



Faculty of Mechanical Engineering

ENERGY AUDIT FOR LIGHTING AND A/C IN ACADEMIC BUILDING – CASE STUDY IN IKM BINTULU

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**ENERGY AUDIT FOR LIGHTING AND A/C IN ACADEMIC
BUILDING –CASE STUDY IN IKM BINTULU**

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in partial fulfilment of the requirements for the degree of Master of Mechanical
Engineering (Energy Engineering)**

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2016

DECLARATION

I declare that this report entitled “*Energy Audit for Lighting and A/C in Academic Building – Case Study in IKM Bintulu*” is the result of my own research except as cited in the references. The report has not been accepted for any master and is not concurrently submitted in candidature of any other master.

Signature : 
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Date :

APPROVAL

I hereby declare that I have read this report and in my opinion this report is sufficient in terms of scope and quality as a partial fulfilment of Master of Mechanical Engineering (Energy Engineering).

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ABSTRACT

In recent years, extensive research and studies have been focused on energy efficiency with the common target to reduce the energy consumptions against the backdrop of challenging of modern days. Various emerging technologies have been developed to reduce the energy consumptions even though there are still some sectors that are not concerned with the important of the energy management at all. Lighting and air conditioning is a key part of energy use in commercial and industrial sector. In fact, it's verified that lighting and air conditioning plays a very important role which affecting the profit margin by energy conservation. Major electrical energy utilization in building is affected by lighting. Lighting required approximately 25% energy consumptions in building. Even worst, in commercial business, 70% to 80% of electricity bills are consumed by lighting. Besides, in view of Malaysian context, major uses of electricity consumed by lighting and approximately 17% of national electricity usage utilized by lighting purposes. Both lighting and air-conditioning plays a very important role in increasing the profit margin by energy conservation. Thus, effective energy management has been considered as the main way to reduce energy consumption by lighting and air-conditioning. Energy audit is an effective management tool to reduce cost. Initially, the existing lighting system and air conditioning system in Block C is analyzed in term of total power, energy consumption, and electricity payment per month and per year. Therefore, the project concentrates on energy audit for lighting and air conditioning system in the Institut Kemahiran Malaysia (IKM) Bintulu case study for academic building. Most of the appliances in the IKM Bintulu building use electricity. As the result, several methods of energy saving proposed. The total cost, annual profit, and payback period for each method are also studied. These appliances have label on them stating how much power they used. The unit tariff charged by SESCO (Sarawak Electricity Supply Corporation) will be reviewed and analyzed. The calculation on the energy consumptions were based on the amount of power utilization.

ABSTRAK

Kebelakangan ini, penyelidikan dan kajian yang menyeluruh telah diberi tumpuan dalam kecekapan tenaga dengan sasaran untuk mengurangkan penggunaan tenaga dalam era yang mencabar pada masa kini. Pelbagai teknologi baru telah dibangunkan untuk mengurangkan penggunaan tenaga walaupun masih terdapat beberapa sektor yang tidak mempedulikan kepentingan dalam pengurusan tenaga. Lampu dan penghawa dingin adalah bahagian terpenting dalam penggunaan tenaga dalam sektor perdagangan dan perindustrian. Malah, lampu dan penyaman udara memainkan peranan yang amat penting yang memberi kesan kepada margin keuntungan dengan pemuliharaan tenaga. Penggunaan tenaga elektrik utama di bangunan dipengaruhi oleh lampu. Ia digunakan kira-kira 25% daripada penggunaan tenaga dalam bangunan. Malah, dalam perniagaan komersial, 70% kepada 80% daripada bil elektrik digunakan oleh lampu. Selain itu, dalam konteks Malaysia, kegunaan tenaga elektrik yang digunakan oleh lampu kira-kira 17% daripada penggunaan elektrik. Kedua-dua lampu dan penyaman udara memainkan peranan yang amat penting dalam meningkatkan margin keuntungan dengan pemuliharaan tenaga. Oleh itu, pengurusan tenaga yang berkesan telah dianggap sebagai cara utama untuk mengurangkan penggunaan tenaga untuk lampu dan penghawa dingin. Tenaga audit adalah cara pengurusan yang berkesan untuk mengurangkan kos. Dalam usaha untuk menjalankan pengurusan tenaga audit, kos bil penggunaan tenaga terdahulu di kawasan-kawasan tertentu mesti disiasat. Oleh itu, projek ini menumpukan tenaga audit untuk pencahayaan dan sistem penyaman udara di bangunan akademik (IKM) Bintulu Institut Kemahiran Malaysia. Kebanyakan peralatan di dalam bangunan IKM Bintulu menggunakan elektrik. Oleh itu, audit tenaga untuk lampu dan penghawa dingin di Blok C telah dianalisis. Kos bil terdahulu telah dijadikan sebagai rujukan untuk menjalankan tenaga audit di Blok C. Perkakas yang berlabel ada menunjukkan jumlah penggunaan kuasa. Tarif unit yang dikenakan oleh SESCO (Sarawak Electricity Supply Corporation) akan dikaji dan dianalisis. Pengiraan penggunaan tenaga adalah berdasarkan kepada jumlah penggunaan kuasa.

