UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ADVANCED GREEN TECHNOLOGY LIGHTING SYSTEM

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor's Degree in Electronics Engineering Technology (Industrial Electronic) (Hons.)

by

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………………………………

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ABSTRAK

Sistem lampu adalah salah satu faktor yang boleh menjadi kadar yang menjimatkan tenaga untuk zon bangunan termasuk kediaman, perdagangan dan perindustrian. Parameter utama untuk memastikan kecekapan yang baik adalah penggunaan tenaga, sumber tenaga dan sistem terkawal. Jadi, projek ini menekankan kecekapan penggunaan elektrik oleh melaksanakan teknologi hijau dan sensor pintar dalam sistem pencahayaan. Formula matematik analisis digunakan untuk menggambarkan pengiraan teori penggunaan tenaga dengan menggunakan undang-undang standard elektronik. Simulasi dijalankan pada perisian serasi untuk mendapat hasil jangkaan awal. LED menggunakan kurang kuasa (watt) bagi setiap unit cahaya yang dijana (lumen) tetapi mempunyai lux mencukupi untuk mencerahkan tempat tertentu. Analisis menunjukkan bahawa lampu LED mempunyai 50 000 jam Purata jangka hayat dan kecekapan hampir 80 % dari segi penggunaan tenaga. LED membantu mengurangkan pelepasan gas rumah hijau dari loji kuasa dan bil elektrik yang lebih rendah yang bermaksud kos kurang tenaga. Solar dan haba yang mengecas bateri digunakan sebagai sumber kuasa untuk lampu LED. Sensor digunakan untuk sistem pencahayaan untuk menguruskan penjimatan kuasa bijak.

ABSTRACT

Lighting system is one of the factor that can be rates as energy saving for the building zone including residential, commercial and industrial. The key parameters to ensure good efficiency is the energy consumption, energy source and manageable system. So, this project is emphasized the efficiency of electricity consumption by implement green technology and intelligent sensor in the lighting system. Analytical mathematic formula is applied to illustrate the theory calculation of energy consumption by using standard law of electronic. Simulations is conducted on compatible software to get early expectation result. LEDs use less power (watts) per unit of light generated (lumens) but has sufficient lux to brighten certain place. The analysis indicated that LED lighting has 50 000 hours of average life span and almost 80% efficiency in terms of energy consumption. LEDs help reduce greenhouse gas emissions from power plants and lower electric bills which means less cost of energy. The battery charged by solar and wasted heat is used as power source to LED lighting. Sensors is applied to the lighting system in order to manage the power saving intelligently.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

LED	-	Light Emitting Diode
IEA	-	International Energy Agency
IC	-	Integrated Circuit
PV	-	Photovoltaic
AC	-	Alternate Current
DC	-	Direct Current
NLPIP	-	National Lighting Product Information Program
CFL	-	Compact Fluorescents
RoHS	-	Restriction of Hazardous Substances
PIR	-	Passive Infrared
PCB	-	Printed Circuit Board
SDLC	-	System Development Life Cycle
IR	-	Infrared
DPDT	-	Double pole, double throw

CHAPTER 1

INTRODUCTION

This introduction chapter is discussed about the overall view of research will be discussed where it will focus on the energy consumption of lighting system on building and how it affect the electrical usage cost and environment. Besides that, this chapter will discussed about the problem statement, objectives and scopes of project. The research will bring significant changes to the most type of the building in terms of energy consumption.

1.1 Background of The Study

Lighting consumes about 19% of all produced electricity worldwide and represents about 35% of total primary energy consumption within buildings, like offices, schools and factory building. In fact, they can yield high return in terms of efficiency improvement because lighting system are major energy user. Therefore, the energy efficiency of lighting is important, especially when the price of the electricity has risen constantly during recent years while at the same time the energy efficiency regulations have become more restrictive.

