Energy Audit of Flouresen Lights at School Building C III Floor Politeknik Negeri Semarang

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Abstract- *Energy audit is very necessary to calculate the level of energy consumption of a building or buildings. The research includes the amount of energy consumption based on the initial energy audit and detailed energy audit as well as saving opportunities based on conditions in the field. Based on the initial energy audit, the value of the Energy Consumption Intensity (IKE) is 0.699 kWH/m2month, while in the detailed audit the IKE value is 0.935 kWH/m2month. Based on the results of a detailed energy audit, the lighting measurement of 325 lux still meets the requirements for a classroom with a standard between 250 lux to 500 lux.*

Keywords: Energy audit, electrical energy

I. INTRODUCTION

In managing energy savings, it is very important, especially in the use of electrical energy, the portion of use and the allocation of funds for its provision is large. It can be seen that equipment such as lights in the Semarang State Polytechnic building which functions as lighting, especially for student learning activities. Efforts to save electrical energy have been carried out by the Polytechnic such as scheduling operations, replacing lamps with energy-saving lamps, but the operational costs of electrical energy still exceed the predetermined standards.

To overcome this problem, energy efficiency is carried out. One of the methods currently used to streamline the use of electrical energy is energy conservation. Energy conservation is an increase in the efficiency of energy used or energy saving processes. This process includes an energy audit, which is a method for calculating the energy consumption level of a building or buildings, the results of which will be compared with existing standards to then look for solutions to save energy consumption if the energy consumption level exceeds existing standards.

Indonesia is rich in energy sources, but their utilization has not been balanced because they depend too much on petroleum energy sources. In fact, today's petroleum energy source is the most important source of income and its supply is limited. This dependence on one energy source, namely petroleum and its derivative products, cannot be allowed to continue because energy needs will continue to increase, both due to increased industry and population growth and an increase in people's welfare.

To deal with the problems mentioned above, energy policy measures have been drawn up by the government, these steps are:

a. Intensification
b. Diversification
c. Conservation

II. METHODS

The research method used is exploration and literature study and energy conservation is carried out. Energy conservation is an increase in the efficiency of energy used or energy saving processes. This process includes an energy audit, which is a method for calculating the energy consumption level of a building or buildings, the results of which will be compared with existing standards to then look for solutions to save energy consumption if the energy consumption level exceeds existing standards.

The research variables include the amount of energy consumption based on the initial energy audit and detailed energy audit as well as saving opportunities based on conditions in the field. In the initial energy audit, the amount of Energy Consumption Intensity (IKE) for each conditioned unit area (net area) will be calculated according to usage based on historical building data. In the detailed energy audit, the IKE will be calculated based on observations of the use of electrical energy in detail with various equipment that consumes electrical energy and the time of its use.
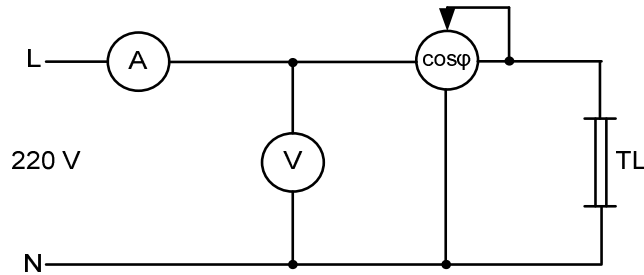
Figure 2. Test circuit

- The equipment used are:
- Digital Lux meter
- Ampere meter (A)
- Voltmeter (V)
- Cos meter
- TL lamp 2x65 Watt

III. RESULTS AND DISCUSSION
4.1 Initial Energy Audit
The SC-III Semarang State Polytechnic Building is a place for lectures for students of the Mechanical Engineering Department, especially the Energy Engineering Study Program. SC-III building uses a lecture schedule on Monday to Friday, lectures start at 07.00 to 21.00 .
By looking at the lecture schedule, it can be determined the length of time the use of electrical energy from PLN. On average, SC-III buildings use a lighting system starting at 16.45 to 21.00 , because natural light is no longer possible for lecture activities.

The following are data on energy consumption and its allocation for the SC-III Semarang State Polytechnic Building for one week (Monday to Friday period during lecture hours). From the use of electrical energy LWBP and WBP (Kwh/Month) by looking at the lecture schedule in one month and energy costs according to the basic electricity tariff table, it can be seen in table 4.1.

