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AUDIT ENERGI DI SEKOLAH MENENGAH PERTAMA NEGERI 1 UNGARAN KABUPATEN SEMARANG

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ABSTRACT; *An energy audit is a systematic evaluation process conducted to assess the energy usage of an organization, building, or industrial process. The primary purpose of an energy audit is to identify opportunities for energy savings, waste reduction, and energy efficiency improvements, which in turn can lower operating costs and reduce environmental impact. An energy audit involves collecting data on energy consumption, analyzing energy usage patterns, and evaluating the performance of existing equipment and systems. Based on the audit findings, recommendations for improvement, such as the adoption of efficient technologies, better energy management, and changes in energy user behavior, can be made. With effective implementation of energy audit results, organizations can achieve significant energy savings, support poverty, and contribute to the reduction of greenhouse gas emissions. Energy audits are an important step in the global effort to create a more efficient and environmentally friendly energy system. This study conducted a survey at State Junior High School 1 Ungaran with an installed electricity capacity of 22 KVA. Energy audit with the main components of field survey, measurement and monitoring, data analysis, identification of potential savings, reports and recommendations to determine the Energy Consumption Intensity (IKE) using the ISO 50001 standard - Energy Management System with area unit metrics. Based on the results of observations of electricity consumption for Class 8 & 9 Buildings at State Junior High School 1 Ungaran, Semarang Regency in one month of 0.4 kWh / m2 / month. Showing that the building uses energy "efficiently" and in accordance with the guidelines in ESDM Regulation No. 03 of 2012.*
Keywords: *Energy Audit, Energy Consumption Intensity, State Junior High School 1 Ungaran, Semarang Regency.*

ABSTRAK; Audit energi adalah proses evaluasi sistematis yang dilakukan untuk menilai penggunaan energi dalam suatu organisasi, bangunan, atau proses industri. Tujuan utama dari audit energi adalah untuk mengidentifikasi peluang penghematan energi, mengurangi pemborosan, dan meningkatkan efisiensi energi, yang pada gilirannya dapat menurunkan biaya operasional dan mengurangi dampak lingkungan. Audit energi melibatkan pengumpulan data tentang konsumsi energi, analisis pola penggunaan energi, dan evaluasi kinerja peralatan serta sistem yang ada. Berdasarkan temuan audit, rekomendasi untuk perbaikan, seperti penerapan teknologi efisien, pengelolaan energi yang lebih baik, dan perubahan perilaku pengguna energi, dapat diberikan. Dengan penerapan hasil audit energi yang efektif, organisasi dapat mencapai tujuan penghematan energi yang signifikan, mendukung keberlanjutan, dan berkontribusi pada pengurangan emisi gas rumah kaca. Audit energi menjadi langkah penting dalam upaya global untuk menciptakan sistem energi yang lebih efisien dan ramah lingkungan. Penelitian ini melakukan survey pada

Sekolah Menengah Pertama Negeri 1 Ungaran dengan daya listrik terpasang 22 KVA. Audit energi dengan komponen utama survey lapangan, pengukuran dan pemantauan, analisis data, identifikasi potensi penghematan, laporan dan rekomendasi untuk mengetahui Intensitas Konsumsi Energi (IKE) menggunakan standar ISO 50001- Sistem Manajemen Energi dengan metrik persatuan luas. Berdasarkan hasil pengamatan konsumsi energi listrik untuk Gedung Kelas 8 & 9 di Sekolah Menengah Pertama Negeri 1 Ungaran Kabupaten Semarang pada satu bulan sebesar 0,4 kWh/m2 /bulan. Menunjukkan bahwa bangunan tersebut menggunakan energi secara "efisien" dan sesuai dengan pedoman yang ada dalam Permen ESDM No. 03 Tahun 2012.
Kata Kunci: Audit Energi, Intensitas Konsumsi Energi, Sekolah Menengah Pertama Negeri 1 Ungaran Kabupaten Semarang.

