Evolution in Electrical and Electronic Engineering Vol. 4 No. 2 (2023) 841-848

EEEE

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/eeee
e-ISSN : 2756-8458

Electrical Energy Audit at Faculty of Computer Science and Information Technology, Universiti Tun Hussein Onn Malaysia

Muhammad Rifqi Aiman[1], Mohd Fairouz Mohd Yousof[1]*

[1]Faculty of Electrical and Electronic Engineering,
Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Johor, MALAYSIA

*Corresponding Author Designation

DOI: https://doi.org/10.30880/eeee.2023.04.02.101
Received 06 July 2023; Accepted 21 August 2023; Available online 30 October 2023

Abstract: Electrical Energy Audit is one of the methods that can be used to analyze the energy consumption of electrical equipment that is operated in the building and the possibility to reduce the energy consumption. There is some research from the previous studies and the results have been obtained through the implementation of this project. The scope of this project is to determine the illumination level of light, temperature, humidity, and thermal energy that may cause the occurrence of an increase in energy consumption in the Faculty of Computer Science and Information Technology, Universiti Tun Hussein Onn Malaysia. This project conducted by walkthrough audit of the building by measuring and recording the data. To facilitate the process of a walkthrough audit in the building, the floor plan of the building was required to plan and determine the area that was suitable to collect the data. Besides that, to get data for each type of measurement. It will use different methods and equipment such as Datalogger (measure temperature and humidity) and lux meter (measure illuminance level of light). From the analysis of the findings, the Energy Saving Measure (ESM) would propose to reduce electrical energy consumption for the building. Furthermore, providing ESM can assist in increasing energy efficiency and energy savings in this building, notably in terms of power bill prices. Indirectly, this audit can reduce energy waste and improve the stability of the local electrical supply system.

Keywords: Energy Audit**,** Illumination Level, Temperature, Humidity, And Thermal Energy

1. Introduction

The most important resource in the world is a stable electrical supply. This increases the quantity of electricity consumed over time, which is growing more modern and complex. Residential, commercial, and industrial sectors are among the numerous ones in each nation that are being actively developed. According to a 2016 survey, the main drivers of high energy usage are the residential and

Corresponding author: fairouz@uthm.edu.my

commercial sectors. It includes the building sector, which accounts for a significant 20% to 60% increase in energy usage [1]. Therefore, other developed countries are changing their method of obtaining this energy source to the use of conventional energy such as coal, oil, and natural gas, even though this method will have many disadvantages for the environment in addition to the high demand from consumers, especially in these three sectors [2].

Buildings consume a lot of energy for heating, cooling, lighting, and technological devices like computer purposes. According to previous research, energy consumption that will be used for the building is between 40% and 50%. While for lighting, it consumes about 13% of energy, and the rate of energy consumption is increasing over time [3]. So, this energy should be used efficiently; avoid using it excessively so that it can cause energy instability for other users. When energy resources are used effectively, many benefits can be obtained apart from being able to save energy consumption, it can also save money from having to spend excessively. Moreover, it increases the efficiency of energy. It can lower greenhouse gas emissions effect, pollution and help to stabilize the price of monthly electricity bills [4].

The project Walk-through Electrical Energy Audit for the Faculty of Computer Science and Information Technology building is focused on the illumination level of light, thermal energy, humidity, and temperature in the building. Each measurement has its procedure, for example, the illuminance level and thermal energy in a room are measured during the day and night. Meanwhile, recorded data on temperature and humidity will be measured within 24 hours. By conducting this project, optimizing energy use can directly benefit universities, power plants, and industrial facilities which help reduce overall costs. So, the use of efficient electrical equipment which has characteristics that can save electricity is highly encouraged.

An electrical energy audit will be conducted at the Faculty of Computer Science and Information Technology (FSKTM) to determine the electrical energy consumption of the building due to the excessive use of electricity at Universiti Tun Hussein Onn Malaysia (UTHM) that causes the monthly payment rate to reach approximately RM 700,000. In addition, this method can also be used to identify the pattern of electricity consumption in each building in the UTHM area. Then, be able to identify any problem that is related to electrical and mechanical equipment used in each main building such as air-conditioning, chiller, and wiring system. Moreover, high energy consumption occurs due to the waste of electric power that consists of the usage of electrical and mechanical components running for long periods without ever stopping although they are not being used. Besides that, the equipment used in the building must follow the specifications that are already set by a regulation (MS1525:2014) “Energy efficiency and use of renewable energy for non-residential buildings – Code of practice” which is according to the national standard. In addition, depending on the guidelines set forth by the Commission, any private installation license holder or user whose net energy generation or overall consumption equals or exceeds 3,000,000 kWh will be sent a notice to designate or appoint an electricity manager licensed to carry out duties and obligations under Regulation 16 in the installation [5].