Although energy efficiency and savings are important, it is vital to remember that most important function of lighting is to provide comfortable visual conditions for the users of the space and help them to perform their visual tasks as easily as possible. For example, if new building would be built, a well-designed lighting system should attained the desired of lighting performance Therefore, besides the quantity of light and how efficiently it is produced, the quality of the light must be considered also. So, this project which entitled as Advanced Green Technology Lighting System to emphasize the efficiency of electricity consumption by implement green technology and intelligent sensor in the lighting system without neglecting the amount of optimum illuminance.

1.2 Problem Statement

The ideas for this project is come out after observing the conventional lamp such as fluorescent lamp use high energy consumption and short life span including eco saving type compared to the LED lighting. The conventional lamp cannot use renewable energy or green technology as power source compared to the LED light. As the economy in industrialized countries has maintained rapid growth, the requirement of energy consumption is increasing. With all the system in building, proper operation and maintenance of luminaries and control increase system life and ensures long term energy saving. As lamp approach the end of their useful live they produce less and less light. Such depreciation may cause a number of problems:

(a) Weak lights cause occupants discomfort, which can result in significant losses in productivity and revenue

(b) Due to low lamp ambient light level, occupants will turn on their own table lamps. Table lamp uses incandescent lamp which draws mere energy use.

(c) In certain retail situation lumen depreciation may adversely affect how products appear to customer, giving the impression of dimly lit spaces of distorting the colour of the merchandise.

When this problem happens we need to replace the lighting system. Replacement of all lighting is more cost effective then replacing individual lamp so lighting designer then must worked on to ret a most cost effective and longer useful life lamp so that it will gain a higher return. Sometimes redesign lighting system in a building need to be done although it is costly to get a long term benefit. Due to the problem encounter above, this shows importance of this project is to the lighting designer, installer (contractor), electrician and other production term in technical planning process. So, the research is aim to design a lighting system which has capabilities to consume less energy, to control the electric usage wisely and also more environmental friendly without reduce the quality of light.

1.3 Objectives

The objectives of this project are:

(a) To design energy saving lighting system.

  (i) The research aim to design a lighting system which consume less energy by based on LED type of lighting.

(b) To build green technology power source for the LED lighting.

  (i) The research aim to build renewable and energy power source which has come from heat and sun lighting that convert it to electricity to be stored to battery.

(c) To create intelligent sensor system for LED lighting to operate efficiently.

  (i) The research aim to create a control system by using sensor to manage and monitor the lighting usage wisely in order to operate more efficiently.

1.4 Scope

The scope of this project is to build a lighting system that will function properly based on the objective and to solve problem faced. The main objective is to build a LED lighting system which is save energy by using solar and wasted heat as power source. The LED is constructed with a circuit which has Zener diode and suitable IC depends on their power consumption. The surface mount type of LED is applicable in this project. The circuit is constructed on certain length which is will be mounted in the housing lamp. The project focuses on renewable energy as power source which are used solar panel or Photovoltaic (PV) and Thermoelectric module is design and will be integrate with the LED lighting as power source. The source energy is obtained from the renewable source and also it stored in the battery as power storage. Solar panel or photovoltaic panel is use to harvest sunlight and convert it to electrical current. Thermoelectric module is to harvest wasted heat around place and convert it to electrical current. Motion or infrared sensor and also sound sensor is constructed (depends on suitability) as intelligent system to manage LED lighting to turn on/off based on vacancy of people or object around the area of the light.

CHAPTER 2
LITERATURE REVIEW

Literature review can be defined as a background study about the knowledge and information needed to develop a project. To develop a complete and functional project it is necessary to writing literature review to go through before starting project analysis and design. This chapter will focus on the theory of each part and software used in my project. The sources from theory are taken from book, journal, article and website that are relevant. Besides, methods and tools used to handle project are described and discussed.

2.1 Study on Lighting

According to (CIE, 2010), visible light (commonly referred to simply as light) is electromagnetic radiation that is visible to the human eye, and is responsible for the sense of sight. Visible light is usually defined as having a wavelength in the range of 400 nanometres (nm), or 400×10^{-9} m, to 700 nanometres – between the infrared, with longer wavelengths and the ultraviolet, with shorter wavelengths as stated by. (Pal & Pravati, 2011) In the extensive study, (Laufer & Gabriel, 2012) presents that these numbers do not represent the absolute limits of human vision, but the approximate range within which most people can see reasonably well under most circumstances.

