результати також виявили взаємозв’язок між коефіцієнтом потужності та EEI, а саме: коли коефіцієнт потужності збільшується, EEI теж збільшується. Розраховано розширену невизначеність світлового потоку.

Ключові слова: світлодіодні лампи, індекс енергоефективності (EEI), енергоспоживання, світловий потік.