2. Methodology

In this part, all the information required to produce the results of the findings is described in the methodology section.

A. The Process of Electrical Energy Audit

To provide suitable and satisfying results, several activities must be completed during the project's development. The process of conducting an electrical energy audit will be shown in Figure 1.

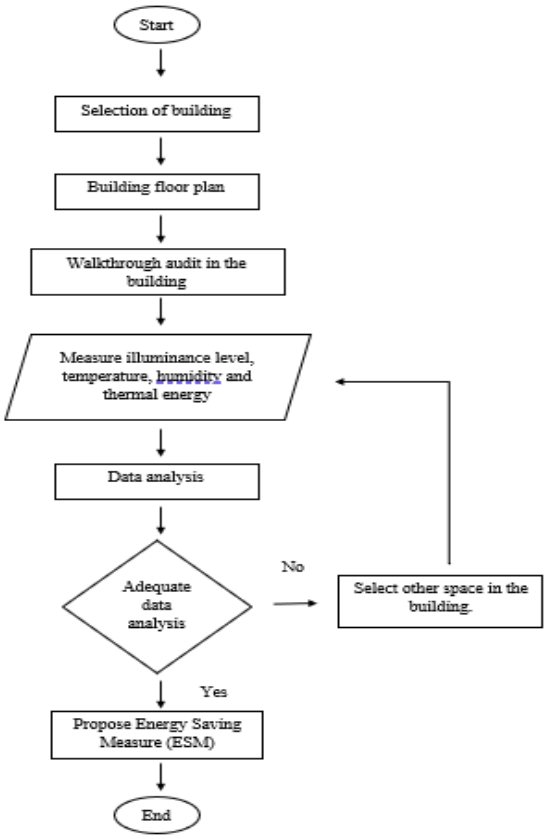


Figure 1: Flowchart of process Electrical Energy Audit

B. List of Equipment

Table 1 tabulated the equipment of the project.

Table 1: List of equipment

Type of Equipment	Function	Characteristic
 Thermal Imager Camera	- Infrared camera, used to detect objects with infrared radiation.	- The data is transformed into an electronic picture displaying the temperature of the object. - The temperature range is 20˚C to 400˚C. - Portable thermal imager.
	- Use to determine the illumination level and for analyzing lighting requirements.	- Digital meter that used a highly accurate visible light sensor. - Consists of the 8-bit microprocessor to process data. - It is suitable to test illuminance within 0 to 20,000 lux.

Lux Meter		
 Humidity/Temperature/ Pressure Datalogger	- It is a function to record humidity, temperature, and pressure.	- Record data measurement, using a non-volatile electronic memory. - Temperature range is -40˚C to 80 ˚C. - The relative humidity range is 0% to 100%. - The pressure range is 750hPa to 1100 hPa.

3. Results and Discussion

The results and discussion section presents data and analysis of the study. In this section, the walkthrough audit on this building has been done. All data acquired were measured throughout the audit walkthrough period.

A. Data for Illumination Level of Light

Based on Figure 2, the blue mark on the picture shows the lighting point that has been measured. Then, the measurement of this lighting level was made at 'Makmal Pembangunan Perisian' but referring to the building plan in the following diagram is 'Makmal Pengaturcaraan 2'. This is because the floor plan obtained is not the latest. Then, here is the following data for the illuminance level created in this room according to the lighting points that have been labeled.

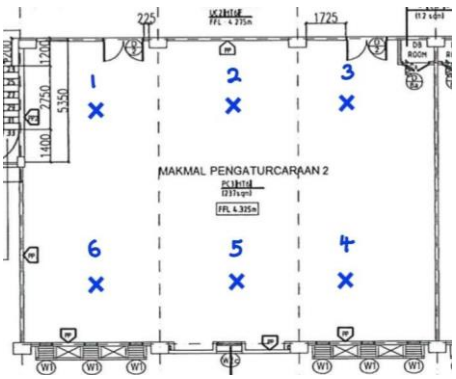


Figure 2: The lighting point at 'Makmal Pembangunan Perisian

According to Table 2 above, six lighting points have been measured by the level of the illuminance rate. Moreover, the level of lighting value was obtained by the guidelines set by Malaysia Standards. However, there are some points whose lighting rate is less than 400 lumens. This may be due to the dim light bulb and the need to change.