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LIST OF ABBREVIATIONS

%	-	Percentage
°C	-	Degree Celcius
hP	-	Horse Power
HVAC	-	Heating, Ventilating and Air Conditioning
IKM	-	Institut Kemahiran MARA
K	-	Kelvin
kWh	-	Kilowatt per hour
LED	-	Light Emitted Diod
Lux	-	Illuminance Level
RM	-	Ringgit Malaysia
SESCO	-	Sarawak Electricity Supply Corporation
SPP	-	Simple Payback Period

LIST OF SYMBOLS

°C	-	Temperature in celcius
A	-	Ampere
Hz	-	Hertz
Lux	-	Illuminance of light
m ²	-	Meter square
nos	-	Luminance of fluorescent lamp
V	-	Voltage
W	-	Watt

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CHAPTER 1

INTRODUCTION

1.1 Overview

This chapter introduces the background of the project, problem statement, objectives, and scope of works as well as report organization. In general, it states out a general introduction of energy audit of lighting and air-conditioning system at Block C, Institut Kemahiran (IKM) Bintulu.

1.2 Research Background

This paper concentrates on energy audit for lighting and air conditioning system which implementation of energy saving measure in the IKM Bintulu academic building. Most of the appliances in the IKM Bintulu building use electricity. These appliances have label on them stating how much power they used. The unit tariff charged by SESCO (Sarawak Electricity Supply Corporation) is in kW.hr. Based on this the amount of power, it can be calculated using the following formula:

$$\frac{X(\text{Watt}) * Y(\text{hour})}{1000} = Z(\text{kW} \cdot \text{hour})$$

To reduce the electricity bill means the buildings needs to reduce amount of Z . This can be done by two methods. First method is by reducing the amount of Y , meaning the duration of usage. Second method is by using energy efficient appliance which requires less X . In

this project the energy audit focuses on the lighting system and air conditioner in Block C (Laboratory Building)

1.3 Problem Statement

Due to lack of dedicated utilities meters, the electricity tariff measured is inclusive of both energy consumption of air conditioning and lighting system. The electricity bill cannot calculate separate. Critical evaluation and advanced studies are needed to provide measures to achieve optimum energy efficiency in buildings. Misconduct electrical energy usage leads to waste energy. The effect of the wastage is not only involves cost, but also affecting nature.

1.4 Project Purpose

All barriers as in the previous section mentioned derived the objectives as below:

- i) To analyze the existing lamps and air conditioner in Block C (Laboratory Building)
- ii) To propose several methods to reduce electricity energy consumption (kWh) and total electricity bill payment (RM) per month

1.5 Scope of Work

The project was conducted at IKM Bintulu which was operated in 2010. The total space of IKM Bintulu industry is about 12,000 m². This project focuses on lighting and air conditioning system in 17 lab rooms in the building (Block C). Therefore, history billing cost energy consumption for each month will be investigated. The total unit of lighting and air-conditioning system will be discovered and study. The measurement for the daily energy consumption was conducted and the data collected will be recorded. Hence, at the

end of the project, energy audit for lighting and air-conditioning system at Block C was conducted and the results will be observed and analyzed.

1.6 Expected Outcome

At the end of this project, the following outcomes are expected:

- The existing of lighting and air-conditioning system at Block C are identify
- Methods to reduce electricity energy consumption (kWh) and total electricity bill payment (RM) per month are discovered.