Various sources define visible light as narrowly as 420 to 680. Under ideal laboratory conditions, people can see infrared up to at least 1050 nm, according to (Lynch, K., Livingston, & Charles, 2010)

The main component of this project is definitely the type of lighting itself. At the moment it seems that new lighting solutions of the near future will be dominated by LEDs and thus it is vital to know what kind of advantages and disadvantages they have compared to more traditional light sources. LEDs use less power (watts) per unit of light generated (lumens) and help reduce greenhouse gas emissions from power plants and lower electric bills. Despite of LED used less energy consumption, it seems that the lighting quality is likely not good as fluorescent lamp because the lux is usually lower than fluorescent lamp and the glare of the LED lighting user is a little bit higher. But it was not a huge problem since the modification and research is implemented to reduce this advantage by redesign the angle of lamp housing, fitting reflector inside housing and mounting anti-glare plastic cover.

2.2 Types of Lighting

2.2.1 Incandescence type of lamp

Incandescent lamps (light bulbs) generate light by passing electric current through a resistive filament, thereby heating the filament to a very high temperature so that it glows and emits visible light over a broad range of wavelengths. Incandescent sources yield a "warm" yellow or white color quality depending on the filament operating temperature. Incandescent lamps emit 98% of the energy input as heat. (Keefe & T.J, 2011). A 100 W light bulb for 120 V operation emits about 1,180 lumens, about 11.8 lumens/W; for 230 V bulbs the figures are 1340 lm and 13.4 lm/W. Incandescent lamps are relatively inexpensive to make. The typical lifespan of an AC incandescent lamp is 750 to 1,000 hours. (Raatma & Lucia, 2010). They work well with dimmers. Older light fixtures are designed for the size and shape of these traditional bulbs.

2.2.2 Fluorescent lamp

Fluorescent lamps work by passing electricity through mercury vapour, which in turn emits ultraviolet light. The ultraviolet light is then absorbed by a phosphor coating inside the lamp, causing it to glow, or fluoresce. Conventional linear fluorescent lamps have life spans around 20,000 and 30,000 hours based on 3 hours per cycle according to lamps NLPIP reviewed in 2006. Induction fluorescent relies on electromagnetism rather than the cathodes used to start conventional linear fluorescent. The newer rare earth triphosphorous blend linear fluorescent lamps made by Osram, Philips, Crompton and others have a life expectancy greater than 40,000 hours, if coupled with a warm-start electronic ballast. The life expectancy depends on the number of on/off cycles, and is lower if the light is cycled often. The ballast-lamp combined system efficacy for then current linear fluorescent systems in 1998 as tested by NLPIP ranged from 80 to 90 lm/W.

2.2.3 Light Emitting Diode Lamp

An LED lamp is a light-emitting diode (LED) product that is assembled into a lamp (or light bulb) for use in lighting fixtures. LED lamps have a lifespan and electrical efficiency that is several times better than incandescent lamps, and significantly better than most fluorescent lamps, with some chips able to emit more than 100 lumens per watt. LED lights come to full brightness without need for a warm-up time; the life of fluorescent lighting is also reduced by frequent switching on and off. Initial cost of LED is usually higher. Degradation of LED dye and packaging materials reduces light output to some extent over time.

2.3 Comparison Chart Between LED Lights vs. Incandescent Light Bulbs vs. CFLs (Inc, 2011)

Table 2.1: Energy Efficiency and Energy Cost

Energy Efficiency & Energy Costs	 **Light Emitting Diodes (LEDs)**	 **Incandescent Light Bulbs**	 **Compact Fluorescents (CFLs)**
Life Span (average)	**50,000 hours**	**1,200 hours**	**8,000 hours**
Watts of electricity used (equivalent to 60 watt bulb). LEDs use less power (watts) per unit of light generated (lumens). LEDs help reduce greenhouse gas emissions from power plants and lower electric bills	**6 - 8 watts**	**60 watts**	**13-15 watts**
Kilo-watts of Electricity used (30 Incandescent Bulbs per year equivalent)	**329 KWh/yr.**	**3285 KWh/yr.**	**767 KWh/yr.**
Annual Operating Cost (30 Incandescent Bulbs per year equivalent)	**$32.85/year**	**$328.59/year**	**$76.65/year**

