

Comparative Analysis of the Use of LED and HPS Lights in PT. Bukit Asam

Rahmat Adiprasetya Al Hasibi^{*1}, Agus Jamal¹, Indar Surahmat², Tio Hardiyanto¹, Yessi Jusman¹,
Fardhan Arkan³

¹Department of Electrical Engineering, Universitas Muhammadiyah Yogyakarta
Jl. Lingkar Selatan, Tamantirto, Kasihan, Yogyakarta, Indonesia

²Faculty of Electrical Engineering and Information Technology, RWTH Aachen University
Templergraben 55, 52062 Aachen, Germany

³Department of Electrical Engineering, Universitas Bangka Belitung
Kampus Terpadu Balun Ijuk Merawang Kabupaten Bangka, Bangka Belitung, Indonesia

*Corresponding author, e-mail: r.a.alhasibi@umy.ac.id

Abstract – *The lamp is the leading construction facility in the company that serves as a support for the economic activities system and mobility in the company. An analysis of the difference between the use of LED lights with HPS lamps at PT. Bukit Asam Tbk reference is used to recommend the use of appropriate (technical) lighting equipment for industrial areas and to obtain better cumulative costs and energy savings for the company in the future. In this study, they are using the lamp replacement method with the same lumen level comparison. The goal is that later the level of lighting produced is the same for each lamp. From the results of this study, it was found that the industrial use of 70W, 150W, 250W, and 400W HPS lamps have an efficacy level of 84 to 123 lm/W. Whereas the 80W, 200W, 300W, 450W LED lamps are 90 lm/W and the results of the cumulative value or the total cost of operating and maintenance costs for 15 years between HPS lamps versus the LED lights that occur is that in HPS lamps the total cost incurred amounting to Rp. 20,604,230,235 while for LED lamps it is Rp. 27,787,386,324 which can be seen that the use of more economical lighting is HPS lamps.*

Keywords: *Corporate, HPS Lighting, LED, Lumen, Efficacy, Economical*

I. Introduction

Lighting is a component in a company that is useful to assist workers in observing the objects they work clearly, efficiently, safely, and comfortably [1]. Proper and adequate lighting will give a good impression in terms of the environment to make it look ethical. Objects will basically be more clearly seen if the object can reflect light, but it can also be a reflection of the aid of a given light source. Thus the purpose of lighting is to help humans make objects that are seen clearly visible [2]. The lighting provided can be adjusted according to the type of work or the level of the object being seen so that later workers can see clearly and help maintain eye health and excitement while working

[3].

As a large-scale coal mining and marketing company, PT. Bukit Asam Tbk. The Tarahan Port Unit has an electric power system and adequate facilities that are applicable so that PT. Bukit Asam Tbk. is an ideal place to apply your knowledge obtained from theories learned in lectures. This lighting system is important in a production process, which is to ensure that all production processes run well, and produce products according to expectations [4].

Light is an electromagnetic wave propagation which propagates in all directions, in that wave has a certain length and frequency and it has its own level value that can be distinguished from other light energy in the electromagnetic light spectrum. Human life depends on light because light helps

humans in their activities so that it becomes an absolute thing in human life and without light life on earth cannot walk and develop. In the room lighting is an absolute must to help people see and create an atmosphere of a comfortable, healthy and conducive industrial area [5]. Besides that, considering the importance of the lighting system in a company as one of the lighting facilities of production equipment. The wider a production area, the more the lighting system will be used. This causes more lamp power to be used due to the use of a large number of lamps as well. That thing will certainly have an impact on the electricity bill for the system that is charged to the company.

Research references that have been carried out to support this research are Irawan (2013) who conducted research on the Analysis of Improvement of Public Street Lighting Efficiency (PJU) in Jember Regency. From the research it was concluded that from the technical and financial analysis for the method of saving public street lighting (PJU) can use 3 methods of savings, namely: 1. Method of discrimination based on hours of lighting. 2. Load discrimination method based on operating hours. 3. The method of changing lamps is by using LED type energy saving lamps with equal lighting levels [6].

