Potential Energy Saving in Ligthing Systems

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Potential Energy Saving in Ligthing Systems

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Abstract

Nowadays, Carbon-rich fuels are the principal energy supply utilized for powering human society, and it will be continued for the next some decades. Connecting with this, modern energy technologies are very essential to convert the available limited carbon-rich fuels and other green alternative energies into useful energy efficiently with an insignificant environmental impression. Therefore, the main objective of this study is assessing the potential of municipal biomass solid waste for briquette production in Bahir Dar city, Ethiopia. To conduct this research, various data collection instrument tools were used to achieve the intended objectives for instance questionnaire, direct measurement, field observation and related literature based on necessity. Moreover, to confirm the reliability of the information obtained through a questionnaire, a focus group discussion was conducted with different concerned bodies. The main finding of this study shows that Bahir Dar city has the potential to generate 50.19 tons of municipal biomass solid waste per day. The collected waste was characterized as 82.5% of them is organic waste that may be converted in to clean energy (briquette and biogas) based on their sized whereas the remaining 17.5% of them were inorganic (plastics, glass, and metals) that can be resent for recycling and reuse to their original sources. Biomass-related solid municipal waste is a promising potential to utilize as a feedstock for briquette production. Besides, it has a prodigious role to reduce deforestation, land degradation, save foreign currency and reduce greenhouse gas emissions. This is because the demands of household's energy that was fulfilled with wood charcoals and fossil fuels are substituted with locally available renewable energy sources. The experimental results confirmed that all the physicochemical properties of briquette charcoal that are produced from municipal solid biomass waste were acceptable. Besides, the burning efficiency of the briquette, fanning time and carbon content determination were measured and obtained as adequate results based on the standards. Hence, it will be a possible alternative fuel for household energy using a special design stove that is available in the market. It has also played a great role in waste management and treatment system to achieve sustainable clean city developments.

Keywords: Energy saving; Lighting; SNI 03-6197-2000

Introduction

Energy plays an important role in every sector of life. Every day the needs for energy continue to increase in line with the increase in population. While the national energy reserves are mostly composed of fossil fuels and dwindling, so it is feared scarcity.

In 2000 and 2015, the electricity demand in Indonesia has increased 150% in line with the increase of the Gross Domestic Product. In 2017, Indonesia's Energy Efficiency Report states that Indonesia consumes up to 36% of total energy needs in Southeast Asia [1]. The energy consumption is spread in several sectors, such as households that consume up to 378.05 million BOE, transportation sector consumes energy up to 303.31 million BOE, the industrial sector amounted to 255.81 million BOE, and other sectors up to 112.13 million BOE [2].

The government was aware of this and tried to find a way to prevent such scarcity from happening. One is through energy conservation policy as stipulated in Government Regulation number 70 of 2009. Energy conservation or energy savings is an activity to improve efficiency in energy use. One of the policies is that users of energy sources must use energy economically and efficiently [3].

In Indonesia, the building sector contributes up to 70% of overall electricity consumption [4]. The energy consumption is dominated by the air conditioning system in the first rank and the lighting system in the second rank [5].

College as a place to gain knowledge is expected to have knowledge and awareness about the importance of energy savings and can apply them in daily learning activities. The savings are most easily done on the lighting system. The trick is to maximize daylighting, due to the use of daylighting is expected to reduce the use of artificial lighting [6]. The issue is not just turning off lights when not in use, but also looking at how these savings do not reduce the comfort of the occupants [7].

The background of this research is the results of the audit conducted by Rudiyanto, Adrya W & Ronaldo [8] in Building A of the Postgraduate Program at Diponegoro University. The Energy Use Intensity (EUI) score was 3.41 kWh/m^2/month [9] (Figure 1). Where the EUI value is still very efficient by Ministry of Energy and Mineral Resources Regulation (PERMEN) Number 13 of 2012 [10]. Another finding is that lamps are the second largest major energy user after air conditioning, which around to 6.10% of total electricity consumption, while the air conditioning was 76.86%. According to this background, it is necessary to re-observe the savings opportunities in the lighting system. The lighting system was chosen because savings can be made with minimal costs, but still pay attention to the applicable standards.

Methodology

Postgraduate building A is facing south. Building A consists of

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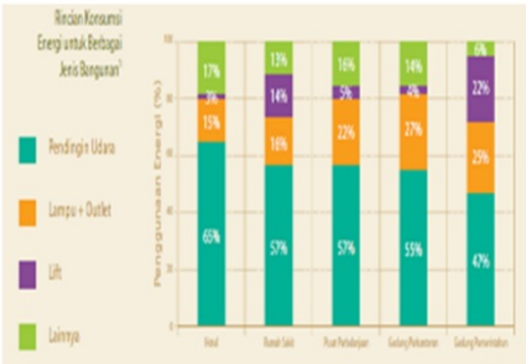

Figure 1: Details of energy consumption from various types of buildings.