Table 4.1 Electrical Energy Consumption Data

No	Room	Usage Time (Hour/Month)		Usage Kwh/Month		Total Kwh/Month	Energy Cost
		LWBP	WBP	LWBP	WBP		
1	01	5	12	3,9	9,36	13,26	12710
2	02	8	12	6,24	9,36	15,6	14804
3	03	5	6	3,9	4,68	8,58	8100
4	04	15	18	11,7	14,04	25,74	24300
5	05	25	36	26	37,44	63,44	60148
6	06	25	36	13	18,72	31,72	30074
7	07	3	-	2,34	-	2,34	2094
8	08	25	36	13	18,72	31,72	30074
9	09	10	12	7,8	9,36	17,16	16200
10	10	5	6	3,9	4,68	8,58	8100
11	north corridor	25	36	6,5	9,36	15,86	15037
12	west corridor	25	36	4,875	7,02	11,895	11277
13	east corridor	25	36	4,875	7,02	11,895	11277
	Maximum	25	36	26	37,44	63,44	60148
	Minimum	3	6	2,34	4,68	2,34	2094

Total	201	282	108,03	149,76	257,79	244200
Average	16,15	21,69	8,31	11,52	19,83	18148

Occupancy Rate
The occupancy rate in the SC III Building of the Energy Conversion Engineering Study Program per room is quite varied. From the occupancy rate data in one month it is calculated that the average occupancy rate in SC III Building, Semarang State Polytechnic is 43.71%.

Electrical Energy Consumption Rate Data
From table 4.1 it can be directly calculated the total number of kWH consumed in School Building C Floor III Semarang State Polytechnic in one month and also the total amount of costs that must be paid for the procurement of electrical energy in that period. The

total kWH is 257.79 kWH and this is worth Rp 244,200.00

Electricity cost:
   b. WBP (Peak Load Time) rate per kWH from PLN The price of Rp 985.00/kWH applies
lectures at 18:00 to 21:00 (3 hours)
b. LWBP Tariff (Over Peak Load Time) per kWH from PLN Price Rp 895.00/Kwh
   class applies at 16:45 to 18:00 (1.25 hours).

To find out the value of the average electricity tariff that applies at School Building C III Floor Semarang State Polytechnic is as follows:

$$WBP = IDR\ 985.00\ /\ kWH\ x\ 3\ hours = IDR\ 2,955.00\ hours/kWH$$
$$\underline{LWBP = IDR\ 895.00\ /\ kWH\ x\ 1.25\ hours = IDR\ 1,118.75\ hours/kWH} +$$
$$Total = IDR\ 4,073.75\ hours/kWH$$

So that the average rate per kWH per hour in lectures is obtained as follows:
$$= IDR\ 4,073.75\ hours/kWH\ /\ 4.5\ hours$$
$$= Rp\ 958.53\ /\ kWH$$

Calculating IKE
From energy consumption data and building area data as well as the level of occupancy rate at School Building C Floor III, it can be calculated the amount of Energy Consumption Intensity (IKE) School Building C Floor III Semarang State Polytechnic. The calculations are as follows:

$$IKE = \frac{kWH\ total}{(Occ.Rate\ x\ Area\ Room) + Area\ non\ Rom}$$

$$= \frac{218,437}{(0,4371\ x\ 580) + 115}$$

$$= 0.699\ kWH/m^2.Month$$

4.2 Detailed Energy Audit
The calculation of electrical energy is carried out using data based on the measured value that is read on the measuring instrument and taking direct measurements of each room in the SC-III Building, Semarang State Polytechnic. The data from the measurement of electrical energy consumption in each room in the SC-III Building of the Semarang State Polytechnic can be seen in table 4.2.

Table 4.2 Fluorescent Lamp Measurement Data For Illumination Level (Illumination), Current (A), Voltage (V) And Power Factor (Cos)

No	Room	Area (m^2)	Ilumination (Lux)	Current (A)	Voltage (V)	Cos φ
1	01	60	325	3,34	215	0,9
2	02	60	325	3,34	215	0,9
3	03	60	325	3,34	215	0,9
4	04	60	325	3,34	215	0,9
5	05	80	333	4,3	215	0,9

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No	Room	Area (m²)	Ilumination (Lux)	Current (A)	Voltage (V)	Cos φ
6	06	40	370	2,1	215	0,9
7	07	60	325	3,34	215	0,9
8	08	35	328	2,1	215	0,9
9	09	60	325	3,34	215	0,9
10	10	60	325	3,34	215	0,9
11	north corridor	35	100	1,2	215	0,9
12	west corridor	75	127	1,3	215	0,9
13	east corridor	45	99	1,1	215	0,9

Energy Consumption Data

The actual power can be found by the equation P = V.I.Cos

Electrical Energy Consumption in one month :
- Usage time (Hours/Month) average LWBP = 16.15 and WBP = 21.69

- Average Kwh/Month usage LWBP = 7.038 and WBP = 9.766
- Total Kwh/Month on average is 16,803
- Average Energy Cost is 15917.390

Tabel 4.3 Occupancy Rate Data and Total kWH/Month

No	Room	Occupanc Rate (%)	Total Kwh/Month
1	01	20	10,986
2	02	23,53	12,925
3	03	12,94	7,109
4	04	38,82	21,327
5	05	71,76	50,755
6	06	71,76	24,788
7	07	3,53	1,939
8	08	71,76	24,788
9	09	25,88	14,218
10	10	12,94	7,109
11	north corridor	71,76	14,164
12	west corridor	71,76	15,345
13	east corridor	71,76	12,984
		Total	218,437