On the other hand, the quality and type of lamps installed in industrial lighting systems also affect the amount of power used, which is related to energy saving efforts [7]. What we need to remember is that the energy problem is very important to be used optimally and efficiently. In providing lighting, a company needs to consider well the cost, level of illumination and lifetime given the large amount of power used for the lighting system. Therefore, it is necessary to have an economic study of lifetime analysis, new investment, or replacement analysis of lamps that have been installed at PT. Bukit Asam (Persero) Tbk. Tarahan Port Unit. With the discussion of this analysis it is hoped that a recommendation can be taken on the construction of existing lighting system infrastructure in the company.

II. Methods

1. Research Tools

In this comparative analysis research the use of this lamp is used a laptop device and software to assist writing in conducting research. The software used in this study is Microsoft Office 2013. It is hoped that with the help of these tools and software researchers can be carried out smoothly and as

desired.

2. Research Materials

a. HPS lamp

In this study using HPS type SON-T lamps where this type of lamp is widely used for industrial lighting. The lamp used for this research is 70W, 150W, 250W, and 400W.

b. Industrial LED lights

In this study, use industrial LED lights where the type of lights used are the same as HPS lamps, namely industrial LED lights for street lights, hallways or tunnels and spotlights.

3. Flowchart of Research

Flowchart for the research is presented in Fig. 1.

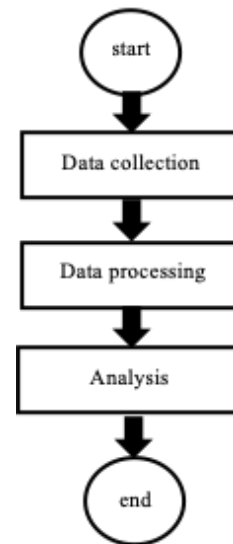


Fig. 1. Research flow chart

Based on the flow chart above, the research carried out includes the following steps:

1. Data Collection

In this data collection there are two stages that will be a process as a reference as a way to be carried out for data collection, namely viewing the technical aspects of the data and economic aspects of the data.

2. Data Processing

After the desired data is collected next is processing data. Existing data are selected according to needs in the field. In processing data, lamp power data, lamp sheet data, number of lamps, and other data are grouped.

3. Data Analysis

a. Technical Analysis

b. Financial Analysis

c. Feasibility Analysis

III. Results and Discussion

III.1. Lighting Data PT. Bukit Asam

From the data in Table I, it can be seen that the use of lamps for the type of HPS lamps is very dominant, where its use consists of SON-T lamps 70 W, 150 W, 250 W which are the use for street and tunnel lights as well as on the SON-T 400 W lamps. for spotlights. Whereas HPI-T is a metal alide lamp and TL is a fluorescent lamp so both are not included in HPS so are not included in this analysis.

III.2. Lamp Life (Lifetime)

Assuming the durability of two different types of lights with the durability of an HPS lamp of 20% around 20,000 hours and an LED lamp which has a lamp life or a lifetime of 50,000 hours. Usage of 11 hour lamps per day:

$$\begin{aligned}
 &\text{Lifetime for HPS lamps} \\
 &= 20000 \text{ hours} / 11 \text{ hours per day} \\
 &= 2000 \text{ days} / 365 \text{ days} \\
 &= 5.47 \approx 5 \text{ years}
 \end{aligned} \tag{1}$$

$$\begin{aligned}
 &\text{Lifetime for LED lights} \\
 &= 50000 \text{ hours} / 11 \text{ hours per day} \\
 &= 2200 \text{ days} / 365 \text{ days} \\
 &= 12.45 \approx 12 \text{ years}
 \end{aligned}$$

From the results of equation 1, obtained lifetime usage (lifetime) LED lights are longer than HPS lamps. This is in accordance with the LED life specifications on the data sheet and the armature industry has imposed the lifetime of the LED is L70 = 50,000 minimum / hour. In Accordance With LLMF of 0.7 during the lighting installation period is set to the same number of hours. New international standards for LED life are to be included in the LED lifespan limit on the published LED lighting fixtures. These standards include. IEC 627171 LED, modules for general lighting, performance requirements and IEC 62722-2-1.

