**COMPARISON BETWEEN FLUORESCENT LAMP AND LED LAMP USING AC SUPPLY**

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**JUNE 2013**

"I hereby declare that I have read through this report entitle "Comparison between fluorescent and LED lamp using AC supply" and found that it has comply the partial fulfilment for awarding the degree of *Bachelor of Electrical Engineering (Industrial Power)*".

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**This report is submitted in partial fulfillment of requirements for the degree of Bachelor of Electrical Engineering (Industrial Power)**

**Faculty of Electrical Engineering**
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I declare that this report entitle “Comparison between fluorescent and LED lamp using AC supply” is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any degree.

Signature :……

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## ABSTRACT

Electrical energy is one of the curial energy sources to all mankind. Our daily life will not be completed without it. Electricity had been used for many kind of things. For example air conditioning, heating, transportation, and powering computers. One of the most popular usages of electric energy is in lighting system. Most of the building in the word use electrical source for their lighting system. Nowadays, there are various types of lamp in the market such as standard fluorescent lamp (FL), compact fluorescent lamp (CFL), and light emitting diode lamp (LED lamp). There are many ways to save this energy so it will not be wasted. One of them is to use the most suitable lamp for lighting system. Thus, this project will make comparison between three types of lamp that had been commonly used these days. In this project, the lamps that will be compared are standard fluorescent lamp, compact fluorescent lamp, and LED lamp. Wiring of each lamp will be done at a store room inside a laboratory in UTeM. The amount of lamp needed for the room need to be calculated according to the MS and JKR standard. From this wiring, a set of data will be taken to accomplish the comparison such as voltage, current, power consumption, lux, harmonic distortion and temperature. The main objective of this project is to compare between standard fluorescent lamp, compact fluorescent lamp, and light emitting diode lamp according to the standard lighting that had been done. The parameter required to make a comparison between each of the different lamp are power consumptions, voltage needed, current, harmonics and lux produced. Besides that, an analysis of this project also will be covered on the most efficient type of lamp to use by consumer base on costing, performance and energy consumptions.

# ABSTRAK

Tenaga elektrik adalah salah satu sumber tenaga yang penting kepada semua manusia. Kehidupan seharian kita tidak akan lengkap tanpa nya. Elektrik telah digunakan untuk banyak jenis perkara. Sebagai contoh penyaman udara, pemanasan, pengangkutan, dan menjanakan komputer. Salah satu kegunaan tenaga elektrik yang paling popular adalah dalam sistem pencahayaan. Kebanyakan bangunan di perkataan menggunakan sumber elektrik untuk sistem lampu mereka. Kini, terdapat pelbagai jenis lampu di pasaran seperti lampu pendarfluor biasa (FL), lampu pendarfluor padat (CFL) dan diod pemancar cahaya lampu (LED). Terdapat banyak cara untuk menjimatkan tenaga ini supaya ia tidak akan sia-sia. Salah satu daripadanya adalah dengan menggunakan lampu yang paling sesuai untuk sistem pencahayaan. Oleh itu, projek ini akan membuat perbandingan antara tiga jenis lampu yang telah biasa digunakan pada hari ini. Dalam projek ini, lampu yang akan dibandingkan adalah lampu pendarfluor biasa, lampu pendarfluor kompak, dan lampu LED. Pendawaian setiap lampu akan dilakukan di bilik stor di dalam sebuah makmal di UTeM. Jumlah lampu yang diperlukan untuk bilik tersebut perlu dikira mengikut spesifikasi MS dan JKR. Dari pendawaian ini, satu set data akan diambil untuk mencapai perbandingan seperti voltan, arus, penggunaan kuasa, Lux, dan herotan harmonik. Objektif utama projek ini adalah untuk membandingkan antara lampu pendarfluor biasa, lampu pendarfluor kompak, dan lampu LED mengikut standard yang telah dilakukan. Data yang diperlukan untuk membuat perbandingan di antara setiap lampu adalah penggunaan tenaga, voltan diperlukan, arus, harmonik dan lux dihasilkan. Selain itu, analisis projek ini juga akan merangkumi jenis lampu yang paling berkesan untuk digunakan oleh pengguna dari segi kos, prestasi dan penggunaan tenaga.