Figure 2: Six room samples located in 2nd to 5th floor in building.

6 floors with an area of 4,802 m^2. This building is used for lectures, administration rooms, and offices for lecturers and employees. Office activities began on Monday-Friday from 8 a.m. to 4 p.m., while the lectures held from Monday to Saturday starting from 8 a.m. to 04:00 p.m. 1st floor area is 825 m^2, 2nd floor is 797 m^2, 3rd floor is 865 m^2, 4th floor is 710 m^2, 5th floor is 721 m^2, and 6th floor is 884 m^2. Building A Diponegoro University Postgraduate is between the Old Building on the west side, BNI Building and Building B on the east side. Here is the documentation of the room to be observed (Figure 2).

All the 6 room samples are located in 2nd to 5th floor in Building A. All the 6 room have a window that faces south, east, and west. Room 301, room 401 and room 501 has the same type of room. This study uses quantitative methods to analyze primary and secondary data on the 6 samples of a lecture hall in Building A.

Primary data is obtained by measuring the illuminance using lux meter. SNI 16-7062-2004 is used as a standard in determining the measuring point [11]. Based on these standards, measurement points are at the intersection of the horizontal line length and width of the room at any given distance with a height of 1 m from the floor. The determination of the measuring point based area of the room in which (Figure 3):

- If the room area is <10 m^2, then the measuring point is every 1 m.
- If the room area between 10-100 m^2, then the measuring point every 3 m.
- If the room area is >10 m^2, then the measuring point is every 6 m.

After luminance measurement results obtained and compared with recommendations on SNI 03-6197-2000 where exposure levels in a classroom at a minimum of 250 lux [8]. As for the secondary data obtained from literature sources.

Results and Discussion

Based on previous audits, researchers tried to look back on energy consumption in the room in Building A. Observations conducted on 6 room samples and the results are shown in the table (Table 1).

Energy consumption is the result of multiplication of the lamp power and time usage of the lamp [12]. The Table 1 shows that under

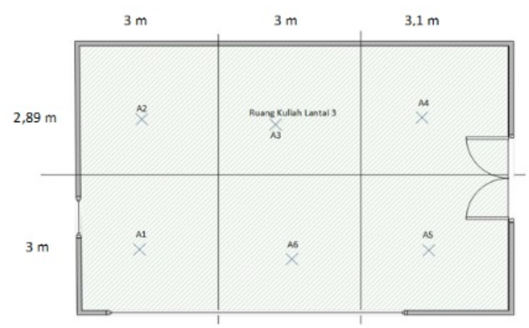

Figure 3: Example of determination of measurement points.

existing conditions assuming the entire room operates at 8 a.m.-6 p.m. on Monday-Saturday, all the 6 room samples in Building A consume up to 2.38 MWh/year of energy or pay electricity bills up to IDR 2,146,176,000 [13].

Before finding savings opportunities, it is necessary to measure the illuminance to determine the condition of the lighting system in each room. Illuminance measurements were done with a guide of SNI 16-7062-2004. Based on observations in the field and luminance measurements obtained the following data.

The table (Table 2) shows that the room with a south facing window receives more daylight than the room whose window orientation faces east and west, this is because the room has a bigger window than the one facing west and east. Besides that, from the west and east sides of the incoming sunlight is blocked by other building.

Based on observations in the field, it can be seen the characteristics of the 6 room samples as follows (Table 3). Based on the Table 3, the opportunity for savings can be done by adjusting the number of lights used, adjusting the time of the lights, and how long the lights are used as follows (Table 4).

Based on the Table 4, the results show that total energy consumption after the adjustment is 1.7 MWh/year, which means that the adjustment was able to save 632,448 Wh/year only for the lighting system in the 6 rooms sample.

After knowing the amount of electrical energy consumption in the

Floor	Room	Orientation	Power (W)	Number of CFL Lights	Energy Consumption 8 a.m.-6 p.m. (Wh)
2	Room 201	East	18	6	1.08
3	Room 301	South	18	8	1.44
3	Room 302	West	18	8	1.44
4	Room 401	South	18	8	1.44
4	Room 402	East	18	8	1.44
5	Room 501	South	18	8	1.44
Total Electric Energy Consumption (Wh/year)					2.384.640
Cost Electric Energy Consumption (Rp/year)					2.146.176.000

Table 1: Energy consumption of lighting systems in existing conditions.

