Energy Conservation Evaluation through Energy Audit at Building on Green Campus of Universitas Negeri Semarang: Case Study on Prof. Dr. Retno Sriningsih Satmoko Building

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Keywords: Energy Consumption, Energy Audit, Green Campus.

Abstract: The high consumption of electrical energy in the college of higher education, making the greater effort to do energy conservation in the campus environment. For that campus undertake a program of decreasing electrical energy consumption through energy management program, where one of them is energy audit. Energy audit conducted in this research is an energy audit in building Research Institute and Community Service / Prof. Dr. Retno Sriningsih Satmoko building of Universitas Negeri Semarang. The energy audit starts with the collection and processing of historical data on building energy consumption, then calculates the Energy Usage Intensity (EUI). The number of rooms in the Prof. Dr. Retno Srininsih Satmoko Building which EUI value into the wasteful category as much as 12 rooms, with the result of energy savings opportunities obtained for IDR. 65.200.882. Based on measurements of Prof. Dr. Retno Sriningsih Satmoko building air governance in the comfort category. Energy audit results need to be followed up by university managers to conserve energy.

1 INTRODUCTION

The reduction of energy consumption in green campus is a priority. This is linked to the high costs that the university pays. On the other hand, it is the responsibility of the college of higher education as a pioneer of sustainable environment to answer the challenges of global warming. The UI Green Metric ranking provides a requirement for participants to comply with the Energy and Climate Change criteria, in which there are indicators of the application of energy efficiency and electrical indicators used in years (UIGM, 2017). Hongwei Tan, et. al (2014) conclude that development of energy and resource efficient campus has been expanded in a large scale in China, mainly aiming at the energy efficient technology application and campus energy management, and all these initiatives are strongly promoted by the national government with policy support and financial funding. Building Prof. Dr. Retno Sriningsih Satmoko is a building has a high enough activity because as a place of administrative center of research activities and community service. All teachers often visit this place therefore need a safe and convenient service. Building electrical appliances work in full ie lighting, air conditioner, photocopy machine, LCD projector, computer, water pump, and others. Prof. Dr. Retno Sriningsih Satmoko building has a building area of 6000 m2 consists of 3 floors each of which has an area of 2000 m2 per floor. In electric system have dual power that is electricity from PLN and 2 Genset as electricity reserve when there is blackout Genset have capacity of 400 KVA and 200 KVA per generator and capacity of MCB 315 A. Electrical system from PLN that supply tariff of S3K with power installed 1385 KVA and Trafindo transformer capacity of 1000 KVA. The building's transportation system utilizes lifts and ladders. For Elevator that serves as emergency when power outages, lift disupplay electric power from 8 pieces accumulator 14.9 v / acumulator. In the irrigation system (water pump) has 3 pumps with different types, first, the submersible pump " Grudfos" pump with a power capacity of 1.5 KW which serves as a water pump from a large scale water storage tub to the building tandon. Second, 2 pumps type Deepwell Pump 'Grudfos' 1.1 KW which serves as a water pumper from the well to the tandon of large-scale

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water storage. Also has a solar panel system with 6 pieces of solar panel outside the building size 40 cm x 30 cm. There are 8 accumulators (batteries) with storage capacity 200 Ah / 12 V per accumulator (battery). 1 Inverter DC-AC with a voltage of 48 V. There is a system of fire extinguisher (free hydrant), Air conditioning system (air conditioning), CCTV (Close Circuit Television) and the central telephone.

Figure 1: Location of the Prof. Dr. Retno Sriningsih Satmoko building.

Figure 2. Front look of Prof. Dr. Retno Sriningsih Satmoko Building.

2 METHODS

This research is designed using a "research and development" approach that is a program that begins a research needs analysis, then developed a development program and test its effectiveness (Sugiyono, 2006). The method of collecting data uses the following techniques: a. Observation technique used to take (1) PLN electricity bill data, (2) total building area, and (3) building specifications. b. Direct Measurement Technique, will be used in retrieving data through measurement of illumination, temperature, humidity, voltage, current, and electrical power in each building panel on the RST phase.