INTRODUCTION

Energy is one of the important resources that supports various sectors of life, including industry, transportation, households, and the commercial sector. Efficient and sustainable energy use is increasingly becoming a major concern amidst increasing global energy consumption that is directly proportional to the rate of economic growth. As a country with a large population, Indonesia faces a major challenge in managing energy consumption in order to support sustainable development, while reducing negative impacts on the environment. The purpose of this study was to determine the maximum use of electrical power, as well as electrical installations in class 8 & 9 buildings and compare them with energy standards to obtain standard energy consumption intensity (IKE) values. The data taken at SMPN 1 Ungaran only a few buildings could be measured because the cables on the MCB were too tight so that they could not be measured using a Clamp Meter / Ampere Clamp, and there were several unused buildings so that there was no load and current flowing.

RESEARCH METHOD

The research will be conducted in the SMPN 1 Ungaran building located at Jl. Diponegoro 197 Ungaran, SIDOMULYO, Kec. Ungaran Timur, Kab. Semarang, Central Java. The research procedure in this final project aims to explain the steps that will be taken when conducting the research. Research tools and equipment function to support the author in completing the final project. Some of the tools and equipment used are Ampere Clamps, Test Pens, Mobile Phones, Laptops. The data used in this study are primary data and secondary data. Primary data is data obtained directly from the research location, namely State Junior High School 1 Ungaran. While secondary data is data obtained from other sources such as

journals, books, or research from other people related to energy audits in buildings. The research steps taken are:

1. Determining the location of data collection at State Junior High School 1 Ungaran.
2. Conducting observations, interviews with related parties regarding electricity consumption and electrical installations. The data that must be obtained in the electricity audit research at State Middle School 1 Ungaran includes: Layout of lights, air conditioners, and also total electricity consumption in kWh, as well as electricity bill costs
3. Auditing electricity consumption data
4. Calculating the cost of using electricity
5. Analysis of the efficient value of the Energy Consumption Intensity criteria
6. Drawing conclusions from the analysis of the research that has been done.

The following are some relevant standards in conducting energy audits including ISO 50001 - Energy Management System is an international standard that provides a framework for efficient energy management in organizations. It includes requirements for the development, implementation, and maintenance of an energy management system, including the energy audit process. ISO 14001 - Environmental Management System: Although not specific to energy audits, ISO 14001 provides a framework that can be used to integrate energy management with environmental management in general.

RESULTS AND DISCUSSION

3.1 Usage of Electrical Energy Load

The cost of using electrical energy can be seen from the pattern of electricity load usage. The pattern of activities carried out by users is based on the applicable activity schedule with interviews and direct observation. The difference in load usage time is based on the need to consume electricity to support usage activities. The use of electrical load is divided into four times, namely 07.00-09.00, 09.00-11.00, and 11.00-13.00 WIB. The cost of the on load is the load used every day, this load is taken from the habit of using space and equipment on active days. Illustration 4.1 Electrical installation can be seen as follows:

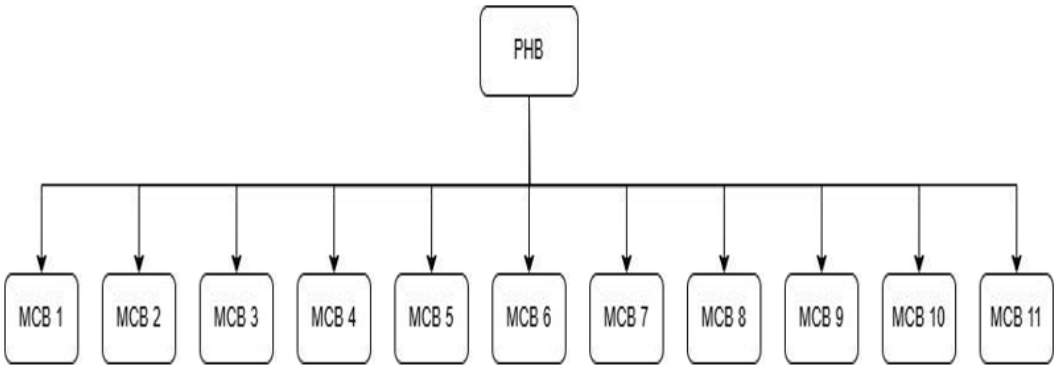

Figure 3.1 Electrical Installation

Descriptions:

Mcb 1: Class 9b Ac

Mcb 2: Class 9c Ac

Mcb 3: Class 9d Ac

Mcb 4: Class 9e Ac

Mcb 5: Class 9d, 9e

Mcb 6: Class 9b, 9c

Mcb 7: Floor 1 And Floor 2 Terrace Lights

Mcb 8: Class 8a, 8b, 8c, 8e

Mcb 9: Class 8f, 8g, 8h

Mcb 10: Class 9f, 9g, 9h

Mcb 11: Class 9f, 9g, 9h AC

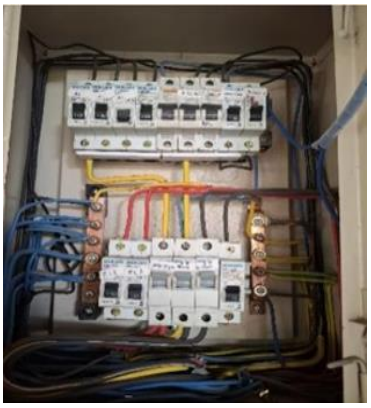

Figure 3.2 MCB 1-1

3.2 Electrical Power Used at State Junior High School 1 Ungaran Semarang Regency MCB 1, MCB 2, MCB 3, MCB 4

Table 3.1 Load Current Data MCB 1, MCB 2, MCB 3, MCB 4

MCB	Jenis Beban	Jumlah	Daya Beban (Watt)	Total Daya (Watt)	Waktu Nyala (Jam)	Arus Terukur(A)		
						07.00-09.00	09.00-11.00	11.00-13.00
MCB 1	AC	1	1000	**1000**	0	0,2	0,4	0,3
	Kipas gantung	2	60	120	2			
MCB 2	AC	1	1000	1000	0	0,3	0,3	0,2
	Kipas Gantung	2	60	120	2			
MCB 3	AC	1	1000	1000	0	0,3	0,4	0,4
	Kipas Gantung	2	60	120	2			
MCB 4	AC	1	1000	1000	0	0,3	0,4	0,4
	Kipas Gantung	2	60	120	2			

Calculation Example on MCB 1

The measured current is multiplied by 220 volts then multiplied by the time it is on (hours) to obtain Electrical Energy (kWh): Electrical Energy = 220V x 2 hours x 0.2 = 88 Watts

Table 3.2 Data on Electrical Energy Calculation Results for MCB 1, MCB 2, MCB 3, MCB 4

MCB	Jenis Beban	Jumlah	Daya Beban (Watt)	Total Daya (Watt)	Waktu Nyala (Jam)	Energi Listrik (Watt jam)			Total Energi Listrik (Watt jam)
						07.00-09.00	09.00-11.00	11.00-13.00	
MCB 1	AC	1	1000	**1000**	0	88	176	132	396
	Kipas gantung	2	60	120	2				
Energi Listrik (Watt jam)									396.0
Energi listrik (kWh)									0.3
MCB 2	AC 1,5 PK	1	0	0	0	132	132	88	352
	Kipas Gantung	2	60	120	2				
Energi Listrik (Watt jam)									352.0
Energi listrik (kWh)									0.3
MCB 3	AC	1	1000	1000	0	132	176	176	484
	Kipas Gantung	2	60	120	2				
Energi Listrik (Watt jam)									484.0
Energi listrik (kWh)									0.4
MCB 4	AC	1	1000	1000	0	132	176	176	484
	Kipas Gantung	2	60	120	2				
Energi Listrik (Watt jam)									484.0
Energi Listrik (kWh)									0.4