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## LIST OF ABBREVIATIONS

| | | |
|---|---|---|
| UTeM | - | Universiti Teknikal Malaysia Melaka |
| BS | - | British Standard |
| MS | - | Malaysian Standard |
| IEEE | - | Institute of Electric and Electronic Engineers |
| JKR | - | Jabatan Kerja Raya |
| TNB | - | Tenaga Nasional Berhad |
| KWh | - | Kilo watt hour |
| THDi | - | Total current harmonic distortion |
| THDv | - | Total voltage harmonic distortion |
| P | - | Real Power |
| Q | - | Reactive Power |
| S | - | Apparent Power |
| A | - | Ampere |
| FL | - | Fluorescent lamp |
| CFL | - | Compact fluorescent Lamp |
| LED | - | Light emitting diode |
| AC | - | Alternating current |
| DC | - | Direct current |

# LIST OF APPENDICES

# CHAPTER 1

# INTRODUCTION

## 1.0 Overview

This chapter will elaborate about the project background, problem statement, project objectives, and project scopes.

## 1.1 Project Background

There are lot types of energies such as electrical energy, potential energy, heat energy, mechanical energy and kinetic energy. Electrical energy is one of the energy that had played a major role in the world. The effect of energy conservation to the environment has been seen as a big problem.

The inefficient use of energy in present days will lead to negative impact in the future. Global warming and greenhouse effect are few examples of negative result of the inefficient use of energy. Both of these phenomenon happened because of excessive amount of carbon dioxides (CO2) in the ozone surface. Burning fossil fuels to fulfil the energy demand had been given big contribution on the excessive amount of CO2. Our earth will suffer more from the increasing of energy demand. The suffering of earth is not the only negative effect of high energy demand. The most significant effect that can be seen nowadays is the increasing in electrical energy consumption in kilowatt hour (kWh) that will furthermore increase electricity bills payment. By using an efficient lighting, these problems can be reduced or even solved.

The aim of this project is to investigate the most efficient type of lamp to be used based on costing, performance and energy consumptions. To determine the most efficient

lamp to be used, a comparison between each different load of lamps need to be done. Thus, this project will be comparing three type of lamp that are very commonly used nowadays which are standard fluorescent lamp, CFL, and LED lamp. This project also will determine the amount of lamp needed for the wiring room based on MS(Malaysia standard) and JKR(Jabatan Kerja Raya) technical guide. Calculation had been done in order to determine it. A standard wiring according to MS and JKR technical guide also had been done. This is to ensure the reading or data that been taken are similar as normal buildings or house.

After the wiring had been done, a set of data had been taken from each type of lamp. The data consist 15 sets of reading from each type of lamp. The parameters in the data are voltage, current, power factor, power, lux and total harmonics distortion (THD). Then an analysis from the data had been done. Each parameter had been compared from each type of lamp. From the analysis, a result and conclusion on the best type of lamp had been made. By guiding from the result, consumer can chose and decide which type of lamp are the most suitable and efficient to be used.

## 1.2 Problem statement

Standard fluorescent lamp, compact fluorescent lamp, incandescent lamp and LED are some example of lamp that are commonly used nowadays. Each type of these lamps has their own capabilities and limits on producing the amount of light (lux) depending on their power consumption. For an example, a 18 watt LED will not produce the same amount of lux compared to a 18 watt fluorescent lamp. The main problem of this project is to determine the most efficient lamp by doing comparison between each type of lamps. Only three types of lamps will be used in this project that are standard fluorescent lamp, compact fluorescent lamp and LED lamp.