TABLE I
SPECIFICATIONS AND LAMP USAGE DATA OF PT. BUKIT ASAM

Lamp Type Usage	Time (hours)	Flux (lumens)	Efficacy (lm / w)	Temperature (K)	Lifetime (hours)	Number of Lamp Points
SON-T 70W	11	6000	84	2000	19000	820
SON-T 150W	11	15000	98	2000	20000	381
SON-T 250W	11	28000	110	2000	20000	81
SON-T 400W	11	48000	123	2000	20000	69
HPI-T 1000W	11	85000	86	4300	12000	44
TL 36 W	11	2500	72	6200	15000	65

TABLE II
LIFETIME CALCULATION DATA PER YEAR

Lamp Type Usage	Time (hours)	Lifetime (hours)	Lifetime (years)
SON-T 70 W	11	19000	5
LED 80 W	11	50000	12
SON-T 150 W	11	20000	5
LED 200 W	11	50000	15
SON-T 250 W	11	20000	5
LED 300	11	50000	15
SON-T 400 W	11	20000	5
LED 450 W	11	50000	12

III.3. Light Efficacy

In determining the amount of efficacy, it must be known that the light flux and lamp power in accordance with the equation 2. In Table III, it can be seen the amount of efficacy in each type of lamp, in the specific light flux or light efficacy (K) in Table 2, it can be seen that for HPS lamps the SON-T type has different levels of light efficacy (K), which the higher the type of lamp the higher the amount of power at the specific light flux level (K). While the results of each type of LED lights of 80W450W for efficacy are all 90 lm / w. To prove it Table III, the calculation can be calculated according to equation 2, following the calculation:

$$\begin{aligned}
 &\text{HPS lamps} \\
 &K = \phi / P \quad (2) \\
 &= 6000 / 70 \\
 &= 8.57 \approx 8.5 \text{ lm / wt} \\
 &\text{LED lights} \\
 &K = \phi / P \\
 &= 7200 / 80 \\
 &= 90 \text{ lm / wt}
 \end{aligned}$$

TABLE III
EFFICACY CALCULATION DATA ON LAMP POWER

Lamp Type Usage	Flux (lumen)	Efficacy (lm/wt)	Power (W)
SON-T 70 W	6000	84	71
LED 80 W	7200	90	80
SON-T 150 W	15000	98	153
LED 200 W	18400	90	204
SON-T 250 W	28000	110	254
LED 300	28500	90	316
SON-T 400 W	48000	123	390
LED 450 W	40000	90	444

In Table III for the efficacy of light (K) is very influential on the power that will be generated per light flux (ϕ) lamp. So from the comparison between HPS lamps and LEDs with the same lumen level, the efficacy values are different for each lamp so that it affects the level of power efficiency produced. In accordance with the National Standardization Agency (BSN) that HPS has a higher light efficacy level than LED lamps and.

III.4. Electricity Fee Calculation

In accordance with Presidential Decree of the Republic of Indonesia No.104 of 2003 subject to

Electricity Basic Tariffs are charged in accordance with the provisions [3]. From the data obtained at PT. Bukit Asam (Persero) Tbk., the company gets an electric power supply from PLN of 8.6 MVA so the company is classified as I-3 / TM tariff which is above 200 kVA. In using this limit the company is charged with the company's expense, the use of lamps per day on average for 1 month with 11 hours usage. The following calculations are used as follows:

$$\begin{aligned}
 &\text{Total Electricity Cost in a month} \\
 &\text{Total Cost of I-3 / TM} \\
 &= \text{Cost of Cost} + \text{Usage Fee} \quad (3) \\
 &\text{HPS lamps} \\
 &\text{Total Cost of I-3 / TM} \\
 &= \text{Cost of Cost} + \text{Usage Fee} \\
 &= \text{Rp. } 356.308.320 + \text{Rp. } 55.509.520 \\
 &= \text{Rp. } 411.817.841/\text{month} \\
 &\text{LED lights} \\
 &\text{Total Cost of I-3 / TM} \\
 &= \text{Cost of Cost} + \text{Usage Fee} \\
 &= \text{Rp. } 356.308.320 + \text{Rp. } 67.387.328 \\
 &= \text{Rp. } 423.695.648/\text{month}
 \end{aligned}$$