1.7 Thesis Outline

The thesis divided into five chapters. The first chapter elaborates the project background, problem statements, objectives, and scope of work as well as report organizations.

Chapter two presents the literature study related to the project background. All the past related works are reviews in this chapter. Particularly, this chapter presents the past literature study related to the energy consumption in a building or household appliances. Moreover, past energy audit works were discussed and remarks as a references to the achievement of the project implementation.

Chapter 3 describes the framework and methodology of the project workflow. The detailed project workflow is presented in the project.

Chapter 4 discussed the results and discussion of the project. The proposed method toward energy audit specifically for Block C is presented in the chapter. The data obtained are compiled for data analysis. In fact, any difficulties in the results is also discussed in this chapter.

Chapter 5 summarizes and concludes thesis outcomes. The final paragraph of this chapter addresses the recommendation to be made for future work on the research findings.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

The chapter of literature review presents all related past literature studies related with the project. The literature studies will be studied and reviewed as a reference for the project development. Thus, the improvement on the energy consumption will be emphasized in this chapter. All the related method to reduce the energy consumptions will be taken into consideration to improve the existing method. The most suitable and applicable research approach in the past literature studies will be taken into consideration as references for this project.

2.2 Energy Consumptions Development

Currently, energy becomes vital in route to rapid growth of economic stability of the country. In fact, world population has reached seven billion in October 2011 and it is estimated that in recent years the world population reach one billion in less than twelve year. Consequently, energy has always been the most important thing that influences the quality of human life. Thus, in conjunction with the acceleration of energy requirement, an urgent need is required to find the reasonable solutions to find out energy saving opportunities and reduce energy consumption per day.

In recent years, extensive research and studies have been focused on energy efficiency with the common target to reduce the energy consumptions against the backdrop of challenging of modern days. Thus, effective energy management has been considered as the main way to reduce energy consumption. On the other hand, building and electrical appliances characteristic plays the significant role which effect the total electricity bill payment per month.

2.3 Electrical Appliances Characteristic

Nowadays, various emerging technologies have been developed to reduce the energy consumptions. Among various type of electrical appliances, lighting and air conditioning is a key part of energy use in commercial and industrial sector. Gan et al. (2013) and Horgan and Dwan (2014) found that lighting and air conditioning plays a very important role which affecting the profit margin by energy conservation. On the other hand, major electrical energy utilization in building is affected by bulbs. It's required approximately 25% energy consumptions in building. Gan et al. (2013) stated commercial business, 70% to 80% of electricity bills are consumed by bulbs. Jain and Kaur (2013) stated, in fact, in view of Malaysian context, major uses of electricity consumed by lighting and approximately 17% of national electricity usage utilized by lighting purposes. Horgan and Dwan (2014) in their past literature review and industrial tests were conducted in order to determine the feasibility of Light-Emitting-Diode (LED) for a widespread uses. The LED became one of a way which shows a great potential to reduce the energy consumptions compared to the energy consumptions by bulbs.

2.3.1 Light-Emitting-Diodes (LEDs) Technology

Horgan and Dwan (2014) shown that development in LEDs technology entered in lighting market as an alternative way to reduce electricity daily use to replace the traditional light sources for instance incandescent and fluorescent bulbs. Hence, in order to properly compare the technical dissimilarity between LED and traditional light sources, laboratory works has been conducted. Particularly, the comparison was conducted to evaluate the energy consumptions for each type of light sources.

The case study was carry out at Universiti Teknikal Malaysia Melaka (UTeM) building as energy saving strategies was proposed and evaluated on two lighting systems. The comparison involved laboratory measurement and verification between LED and fluorescent tube. Figure 2.1 shows the experimental setup between two lighting systems.