Table 3.3 MCB Load Current Data 5

Kelas	Jenis Beban	Jumlah	Daya Beban (Watt)	Total Daya (Watt)	Waktu Nyala (Jam)	Arus Terukur (A)		
						07.00-09.00	09.00-11.00	11.00-13.00
9D	Proyektor	1	200	200	2	1,8	2,8	2
	Kipas Angin Dinding	2	40	80	2			
	Lampu	4	36	144	2			
9E	Proyektor	1	200	200	2			
	Kipas Angin Dinding	2	40	80	2			
	Lampu	4	36	144	2			

Table 3.4 Electrical Energy Calculation Result Data on MCB 5

Kelas	Jenis Beban	Jumlah	Daya Beban (Watt)	Total Daya (Watt)	Waktu Nyala (Jam)	Energi Listrik (Watt Jam)			Total Energi Listrik (Watt Jam)
						07.00-09.00	09.00-11.00	11.00-13.00	
9D	Proyektor	1	200	200	2	792	1232	880	2904
	Kipas Angin Dinding	2	40	80	2				
	Lampu	4	36	144	2				
9E	Proyektor	1	200	200	2				
	Kipas Angin Dinding	2	40	80	2				
	Lampu	4	36	144	2				
Energi Listrik (Watt jam)									2904.0
Energi Listrik (kWh)									2.9

Table 3.5 MCB Load Current Data 6

Kelas	Jenis Beban	Jumlah	Daya Beban (Watt)	Total Daya (Watt)	Waktu Nyala (Jam)	Arus Terukur (A)		
						07.00-09.00	09.00-11.00	11.00-13.00
9B	Proyektor	1	200	200	2	2,8	1,5	1
	Kipas Angin Dinding	2	40	80	2			
	Lampu	4	36	144	2			
9C	Proyektor	1	200	200	2			
	Kipas Angin Dinding	2	40	80	2			
	Lampu	4	36	144	2			

Table 3.6 Data from the results of the MCB 6 electrical energy calculation

Kelas	Jenis Beban	Jumlah	Daya Beban (Watt)	Total Daya (Watt)	Waktu Nyala (Jam)	Energi Listrik (Watt Jam)			Total Energi Listrik (Watt Jam)
						07.00-09.00	09.00-11.00	11.00-13.00	
9B	Proyektor	1	200	200	2	1232	660	440	2332
	Kipas Angin Dinding	2	40	80	2				
	Lampu	4	36	144	2				
9C	Proyektor	1	200	200	2				
	Kipas Angin Dinding	2	40	80	2				
	Lampu	4	36	144	2				
Energi Listrik (Watt jam)									2332.0
Energi Listrik (kWh)									2.3

Table3.7 MCB7 MeasuredCurrent Data

Lampu Teras	Jenis Beban	Jumlah	Daya Beban (Watt)	Total Daya (Watt)	Waktu Nyala (Jam)	Arus Terukur(A)		
						07.00-09.00	09.00-11.00	11.00-13.00
Lantai 1	Lampu	4	36	144	2	1	0,4	0,3
Lantai 2	Lampu	4	36	144	2			

Table 3.8 MCB 7 Electrical Energy Calculation Result Data

Lampu Teras	Jenis Beban	Jumlah	Daya Beban (Watt)	Total Daya (Watt)	Waktu Nyala (Jam)	Energi Listrik (Watt Jam)			Total Energi Listrik (Watt jam)
						07.00-09.00	09.00-11.00	11.00-13.00	
Lantai 1	Lampu	4	36	144	2	440	176	132	748
Lantai 2	Lampu	4	36	144	2				
Energi Listrik (Watt jam)									748.0
Energi listrik (kWh)									0.7