Room Name	Orientation	Time	Illuminance (lux)					
			A1	A2	A3	A4	A5	A6
Room 201	East	9.56	17,9	37,5	63,4	132,4	38,2	22,3
		13.14	11,6	28,6	47	114	23	13,9
		15.49	6,7	9,4	13,8	50,1	9,4	5,3
Room 301	South	8.3	324	123	125	113	175	258
		13.21	187	59,6	58,5	55,4	136,4	141
		15.53	56,5	19,2	18,1	18,6	47,3	44,2
Room 302	West	9.22	27,8	93,5	36	17,4	18	30
		13.36	20	92	34	13	13	22
		16.09	5,4	26,3	8,7	3,6	3,4	5,7
Room 401	South	10.53	462	205	199	152	221	403
		13.39	795	358	390	272	440	626
		15.36	728	201	252	194	679	847
Room 402	East	11.15	34,1	76,3	220	231	64	30
		13.45	35	77	211	150	64	32
		15.42	20,2	38,5	132,9	145,9	38,2	20,9
Room 501	South	11.3	898	793	456	322	472	724
		13.51	1177	983	536	368	788	1050
		15.27	1152	1022	478	363	1004	1261
Note: Yellow blocks are luminance that is matched with SNI standards.								

Table 2: Daylighting measurement results.

Room Name	Room Condition	Daylight Condition
Room 201	Room with a 9.43x6.04 m wide and has a window with an east-facing orientation.	Daylight that enters the room is blocked by the BNI building, so that sunlight cannot be fully utilized.
Room 301	Room with a 9.1x5.89 m wide and has a south and east facing window orientation.	Based on the determination of measurement points and measurement results, daylighting can be used properly in a room measuring area of 6x3 m at 8 a.m.-12 p.m.
Room 302	Room with a 9.62x4.71 m wide and has a west and east facing window orientation.	Daylighting cannot be fully utilized in this room because the windows on the east side face the hallway. While the windows on the west side with a size of 120x60 cm and is often covered by the whiteboard.
Room 401	Room with a 9.23x5.73 m wide, with the sa.m.e type of room with 301.	Based on observations and measurements results, the use of daylighting can be divided into various time as follows: • At 8 a.m.-12 p.m. (4 hours), just turn on 6 of the 8 lights. • At 12 p.m.-2 p.m., 8 lights can be turn off, because in this hour span the sunlight can be utilized to the maximum. • At 2 p.m. – 5 p.m., there are 4 measuring points still meet the standards that recommended by SNI, is located 9,1 m x 3 m from the window and 1 point in the area of 3x2.89 m. • At 5 p.m.-6 p.m. the 8 lights must be used.
Room 402	Room with a 9.50x4.40 m wide and has an east-facing window orientation.	Daylighting in this room cannot enter optimally because it is blocked by the BNI building and building B.
Room 501	Room with a 9.23x5.73 m wide and has a south and west facing window orientation and the west, with the same type of room with 301 and 401.	Because nothing prevents incoming sunlight into the room, then from 8 a.m.-5 p.m. daylighting is able to illuminate this room. After 5 p.m., the room needs to be supported by artificial lighting.

Table 3: Characteristics of the room.

Room	8 a.m.-6 p.m.	8 a.m.-12 p.m.	12 p.m.-6 p.m.	5 p.m.-6 p.m.	12 p.m.-2 p.m.	2 p.m.-5 p.m.	Total energy consumption (Wh)
201	6 lamps	-					1080
301		6 lamps	8 lamps	-			1296
302	8 lamps	-					1440
401		6 lamps	-	8 lamps	-	2 lamps	684
402	8 lamps						1440
501	-			8 lamps			144
Total Electric Energy Consumption (Wh/year)							1.752.192
Cost of Electric Energy Consumption (Rp/ year)							1.576.972.800

Table 4: Time lamps settings.

Existing Energy Consumption (kWh/year)	Existing Electricity Bill (Rp/year)	Energy Consumption After Adjustment (kWh/year)	Existing Electricity Bill Adjustment (Rp/year)
2.384.640	2.146.176.000	1.752.192	1.576.972.800

Table 5: Comparison of total consumption of electricity.

lighting system and billing costs for one year in the 6 rooms, it can be compared to energy consumption between the existing conditions and after being an adjustment.

From the Table 5 it can be seen that after adjustments were made, savings of up to 26.52% were obtained or if expressed in rupiah the savings were IDR 569.203.200 each year for 6 rooms sample. The savings value will be even more if applied to another room.

Conclusion

Based on the observations and measurements in the field, it was concluded that the improvement in energy consumption in the lighting system by adjusting the number of lights used, adjusting the time of the light, and how long the lamp is used resulting in savings of up to 26.52% from existing conditions. The biggest savings are obtained from room 501 with south and west oriented windows, this room gets good daylighting. Besides that, rooms with south-oriented windows tend to have a large intensity of daylighting because the incoming sunlight is not blocked by other buildings when compared to rooms that have west or east windows facing orientation.

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