In order to complete this project, a wiring work needs to be done. Before that, the preparations for the wiring need to be done. First, the amount of lamp needs to be calculated. All types of lamps will produce the same minimum illumination level, so the amount of lamp for each type will not be the same. Then, the wiring diagram needs to be prepared. Each types of lamps will had a different wiring diagram due to different amount

of lamps. The amount of wires and type of tools will also need to be determined. A set of data will be taken from the wiring to do the comparison.

The parameter in the data that had been used for the comparison are voltage, current, power factor, power, lux and total harmonics distortion. This comparison would more precise if the colour rendering index and colour temperature actual value are measured and included as the parameters.

High electricity bills are the main motivation of this project. With this comparison, consumer can decide which is the best lamp to be used. It is important because an efficient used of energy can save a lot of money. Besides that, a high energy demand problem could also be reduced. It is important to the environment because to produce more electrical energy required more burning fossil fuels which furthermore brings to pollutions. In addition, the rationale of this project is to make a guidelines or reference to study the best lamp that customer can choose.

## 1.3 Project Objective

There are three objectives that need to be accomplished in this project which are:

1. To determine the amount of lamp needed for the wiring room based on MS and JKR technical guide.
2. To compare the performance between standard fluorescent lamp, CFL, and LED lamp. The criteria used to do the comparison are voltage, current, power factor, power, lux and total harmonics distortion (THD).
3. To investigate the most efficient type of lamp to be used base on costing, performance and energy consumptions.

## 1.4 Project Scope

The scope of this project can be divided into four sections which are type of lamp, location, parameter and tools.

### 1.4.1 Type of lamp

The scope of this project is to compare between three types of lamps which are standard fluorescent lamp, CFL, and LED lamp. Other type of lamp like halogen bulb or incandescent bulb is not included. This is because those three lamps are commonly used nowadays.

### 1.4.2 Location

The wiring of the project will be done in a store room at UTeM laboratory. The size of the room is 3.3metres height, 3.018metres width and 5.593metres length. The illumination level and amount of lamp needed for the room is determined based on MS and JKR technical guide.

### 1.4.3 Parameters

The parameter in the data that had been used for the comparison are voltage, current, power factor, power, lux and total harmonics distortion (THD). Power factor consist of two data which are true power factor and displacement power factor. Power consists of three data which are real power, P (W) reactive power, Q (VAR) and apparent power, S (VA). THD consist of two data which are THDi and THDv.

### 1.4.4 Tools and apparatus

There are a few tools and equipment needed for this project. For wiring process, it required some of the equipment such as wiring tools, conduit, and electrical wire. For justification and validation, the measurement equipment such as Multimeter, Fluke Power Quality Analyser, and Lux meter are needed.

# CHAPTER 2

# LITERATURE REVIEW

## 2.0 Overview

This chapter is focused on the exploration of the study that been conducted and discuss the review from others project that can be implemented in this project. The source of review is from the past journals, books and articles related to the project.

## 2.1 Energy Consumption In Malaysia

From 1980 to 2010, the yearly electricity demand per capita (kWh/person) has increase from 626kw to 3200kw [1]. This dramatically increasing energy consumption is caused by a highly economic growth in Malaysia. In a research among ASEAN countries, Malaysia had consumed most electrical energy. Figure 2.1 shows the Malaysia statistic of energy usage in 2007. It states that industrial sector consumed most energy which is 48% followed by commercial sector 32% and residential area 19% [2].