So in one month the total electricity costs for lighting PT. Bukit Asam (Persero) Tbk. issued a budget of HPS lamps of Rp. 411.817.841, if using HPS lamps. Whereas when using LED lights the total budget for electricity costs for lighting is Rp. 423.695.648.

TABLE IV
ELECTRICITY COST CALCULATION DATA

Lamp Type Usage	Electric Power Consumption Eload (KWH)	1 Year Electricity Cost
SON-T 70 W	57.4	Rp. 238.706.894
LED 80W	65.6	Rp. 272.807.879
SON-T 150 W	57.15	Rp. 237.667.230
LED 200W	76.2	Rp. 316.889.640
SON-T 250W	120.25	Rp. 84.212.798
LED 300W	24.3	Rp. 101.055.357
SON-T 400 W	27.6	Rp. 114.778.924
LED 450W	31.05	Rp. 129.126.290

From an operational level to the level of electricity payment in Table IV the LEDs are bigger because in terms of greater power consumption. In Table IV, the total costs above do not include expenses in a year.

III.5. Investment Costs

Investment costs used for HPS lamps and LEDs in the value of capital investment are things that must be taken into account so that later can know the beginning of the purchase and know the amount that will be issued next. Here's how the calculations are:

HPS lamps
 Initial investment cost
 = Lamp Price x Number of Lights (4)
 = 1.750,000.00 x 820
 = Rp 1.435.000.000

LED lights
 Initial investment cost
 = Lamp Price x Number of Lights
 = 3.700.000.00 x 820
 = Rp 3.034.000.000

III.6. Feasibility Analysis

The results of the analysis have been carried out

on a technical and financial analysis for the method of changing lamps with the same lumen level by comparing both technically and financially. Technically, the method used is feasible to be used as a basis for comparison to find out how to calculate the age of each lamp, the efficacy of light, intensity of light, intensity of illumination, as well as the ratio of power consumption used by lamps.

As for the financial level for the method of changing lamps with the same lumens, which directly compares the level of the cost of energy used, the comparison of investment costs, as well as the cumulative cost difference for 15 years. The following analysis results are obtained as seen in Table IV.

It can be seen in Table VI financially about the feasibility analysis with the method of changing lamps with the same lumen level. It can be said that the use of lamps is more profitable with HPS lamps which in terms of electricity, investment and cumulative costs are more economical and efficient than LED lamps.

TABLE V
 INVESTMENT COST CALCULATION DATA

Lamp Type Usage	Point	Lamp Prices	Investment Cost
SON-T 70 W	820	Rp. 1.750.000,00	Rp. 1.435.000.000,00
LED 80W		Rp. 3.700.00000	Rp. 3.034.000.000,00
SON-T 150 W	381	Rp. 1.840.000,00	Rp. 701.040.000,00
LED 200W		Rp. 6.600.000,00	Rp. 2.514.600.000,00
SON-T 250W	81	Rp. 1.650.000,00	Rp. 133.650.000,00
LED 300W		Rp. 9.250.000,00	Rp. 74.250.000,00
SON-T 400 W	69	Rp. 2.420.000,00	Rp. 166.980.000,00
LED 450W		Rp. 12.325.000,00	Rp. 850.425.000,00
Total Investment Cost of HPS			Rp. 2.436.670.000,00
Total LED Investment Cost			Rp. 7.148.275.000,00

TABLE VI
 FINANCIAL ANALYSIS RESULTS FROM THE COMPARISON METHOD

Lamp Type Usage	1 month TDL fee	Investment Cost	Cumulative Cost
HPS	Rp. 411.817.841	Rp. 3.243.231.996	Rp. 20.604.230.235
LED	Rp. 423.695.648	Rp. 7.148.275.000	Rp. 27.787.386.324

IV. Conclusion

After doing a simulation calculation and discussion of the results of the comparative analysis of HPS lamps and LED lamps, a conclusion can be drawn as follows:

1. Comparison of the life of the two lamps during

usage 11 hours a day, the average age of HPS lamps is 5 years, whereas for LED lamps it has 12 years old. So the benefits of LED lights have a longer life than HPS lamps.