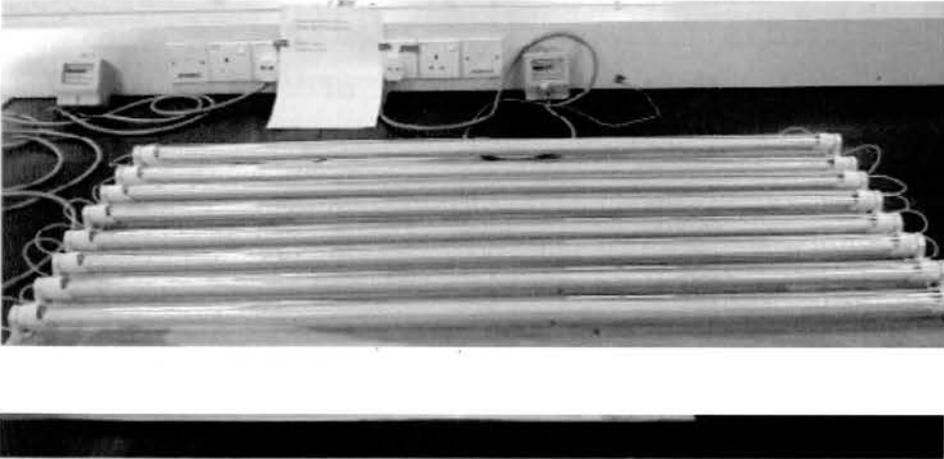


Figure 2.1: Experimental Setup between Two Lighting Systems (Gan et al., 2013)

Gat et al. (2013) carried out the experimental between two lighting; the LED was setup at the top, meanwhile the fluorescent lamp at the bottom as shows in Figure 2.1. Both lighting system consist of eight T8 type lighting tube with 36W for fluorescent and 18W

for LED respectively. The experimental works was conducted for 31 days. Figure 2.2 presents the experimental results between these two lighting systems.

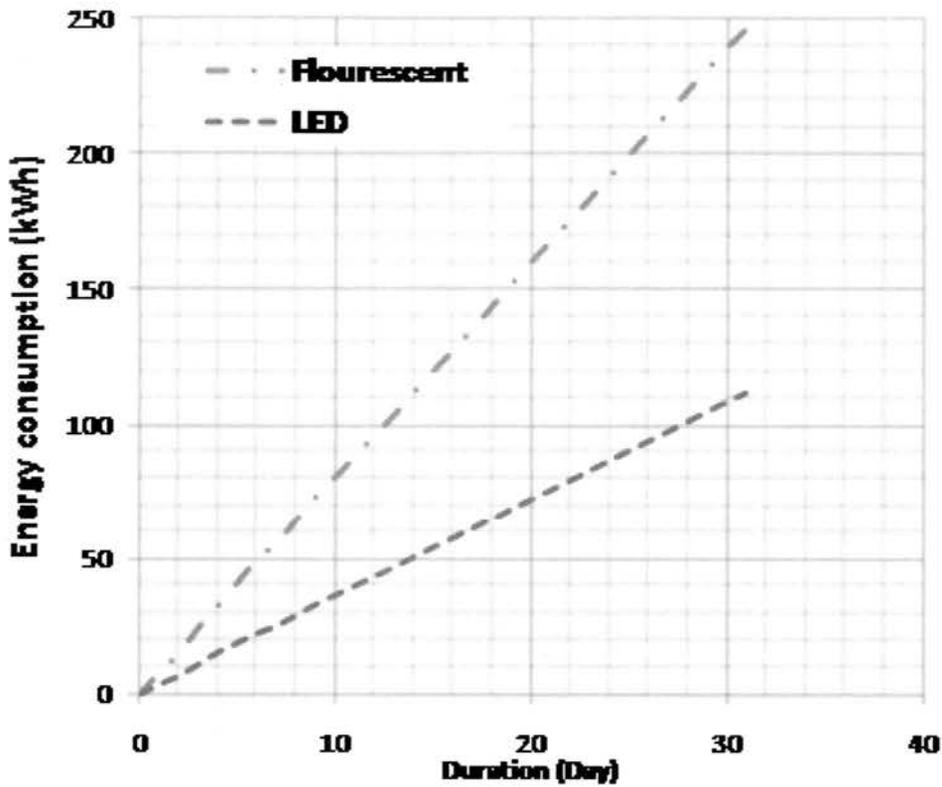


Figure 2.2: Experimental Results between Two Lighting Systems (Gan et al., 2013)

Based on the literature study as presents as in Figure 2.1, the performance of LED is proved which consumed minimum energy consumption compare to fluorescent tube. Throughout the experimental results as in Figure 2.1, the LED lighting shows the great potential to replace the traditional lighting systems in term of energy saving while also reduce the carbon dioxide emissions.