3 RESULT

Table 1: SpEUIfication of the building.

a. Building name	Prof. Dr. Retno Sriningsih Satmoko
b. Building area	First floor = 2000 m^2 Second floor = 2000 m^2 Third floor = 2000 m^2
c. Number of floors	3
d. Brand Trafo	Trafindo
e. Voltage	220-380 V
f. Trafo Capacity	1000 KVA
g. Genset (backup)	200 KVA / MCB 315 A
h. Power	1385
i. ID. Customer	523530250393
j. rate Group	S3K

Table 2: Energy Consumption per month 2017.

Month	Number of Electricity (kWh)
January	16.294
February	18.816
March	12.176
April	17.888
May	15.584
Juny	11.440
July	17.136
August	13.504
September	10.768
October	18.608
November	15.616
December	18.868
Total	186.694

Table 3: Daily electrical load (KWh).

Measurement Time			
Day	07.00-18.00	11.00-12.00	14.30-15.30
Monday	16,401	19,520	16,621
Tuesday	17,641	20,298	17,555
Wednesday	18,994	22,215	14,808
Thursday	17,878	21,332	12,571
Friday	12,604	18,409	16,004

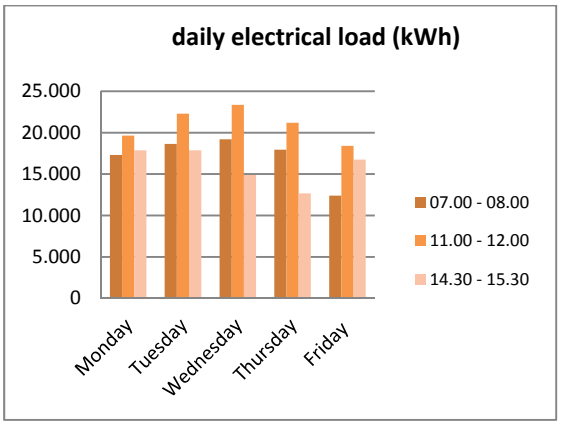

Figure 3: Daily electrical load.

Table 1 shows the SpEUIfication of the building. Energy Consumption per month in 2017 is appeared in Table 2. Table 3, shows that the largest average use of energy during the day due to high work activity and the use of electrical equipment to the maximum.

The results of the measurement of the intensity of energy consumption in Prof. Dr. Retno Sriningsih Satmoko building shows that there are 12 rooms of 38 rooms which are wasteful of electric energy consumption so it is important that the AC energy efficiency program is to replace the old air conditioner with environmentally friendly AC inverter, room temperature setting and life time regulation. Measurement of the strong level of illumination in each room of Prof. Dr. Retno Sriningsih Satmoko building done at 7.00-16.00 hours (working hours) is described as follows Figure 3.

Seen that most of the room there is less and there is more than the strong standard of illumination SNI 6197: 2011.

From the measurement of Prof. Dr. Retno Sriningsih Satmoko building temperature, it is known that the average temperature and humidity in the air system is temperature + 28 ^{o}C and humidity + 73 %.

In SNI 6390: 2011 for highland or mountain areas with an average maximum air temperature of about 28 ^{o}C DB and 24^{o}C WB or less (or an average temperature of 23 ^{o}C or less), generally no artificial air conditioning is required. Means that the air system in the Prof. Dr. Retno Sriningsih Satmoko building is not needed artificial air conditioning because it is included in the highland or mountainous areas, the achievement of thermal comfort and the availability of clean air is entirely charged to the optimization of the architecture design passively.

To determine the potential energy savings opportunities that can be applied to a room that is not categorized as efficient in using electricity, then the difference in EUI value calculated with the standard EUI value must first be calculated. To calculate the energy saving opportunities that can be applied to a room can be used the following that is:

Energy Saving opportunities = EUI x total area of space x electricity rates divided by 12 months

The electricity tariff used to calculate the energy savings opportunities in this study is adjusted with *the basic electricity tariff* the Prof. Dr. Retno Sriningsih Satmoko building is Rp. 16,168,-. The following table will show the calculation of EUI and energy saving opportunities in each room of Prof. Dr. Retno Sriningsih Satmoko building. The efficient EUI standard for air-conditioned buildings is 7.93 KWh / m^2/month whereas the efficient EUI Standard building is not air conditioned ie 0.84 KWh / m^2 / month. Energy savings opportunities of LP2M building are presented in the following Table 5.