Tabel 3.9 Data Arus Terukur MCB 8

Kelas	Jenis Beban	Jumlah	Daya Beban (Watt)	Total Daya (Watt)	Waktu Nyala (Jam)	Arus Terukur (A)		
						07.00-09.00	09.00-11.00	11.00-13.00
8A	Proyektor	1	200	200	2			
	Kipas Angin Dinding	2	40	80	2			
	Lampu	4	36	144	2			
	Proyektor	1	200	200	2			

8B	Kipas Angin Dinding	2	40	80	2	4	4,5	2
	Lampu	4	36	144	2			
8C	Proyektor	1	200	200	2			
	Kipas Angin Dinding	2	40	80	2			
	Lampu	4	36	144	2			
8E	Proyektor	1	200	200	2			
	Kipas Angin Dinding	2	40	80	2			
	Lampu	4	36	144	2			

Table 3.10 MCB 8 Electrical Energy Calculation Result Data

Kelas	Jenis Beban	Jumlah	Daya Beban (Watt)	Total Daya (Watt)	Waktu Nyala (Jam)	Energi Listrik (Watt jam)			Total Energi Listrik (Watt jam)
						07.00-09.00	09.00-11.00	11.00-13.00	
8A	Proyektor	1	200	200	2	1760	1980	880	4620
	Kipas Angin Dinding	2	40	80	2				
	Lampu	4	36	144	2				
8B	Proyektor	1	200	200	2				
	Kipas Angin Dinding	2	40	80	2				
	Lampu	4	36	144	2				
8C	Proyektor	1	200	200	2				
	Kipas Angin Dinding	2	40	80	2				
	Lampu	4	36	144	2				
8E	Proyektor	1	200	200	2				
	Kipas Angin Dinding	2	40	80	2				
	Lampu	4	36	144	2				
Energi Listrik (Watt jam)									4620.0
Energi listrik (kWh)									4.6

Table 3.11 MCB 9 Measured Current Data

Kelas	Jenis Beban	Jumlah	Daya Beban (Watt)	Total Daya (Watt)	Waktu Nyala (Jam)	Arus Terukur (A)		
						07.00-09.00	09.00-11.00	11.00-13.00
	Proyektor	1	200	200	2			
P8F	Kipas Angin Dinding	2	40	80	2	2,7	2,6	2
	Lampu	4	36	144	2			
8G	Proyektor	1	200	200	2			
	Kipas Angin Dinding	2	40	80	2			
	Lampu	4	36	144	2			
8H	Proyektor	1	200	200	2			
	Kipas Angin Dinding	2	40	80	2			
	Lampu	4	36	144	2			

Table 3.12 MCB 9 Electrical Energy Calculation Result Data

Kelas	Jenis Beban	Jumlah	Daya Beban (Watt)	Total Daya (Watt)	Waktu Nyala (Jam)	Energi Listrik (Watt jam)			Total Energi Listrik (Watt jam)
						07.00-09.00	09.00-11.00	11.00-13.00	
8F	Proyektor	1	200	200	2	1188	1144	880	3212
	Kipas Angin Dinding	2	40	80	2				
	Lampu	4	36	144	2				
8G	Proyektor	1	200	200	2				
	Kipas Angin Dinding	2	40	80	2				
	Lampu	4	36	144	2				
8H	Proyektor	1	200	200	2				
	Kipas Angin Dinding	2	40	80	2				
	Lampu	4	36	144	2				
Energi Listrik (Watt jam)									3212.0
Energi Listrik (kWh)									3.0

Table 3.13 MCB 10 Measured Current Data

Kelas	Jenis Beban	Jumlah	Daya Beban (Watt)	Total Daya (Watt)	Waktu Nyala (Jam)	Arus Terukur (A)		
						07.00-09.00	09.00-11.00	11.00-13.00
9F	Proyektor	1	200	200	2			
	Kipas Angin	2	40	80	2			
	Dinding							
	Lampu	4	36	144	2			
9G	Proyektor	1	200	200	2	2	2,7	1,4
	Kipas Angin Dinding	2	40	80	2			
	Lampu	4	36	144	2			
9H	Proyektor	1	200	200	2			
	Kipas Angin Dinding	2	40	80	2			
	Lampu	4	36	144	2			