Calculating IKE

From energy consumption data and building area data as well as the level of occupancy rate at School Building C Floor III, it can be calculated the amount of Energy Consumption Intensity (IKE) School Building C Floor III Semarang State Polytechnic in one month. The calculations are as follows:

$$IKE = \frac{kWH\ total}{(Occ.Rate \times Area\ Room) + Area\ non\ Rom}$$

$$= \frac{218,437}{(0,4371 \times 580) + 115}$$

$$= 0.935\ kWH/m^2.Month$$

IV. CONCLUSION

From the results of the analysis that has been carried out, several conclusions from the energy audit results, related to energy consumption, air conditioning systems at SC III Building, Semarang State Polytechnic, can be drawn, among others:

    b. Based on the initial energy audit, the Energy Consumption Intensity (IKE) value is 0.699 kWH/m²month, while in the detailed audit the IKE value is 0.935 kWH/m²month.

b. Based on the results of a detailed energy audit, the luminance measurement of 325 lux still meets requirements for classrooms with standards between 250 lux to 500 lux.

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REFERENCES

[1]   Selamet riadi dan Erry Trigunadi. "Audit Energi Untuk Mencapai Peluang Penghematan Energi". Jurnal Teknologi Vol. 7, No. 1 Januari 2017. ISSN 2088-3315.

[2]   Muhamad Aris Raharjo dan Selamet Riadi. "Audit Konsumsi Energi Untuk Mengetahui Peluang Penghematan Energi Pada Gedung PT INDONESIA CAPS AND CLOSURES". Jurnal PASTI Volume X No. 3, 342 - 356.

[3]   Babu, Manjunatha. "Energy Audit, Conservation And Power Factor Improvement For BMSIT Campus". International Journal of Research Engineering and Technology, Vol.1 No.1. 2013.

[4]   Malik, Abdul. "Audit Energi Pada Gedung IV Kantor PT PLN (PERSERO) Wilayah Kalimantan Barat". Jurnal ELKHA Vol.5, No.2. 2013.

[5]   Untoro, Jati. Audit Energi dan Analisa Penghematan Konsumsi Energi pada Peralatan Listrik di Gedung Pelayanan Unida. Jurnal Rekayasa dan Teknologi Elektro Vol 8, No.2. 2014.

[6]   Agung Wahyudi dan Dadang S. Permana. "Analisis Audit Energi Untuk Pencapaian Efisiensi Energi Di Gedung AB, Kabupaten Tangerang, Banten". Jurnal Teknik Mesin (JTM), Vol. 06, 2017.

[7]   Purbaningrum, Sanurya Putri. "Audit energi dan analisis peluang penghematan konsumsi energi listrik pada rumah tangga." Jurnal Media Mesin, Vol. 15, No. 1, januari 2014, hal. 26 – 33.

[8]   Biantoro, Agung Wahyudi, and Dadang S. Permana. "Analisis AuditEnergi untu Pencapaian Efisiensi Energi di Gedung Ab, Kabupaten Tangerang, Banten." Jurnal Teknik Mesin Mercu Buana 6.2 (2017): 85-93.

[9]   Marzuki, Achmad. "Audit Energi pada Bangunan Gedung Direksi PT. Perkebunan Nusantara XIII (Persero)." Vokasi, Volume 8, Nomor 3, Oktober 2012. hal 184 – 196.

[10] Mulyani, Fajariyah, Hadi Suyono, and Rini Nur Hassanah. "Audit dan Rancangan Implementasi Sistem Manajemen Energi berbasis ISO 50001 di Universitas Brawijaya Malang." Jurnal EECCIS 12.2 (2018): 78-84.

[11] Rahayu, Nirita Noviyati. "Audit Energi Listrik Pada PT. X." Jurnal Online Mahasiswa (JOM) Bidang Teknik Elektro 1.1 (2016): 1-9.

[12] Purwito, Purwito, Tadjuddin Tadjuddin, and Akbar Akbar. "Audit Energi dan Analisis Peluang Penghematan Energi di PT. Daikin Air Conditioning Makassar." INTEK: Jurnal Penelitian 5.2 (2018): 115-121.

[13] Marzuki, Achmad. "Audit Energi pada Bangunan Gedung Direksi PT. Perkebunan Nusantara XIII (Persero)." Vokasi, Volume 8, Nomor 3, Oktober 2012. hal 184 – 196.

[14] Jamal, Marlina, Floransya Dwi. "Audit Energi dan Analisis Peluang Penghematan Energi Listrik Pada Bagian Produksi di PT. EPFM Makassar". Sinergi No. 1, Tahun 17, April 2019.

[15] M. Ikhsan and M. Saputra, "Audit Energi Sebagai Upaya Proses Efisiensi Pemakaian Energi Listrik Di Kampus Universitas Teuku Umar (UTU) Meulaboh," Jurnal Mekanova, vol. 2, no. 3, pp. 136-146, 2016.

[16] F. Hazrina, V. Prasetia and A. A. Musyafiq, "Audit dan Analisis Penghematan Energi Sistem Tata Cahaya Gedung E dan F (Studi Kasus di Politeknik Negeri Cilacap)," Jurnal ECOTIPE, vol. 7, no. 1, pp. 12-19, April 2020.