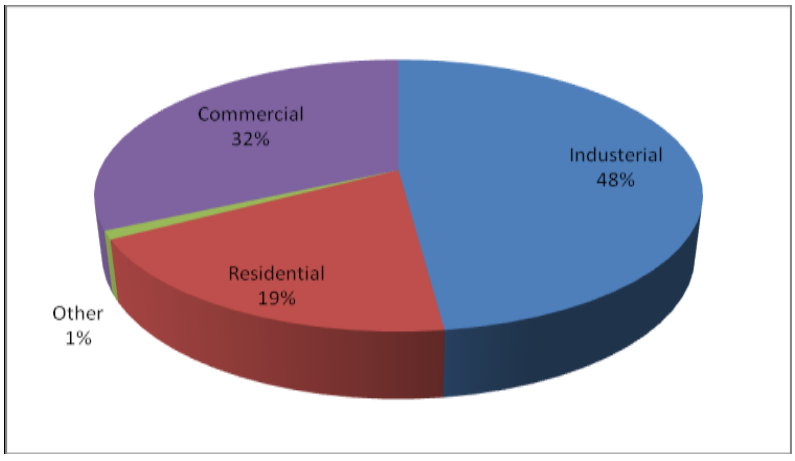


Figure 2.1: Malaysia statistic of energy usage in 2007[2]

A research had been done in a typical Malaysian office building and it shows that 58% from the energy consumption is from air-conditioning, 20% from lighting, 19% from office equipment and 3% from others [2]. Energy consumption including gas and electricity in a averaged household in Malaysia shows cooking appliances including cooking gas, refrigerator and other electrical cooking tool is the largest contributor which is 45% followed by cooling equipment including fan and air-conditioner which in 29%. Lighting consumed only 8% while the other 18% is from other electrical appliances [3]. Figure 2.2 shows the lighting energy consumption in typical office building and average household.

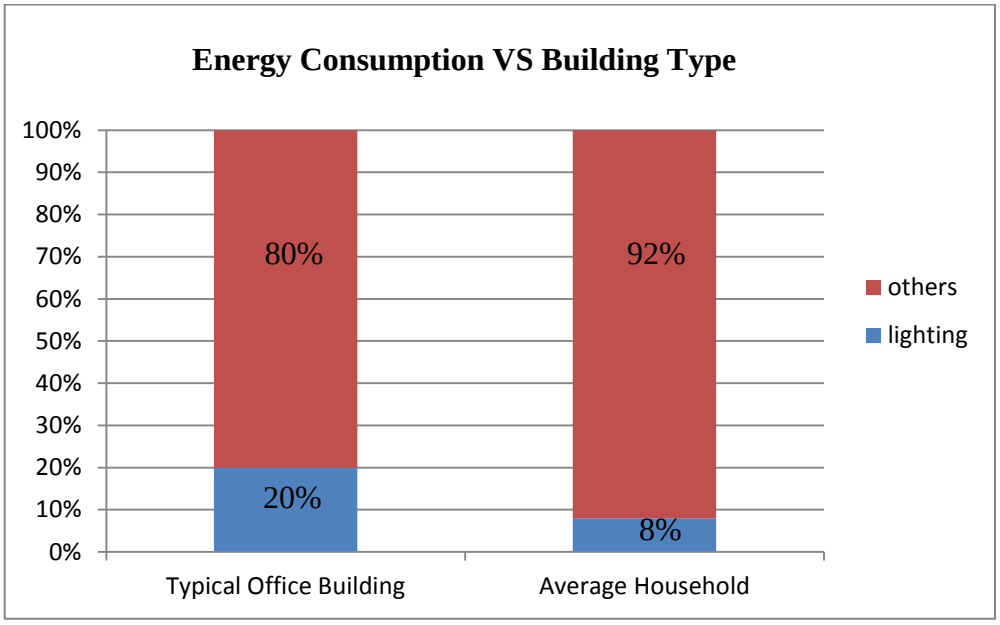


Figure 2.2: Lighting energy consumption in typical office building and average household [2,3].