Table 2: The illuminance level at 'Makmal Pembangunan Perisian'

Lighting Point	Illuminance Level (lux)	Malaysia Standard (lux)
1	234	500
2	418	500
3	310	500
4	391	500

5	462	500
6	427	500

B. Data on Temperature and Humidity

Temperature and humidity are crucial factors that influence energy consumption in buildings. The energy efficiency of a building can be considerably improved by adjusting the temperature and humidity levels.

Figure 3, shows the red lines that indicate the result of temperature (˚C), and the green line indicates relative humidity (%RH) at 'Pejabat ICT'. From the graph, the maximum value of temperature is 27˚C and it occurs at 9.30 a.m. The temperature has become the highest at this time compared to other times, probably due to the building being affected by the sun's rays and heat entering the office space through the windows. While the minimum value of temperature is 24.3˚C and the average value is 24.9˚C for this office. Then, for the relative humidity, the highest value is 79.7%RH which is more than 10% than the recommended design relative humidity for the indoor design conditions of buildings. Therefore, the users in this office won't be much impacted by the rise in relative humidity in the ICT office area.

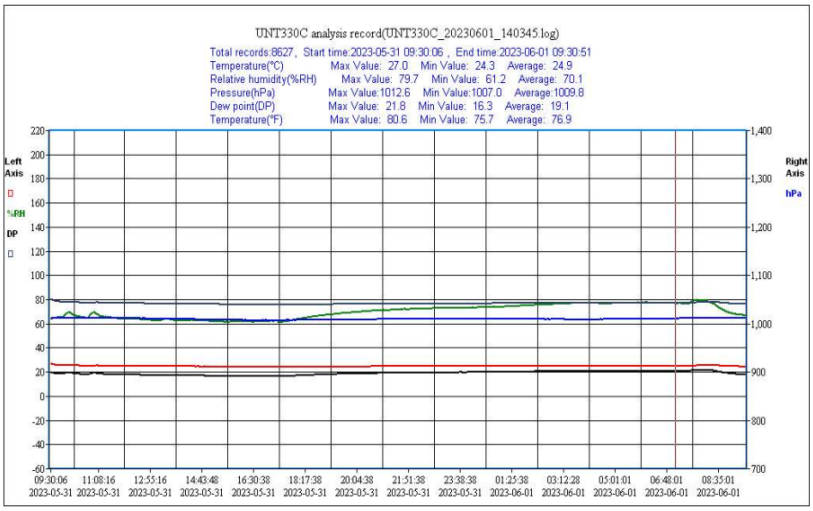
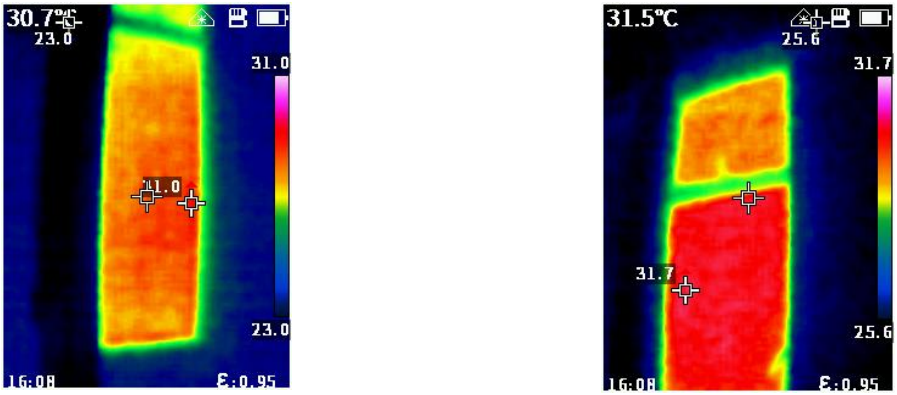


Figure 3: Data of temperature and humidity at 'Pejabat ICT'

C. Data of Thermal Energy

Thermal energy is the crucial thing that needs to be considered in energy audits. It refers to the energy that is associated with heating or cooling the indoor spaces to keep occupants in the building comfortable. In numerous of the building's rooms, measurements have been made to gather information on the thermal energy in this structure.