2. Comparison with the same lumen level between HPS lamps and LEDs. The efficacy value influences the light flux and the resulting lamp power according to the light efficacy formula $K =$

ϕ / P . In Table III, the light efficacy value obtained for HPS lamps is 84 to 123 lm / wt , and the LED lights are 90 lm / wt . So that when the same lumen level (ϕ) is needed in the comparison of the HPS lamp and the power LED light (P) generated on the LED lamp is greater than the HPS lamp. Total electricity consumption of HPS lamps is 162.4 kW and LED lamps are 197.15 kW.

3. The initial investment cost budget required for LED lamps of Rp. 7.148.275.000 is far greater than the investment cost budget of HPS lamps of Rp. 2.436.670.000.
4. The results of the calculation of the total cumulative costs for 15 years for the use of HPS lamps with LED lamps are for the use of various types of HPS lamps amounting to Rp. 20.604.230.235 while the total cost for LED lighting clothing is Rp. 27.787.386.324. So based on the results of total / cumulative costs for 15 lamps that are more efficient in terms of investment, operational costs and as a means of lighting are HPS lamps.

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Authors' information



Rahmat Adiprasetya Al Hasibi obtained his B. Eng in Electrical Engineering from Universitas Gadjah Mada, Indonesia in 2001. His Master study was done at the Electrical Engineering, Universitas Gadjah Mada, Indonesia. He currently is a lecture in department of electrical engineering, Universitas Muhammadiyah Yogyakarta.



Agus Jamal obtained his B.Eng. in Electrical Engineering from Universitas Gadjah Mada, Indonesia in 1994. His Master study was done at 2010 at the Electrical Engineering, Universitas Gadjah Mada, Indonesia. He currently is a lecture in department of electrical engineering, Universitas Muhammadiyah Yogyakarta.



Indar Surahmat obtained his B.Eng. in Electrical Engineering from Universitas Gadjah Mada, Indonesia in 2005. His Master study was done at 2011 at the Electrical Engineering, Institut Teknologi Bandung, Indonesia. He is studying for Ph.D. at Faculty of Electrical Engineering and Information Technology, RWTH Aachen University, Germany. He currently is a lecture in department of electrical engineering, Universitas Muhammadiyah Yogyakarta.

Tio Hardiyanto obtained his B.Eng. in Electrical Engineering from Universitas Muhammadiyah Yogyakarta, Indonesia in 2017.



Yessi Jusman obtained her B.Eng. in Electrical and Electronic Engineering from Andalas University, Indonesia in 2007. She worked as a Research Assistant started in July 2008 until November 2009 in Universiti Sains Malaysia. Her Master study was done at 2012 at the School of Electrical and Electronic Engineering, USM Engineering Campus in Nibong Tebal, Penang, Malaysia. She was finished her PhD degree at 2016 in University of Malaya with specializes in Image, Signal Processing, and algorithms. She currently is a lecture in department of electrical engineering, Universitas Muhammadiyah Yogyakarta.



Fardhan Arkan Received B.Sc. degree from Department of Electrical Engineering Universitas Muhammadiyah Yogyakarta in 2000, M.Eng. degree from Department of Electrical Engineering, Universitas Andalas, Padang, Indonesia in 2014. Fardhan Arkan, M.Eng. is a Lecturer in Department of Electrical Engineering, Universitas Bangka Belitung, Indonesia. His research interests are in electronics, telecommunications, and its applications.