Table 5: Results of calculate saving opportunities Prof. Dr. Retno Sriningsih Satmoko building.

No	Room	Calculation energy saving opportuities	Results IDR
1	Conservation Office (CO)	(34,76-7,93)*48*16168	20.821.797
2	Head of CO	(34,42-7,93)*9*16168	3854612
3	Staff PBB	(6,25-0,84)*61,7*16168	5.396.830
4	FKPMN	(22,07-7,93)*30*16168	6.858.465
5	Head of KKN	(21,15-7,93)*16,5*16168	3.526.725
6	R. Admin	(12,44-0,84)*7,5*16168	1.406.616
7	R. Sek. BPM	(16,35-7,93)*18*16168	2.450.422
8	R. Conference	(16,35-7,93)*13,5*16168	1.837.816
9	Guest BPM	(4,82-0,84)*13,5*16168	868.706
10	R. Penjamin Mutu	(51,64-7,93)*17,5*16168	12.367.307
11	Head Office Admin	(22,12-7,93)*15*16168	3.441.358
12	R. 307	(22,59-7,93)*10*16168	2.370.222

4 CONCLUSIONS

The result of EUI calculation was found in Prof. Dr. Retno Sriningsih Satmoko building EUI value 31,65 KWh / m2 / year while for EUI value standard equal to 240 KWh / m2 / year hence building of Prof. Dr. Retno Sriningsih Satmoko buildings into the category of efficients buildings

The number of 38 Prof. Dr. Retno Sriningsih Satmoko building rooms that were evaluated was 26 rooms which were categorized as efficient while there were still 12 rooms that were not in the efficient category. The number of rooms in the Prof. Dr. Retno

Sriningsih Satmoko Building which EUI value into the extravagant category as much as 12 rooms, with the result of energy savings opportunities obtained for IDR 65.200.882,-.The energy audit of a building can be a strategic step for energy efficiency and conservation. The lower consumption of electrical energy will reduce greenhouse emissions so environmentally friendly. Energy audits in the Prof. Dr. Retno Sriningsih Satmoko building can contribute to a sustainable university, especially providing a good value for the UI green metric ranking for universities.