The measurements have been done at 'Makmal Pengaturcaraan' which is located on the first floor and this laboratory is often used by office staff in carrying out activities such as meetings and others. Figure 4, the image displays several hot spots within the lab where heat is being transferred from the outside into the structure and it is known as thermal energy. This happens due to the increase in temperature and humidity that occurs outside the building area that tries to enter the building through the windows with the help of the air. By focusing on Figure 4(b), the value of temperature is higher compared to the value in Figure 4(a) and the difference between the two values is 2.5%.



(a) (b)

Figure 4 : Image at Makmal Pengaturcaraan

D. Building Load Profile

In determining the total amount of energy used at the FSKTM building, the implementation of building load profiles needs to be measured. Building load profiles refer to the pattern of energy demand or consumption for a certain building over a certain amount of time. The procedure of gathering this data was carried out twice, with the first-time taking place between April 1, 2023, at midnight and April 17, 2023, at midnight. During the days. Most of the students carried out the online learning process.

According to the graph, an ascend in total energy consumption occurs starting from 7.30 a.m. to 4.30 p.m., and the maximum value of power consumption is as much as 354kW which occurs in the morning of April 16. The average value of power consumption throughout the 11-day data collecting period, which was used on weekdays is 13.923kW multiplied by RM 0.365 sen/kWJ equals RM 5,081.95. So, this value is the total electricity charge for 11 days (weekdays) based on the data of power used in the FSKTM building as shown in Figure 5.

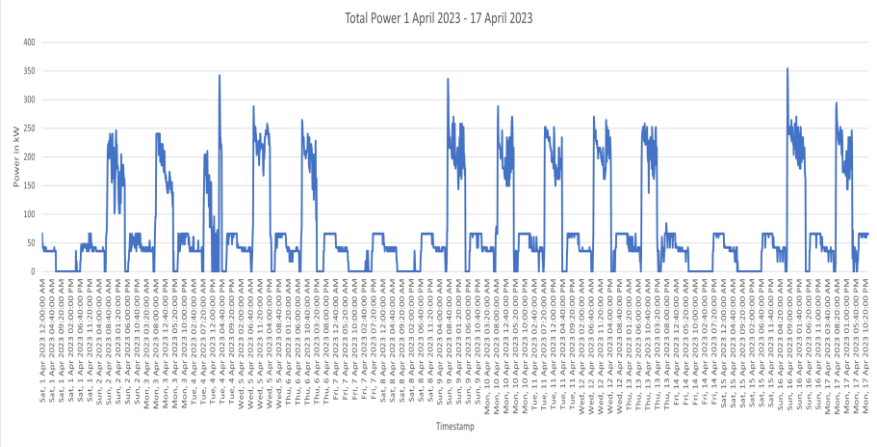


Figure 5: Total power consumption from 1 April 2023 to 17 April 2023

Compared to the graph in Figure 6, the increase in energy consumption has become more than the data in Figure 5. According to the graph, the increase in energy consumption occurs starting between 7.30 a.m. and 5.00 p.m. On May 14, it's the highest value of power consumption whereas the value is 528 kW. Moreover, the second highest power that has been spent by the building is 510kW and it happened on May 16 in the morning. In addition, only a 3.4% difference between this value and the greatest value in the past. At a certain time, the total power consumption drops to a lower value which is at night.