Table 2.2: Environmental Impact

Environmental Impact	 **Light Emitting Diodes (LEDs)**	 **Incandescent Light Bulbs**	 **Compact Fluorescents (CFLs)**
Contains the TOXIC Mercury	**No**	**No**	**Yes** - Mercury is very toxic to your health and the environment
RoHS Compliant	**Yes**	**Yes**	**No** - contains 1mg-5mg of Mercury and is a major risk to the environment
Carbon Dioxide Emissions (30 bulbs per year) Lower energy consumption decreases: CO2 emissions, sulfur oxide, and high-level nuclear waste.	**451 pounds/year**	**4500 pounds/year**	**1051 pounds/year**

Table 2.3: Important Facts

Important Facts	 Light Emitting Diodes (LEDs)	 Incandescent Light Bulbs	 Compact Fluorescents (CFLs)
Sensitivity to low temperatures	None	Some	Yes - may not work under negative 10 degrees Fahrenheit or over 120 degrees Fahrenheit
Sensitive to humidity	No	Some	Yes
On/off Cycling Switching a CFL on/off quickly, in a closet for instance, may decrease the lifespan of the bulb.	No Effect	Some	Yes - can reduce lifespan drastically
Turns on instantly	Yes	Yes	No - takes time to warm up
Durability	Very Durable - LEDs can handle jarring and bumping	Not Very Durable - glass or filament can break easily	Not Very Durable - glass can break easily
Heat Emitted	3.4 btu's/hour	85 btu's/hour	30 btu's/hour
Failure Modes	Not typical	Some	Yes - may catch on fire, smoke, or omit an odor

Table 2.4: Light Output

Light Output	 Light Emitting Diodes (LEDs)	 Incandescent Light Bulbs	 Compact Fluorescents (CFLs)
Lumens	Watts	Watts	Watts
450	4-5	40	9-13
800	6-8	60	13-15
1,100	9-13	75	18-25
1,600	16-20	100	23-30
2,600	25-28	150	30-55

2.4 Study of Photovoltaic

Photovoltaics (PV) is a method of generating electrical power by converting solar radiation into direct current electricity using semiconductors that exhibit the photovoltaic effect. Photovoltaic power generation employs solar panels composed of a number of solar cells containing a photovoltaic material. Solar photovoltaics power generation has long been seen as a clean sustainable (Pearce & Joshua, 2011) energy technology which draws upon the planet's most plentiful and widely distributed renewable energy source – the sun. The direct conversion of sunlight to electricity occurs without any moving parts or environmental emissions during operation. It is well proven, as photovoltaic systems have now been used for fifty years in specialised applications, and grid-connected systems have been in use for over twenty years. (Bazilian, et al., 2013)

A solar cell (also called a photovoltaic cell) is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect. It is a form of photoelectric cell (in that its electrical characteristics—e.g. current, voltage, or resistance—vary when light is incident upon it) which, when exposed to light, can generate and support an electric current without being attached to any external voltage source, but do require an external load for power consumption. The term "photovoltaic" comes from the Greek φῶς (phōs) meaning "light", and from "volt", the unit of electro-motive force, and the volt, which in turn comes from the last name of the Italian physicist Alessandro Volta, and inventor of the battery (electrochemical cell). The term "photo-voltaic" has been in use in English since 1849.

Photovoltaics is the field of technology and research related to the practical application of photovoltaic cells in producing electricity from light, though it is often used specifically to refer to the generation of electricity from sunlight. Cells can be described as photovoltaic even when the light source is not necessarily sunlight (lamplight, artificial light, etc.). In such cases the cell is sometimes used as a photodetector (for example infrared detectors), detecting light or other electromagnetic radiation near the visible range, or measuring light intensity.