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APPENDIX

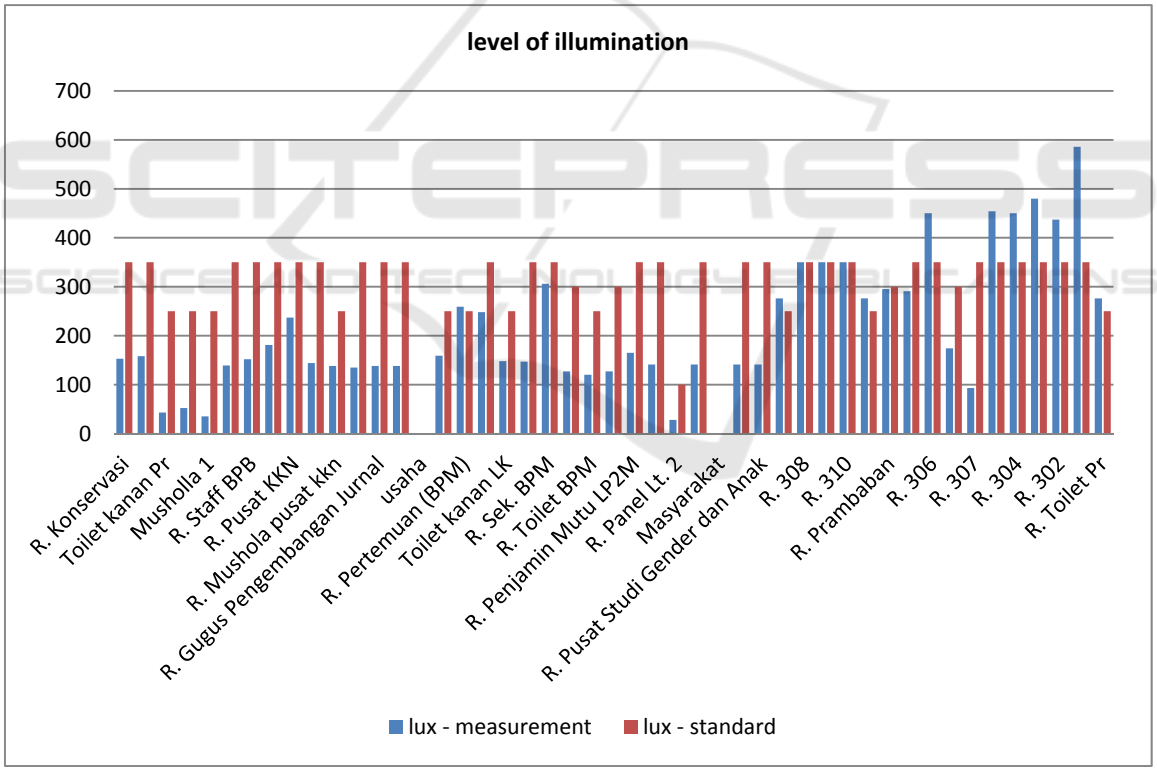

Figure 4: Result measurement level illumination each room of building.

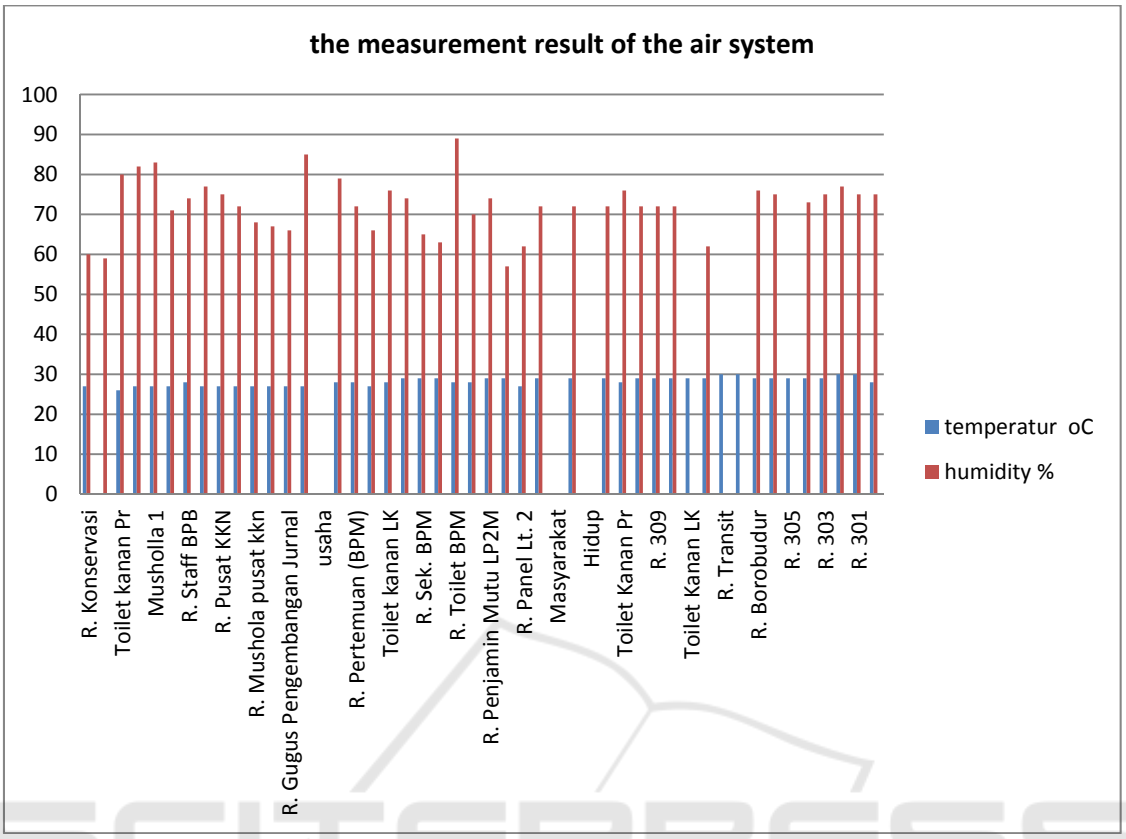

Figure 5: Result measurement of the air system each room of building.