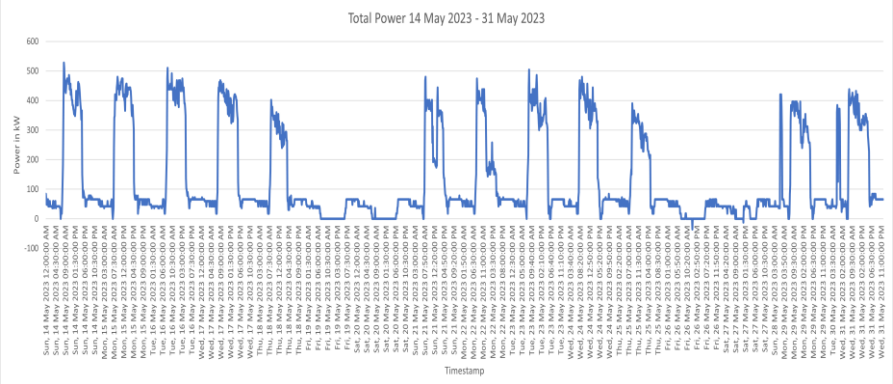


Figure 6: Total power consumption on 14 May 2023 to 31 May 2023

E. Propose of Energy Saving Measure (ESM)

Energy Saving Measure (ESM) is one of the methods used to reduce energy consumption and improve energy efficiency. Illuminance level of light, thermal energy, temperature, and relative humidity are interconnected factors in implementing ESM. For example, the lux level of light needs to be balanced according to the specific task in a space and it also can affect the perception of temperature and humidity. Thermal energy, temperature, and relative humidity in the building play a significant role in proposing ESM because it will cause discomfort situation, especially for the occupants. Furthermore, it may lead the cooling system to operate all the time which can cause high consumption of energy and high cost of electricity for the building.

Therefore, the proposal of ESM will be done after an energy audit has been carried out for the building. Furthermore, the proposal depends on the results of the energy audit, and from this procedure energy consumption may be decreased without impacting the operation of the building. Therefore, the Energy Saving Measures (ESM) that may be implemented based on the building's findings are suggested in Table 3.

Table 3: Energy Saving Measure (ESM) for FSKTM building

	No.	Recommendations
No Cost	1.	De-lamping of a fluorescent lamp (area with over brightness)
	2.	Reduction of lighting time of use (by occupancy)
	3.	Label switches of lights to be switched on/off
Mid Cost	4.	Replace compact fluorescent with efficient lamps such as LED
	5.	Ensure fittings are clean and free of dust.
	6.	Frequent window or fitting cleaning to maximize natural illumination.
High Cost	7.	Install lighting control (energy management system)
	8.	Reduction of whole or part of the illumination
	9.	Install shading elements (awning, shading devices)
	10.	Upgrade the building insulation system

4. Conclusion

The Electrical Energy Audit functions to optimize energy consumption and determine energy efficiency for residential, industrial, or commercial, especially for the building. In this project, the energy audit has been conducted by walkthrough in the building which is by collecting the data of

illuminance level, temperature, humidity, and thermal energy all of which will contribute to the increase of energy consumption and the cost of electricity. All the results obtained were collected by using specific instruments such as a thermal imager camera, datalogger, and lux meter. According to the results, finding each such element is heavily influenced by a variety of circumstances, particularly in the illumination level measurement portion, which includes sunlight and objects that reflect light on the surface, which results in a measurement that does not satisfy the norm. On the other hand, the audit could not be done in all spaces and levels because of not having full access to the building. Indirectly the amount of energy consumption for this building cannot be adequately measured. At the end of this project, To determine the actual value of energy consumption, which was previously completed by the auditor, some numerous steps and procedures must be done to ensure the energy of electricity supplied is not wasted and is in a stable state.

Acknowledgement

The authors would like to thank the Faculty of Electrical and Electronic Engineering for supporting the development of this project.

References

[1] S. Birkha Mohd Ali, M. Hasanuzzaman, N. A. Rahim, M. A. A. Mamun, and U. H. Obaidellah, "Analysis of energy consumption and potential energy savings of an institutional building in Malaysia," *Alexandria Engineering Journal*, vol. 60, no. 1, pp. 805–820, Feb. 2021, doi: 10.1016/J.AEJ.2020.10.010.

[2] M. Hasanuzzaman, U. S. Zubir, N. I. Ilham, and H. Seng Che, "Global electricity demand, generation, grid system, and renewable energy policies: a review," *Wiley Interdiscip Rev Energy Environ*, vol. 6, no. 3, May 2017, doi: 10.1002/WENE.222.

[3] M. A. Habib, M. Hasanuzzaman, M. Hosenuzzaman, A. Salman, and M. R. Mehadi, "Energy consumption, energy saving and emission reduction of a garment industrial building in Bangladesh," *Energy*, vol. 112, pp. 91–100, Oct. 2016, doi: 10.1016/J.ENERGY.2016.06.062.

[4] N. O. Onubogu, K. K. Chong, and M. H. Tan, "Review of Active and Passive Daylighting Technologies for Sustainable Building," *International Journal of Photoenergy*, vol. 2021, 2021, doi: 10.1155/2021/8802691.

[5] "Peraturan-Peraturan Bekalan Pemegang Lesen, 1990." https://www.st.gov.my/details/policies_details/12/2 (accessed May 09, 2023).