Table 3.14 MCB 10 Electrical Energy Calculation Result Data

Kelas	Jenis Beban	Jumlah	Daya Beban (Watt)	Total Daya (Watt)	Waktu Nyala (Jam)	Energi Listrik (Watt jam)			Total Energi Listrik (Watt jam)
						07.00-09.00	09.00-11.00	11.00-13.00	
9F	Proyektor	1	200	200	2	880	1188	616	2684
	Kipas Angin Dinding	2	40	80	2				
	Lampu	4	36	144	2				
9G	Proyektor	1	200	200	2				
	Kipas Angin Dinding	2	40	80	2				
	Lampu	4	36	144	2				
9H	Proyektor	1	200	200	2				
	Kipas Angin Dinding	2	40	80	2				
	Lampu	4	36	144	2				
Energi Listrik (Watt jam)									2684.0
Energi Listrik (kWh)									2.6

Table 3.15 MCB 11 Measured Current Data

KELAS	Jenis Beban	Jumlah	Daya Beban (Watt)	Total Daya (Watt)	Waktu Nyala (Jam)	Arus Terukur(A)		
9F	AC	1	1000	1000	0	1,8	2	1
	Kipas gantung	2	60	120	2			
9G	AC	1	1000	1000	0			
	Kipas Gantung	2	60	120	2			
9H	AC	1	1000	1000	0			
	Kipas Gantung	2	60	120	2			

Table 3.16 Data on Electrical Energy Measurement Results for MCB 11

KELAS	Jenis Beban	Jumlah	Daya Beban (Watt)	Total Daya (Watt)	Waktu Nyala (Jam)	Energi Listrik (Watt jam)			Total Energi Listrik (Watt jam)
						07.00-09.00	09.00-11.00	11.00-13.00	
9F	AC	1	1000	**1000**	0	792	880	440	2110
	Kipas gantung	2	60	120	2				
9G	AC	1	1000	1000	0				
	Kipas Gantung	2	60	120	2				
9H	AC	1	1000	1000	0				
	Kipas Gantung	2	60	120	2				
Energi Listrik (Watt jam)									2110.0
Energi Listrik (kWh)									2.1

3.2 Electrical Energy Consumption

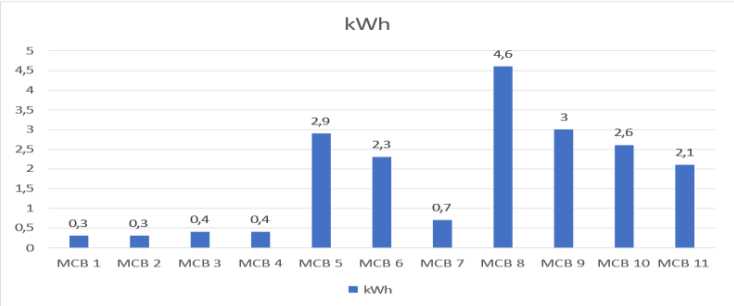

Figure 3.3 Daily Use of Electrical Energy at State Junior High School 1 Ungaran,

Semarang Regency

The graph above shows the measured energy (kWh) in one day. Ideally, the electrical power used at State Junior High School 1 Ungaran, Semarang Regency above shows that on active working days the amount of power on MCB 8 connected to Class 8A, 8B, 8C, and 8E is greater than the other MCBs. This is because in one MCB, namely MCB 8, it connects to 4 Classes at once, thus affecting the amount of power consumption, while on MCB 1, MCB 2, MCB 3, MCB 4 the usage tends to be more stable. This is because the use of the load on the MCB is only used for the use of a hanging fan while the AC has not been used for a long time.