## 2.2 Difference between lux, lumen and watt

The SI derived unit of illuminance or illumination are known as lux (lx) which is equal to one lumen per square metre ($lm/m^2$). Luminous flux,Φ is measured by lumens where flux, Φ is equal to illumination (E) times area (A) [9]. It measures the total amount of light produced and it is the quantity of light emitted by the light source. Basically, the purpose of lux is to determine the amount of necessary lumens required to illuminate a

certain area. A single fluorescent lamp with 1200 lumens might be possible to achieve an illuminance of 500 lux if it is in a home kitchen but it is impossible to light a factory with dozens of times the area of the kitchen. This shows that a larger number of lumen is required to light a larger area with a same amount of lux. Lux depends on area which the luminous flux is spread. For an example, illuminance of 1000 lux are equal to 1000 lumen concentrated to an area of 1 square meter but when 1000 lumens is concentrated to an area of 10 square meter, it will only produce illuminance of 100 lux [4]. There are few standards that state the illumination level for certain categories. In Malaysia, Malaysian Standard (MS1525:2007) and JKR technical guide are often used as a reference [5]. On the other hand, wattage of a light source is the power consumed by the lamp. The wattage is the sum of the energy to emit light and the heat generated.

## 2.3 LED and Fluorescent Lamp

Each type of lamps is made from different material and had their own characteristics. LED has its own way on producing light. When there are current flows into a diode, negative electrons and positive holes will move to an opposite direction. The free electron has a higher energy level than the holes. When the free electron falls into the hole, it will lose energy and the energy is emitted in form of a light photon. The energy level of the photon is determined by the size of the electron that falls, which will determine its colour. A higher energy level photon produced from bigger falls and a higher light frequency is produced from a photon with higher energy [6]. On the other hand, fluorescent lamp are much different. Fluorescent lamp has a pin terminal and when current flows through it, the filament inside the tube becomes hot and ionizes the inert gas. During the same time, electrons will be emitted by the filament and this will causes the mercury to evaporate [16]. Mercury vapour is excited and will emit energy ultraviolet radiation. The inner layer of phosphorus will convert energy ultraviolet radiation to visible light [7]. Contains of mercury inside fluorescent lamp has made it a hazardous toxic waste. Mercury is very toxic and can damage the brain, liver, kidneys and central nervous system. This is also one of the advantages of fluorescent lamp.

## 2.4 Performance Comparison of LED Lamp, Incandescent Bulb and CFL.

In term of average life span, LED lamp will last longer than other types of lamps. The average life span of LED lamp is 50,000 hours while CFL can last up to 8,000 hours. Incandescent bulb has the shortest life span which is 1,200 hours [8]. LED lamp can last up to 10 times compared to CFL [10]. For energy efficiency, LED uses less power per unit of light generated. By using less power, it will help to reduce greenhouse gas emission from power plants as well as reducing electricity bills. A 6 to 8 watts LED lamp is equal to 60 watts incandescent lamp or 13 to 15 watts of CFL. Lower energy consumption will decrease carbon dioxide admission, sulphur oxide, and high level nuclear waste. By assuming the usage of 30 bulbs per year, carbon dioxide emission of LED is 451 pounds/year while incandescent bulb will produce 4500 pounds/year and CFL will produce 1051 pound/year [8]. CFL also had a potential to bring a negative impact on the human health. This is because, it has mercury that is very toxic to human health and the environment [10]. All CFL and some of incandescent bulbs are sensitive to certain temperature. A CFL may not work under negative 10 degrees Fahrenheit or over 120 degrees Fahrenheit. LED lamps have no sensitivity to temperature. CFL also has sensitivity to humidity. Some of incandescent also sensitive to humidity while LED lamp is not. Switching a CFL on/off quickly may decrease the life span of the bulb but it has no effect on LED lamp and some incandescent bulb will be affected. LED lamp is very durable. It can handle jarring and bumping while CFL and incandescent bulb is not very durable because its glass can easily broke. A 4-5 watt LED lamp, 40 watt incandescent lamp, and 9-13 watt CFL will produce the same amount of lumens which is 450. This shows that LED has the lowest power consumption to produce the same amount of lumen [8].