1.1. Calculation of Electricity Costs

The use of electricity for one day in the 8th and 9th grade buildings of State Junior High School 1 Ungaran, Semarang Regency is 19.6 kWh. The use of electricity for one day in the 8th and 9th grade buildings of State Junior High School 1 Ungaran, Semarang Regency is obtained from 19.6 kWh multiplied by 30 days, so that 588 kWh is obtained. The number of types of loads is multiplied by the amount of power multiplied by the time the electricity is on, then multiplied by the PLN 22 KVA Group B-2/ TR installed power tariff of Rp 1,444.70 per kWh.

Electricity usage costs = kWh usage for 1 month x Basic Electricity Tariff (Rp) = 588 x Rp 1,444.70 (Rp) = 849,483.6

Public Street Lighting Tax (PPJU) of (5%)

= 5% x electricity usage fee

= 5% x 849,483.6

= Rp 42,474.18

PLN electricity bill fee

= Electricity usage fee + PPJU

= Rp 849,483.70 + 42,474.18

= Rp 891,957

The results of the calculation obtained the amount of electricity costs used in the 8th and 9th grade buildings of State Junior High School 1 Ungaran, Semarang Regency for one month.

The estimated cost for one month is 588 kWh, which is Rp891,957. The higher the level of electricity needs, the greater the use of the used load, especially if the use of the AC has been reused so that the payment burden is greater and some loads are used alternately according to existing needs.

1.2. Calculation of Energy Consumption Intensity (IKE)

Calculation of Energy Consumption Intensity (IKE) on each MCB requires usage power for one month. The Energy Consumption Intensity graph for each MCB can be seen in graph

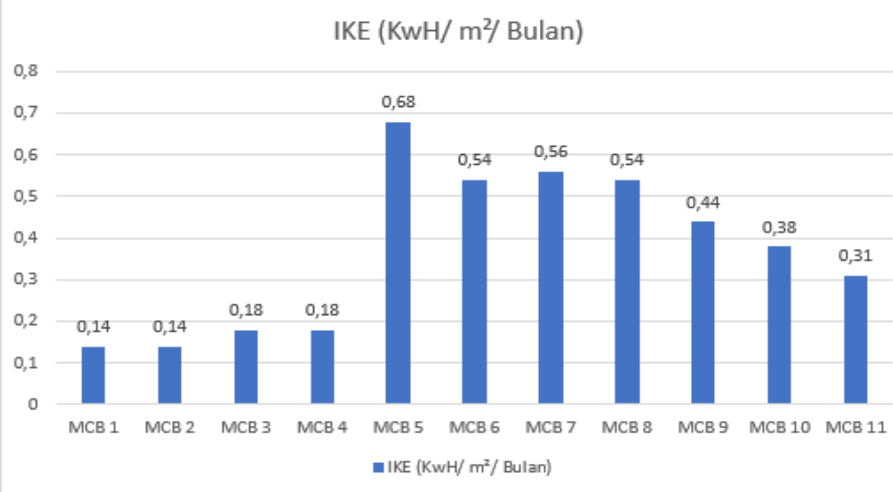

Figure 4.4 Energy Consumption Intensity (IKE) for each MCB

CONCLUSION AND SUGGESTIONS

Conclusion

The research that has been conducted can be concluded that:

1. To save electricity in the 8th and 9th grade buildings at State Junior High School 1 Ungaran, efforts that can be made include the application of energy-saving technology, wise energy management, facility maintenance, and socialization to all elements of the school regarding the importance of energy conservation.
2. The use of electricity load for one month in the 8th and 9th grade buildings of State Junior High School 1 Ungaran, Semarang Regency in one month is 0.4 kWh/m2/month. Showing that the building uses energy efficiently and in accordance with the guidelines in ESDM Regulation No. 03 of 2012 to achieve the goal of sustainable energy conservation.

Sugestions

1. Mematikan beban listrik yang tidak digunakan
2. mengganti atau memasang peralatan listrik dengan peralatan yang lebih hemat energi
3. Kabel pada box panel lebih di rapikan dan dirawat.

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