ENERGY EFFICIENCY IMPROVEMENT FOR FACULTY OF TECHNICAL AND VOCATIONAL EDUCATION BUILDING

SUHAIMI BIN MOHAMAD

A project report submitted in partial
fulfillment of the requirement for the award of the
Degree of Master of Electrical Engineering

Faculty of Electrical and Electronic Engineering
Universiti Tun Hussein Onn Malaysia

JULY 2014

For my beloved father Mohamad Bin Embong, my mother Yahana Binti Othman, my lovely wife Anita Binti Harun, my kids Ahmad Ashraf, Ahmad Irfan, Aishah Amani and Ahmad Arif Mukmin. Thanks for yours full support.

ACKNOWLEDGEMENT

I would like to express my utmost and deepest gratitude to my supervisor, Dr Kok Boon Ching for his advise and persistent guidance when needed throughout the whole academic year. It would be very difficult to complete this project without the enthusiastic support, insight and advice given by him.

Subsequently I would like to thank to my family for moral support given in entire process to complete my study.

Last but not least thanks to all friends and all people whom I have not mentioned who help me in completing this project.

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I hereby declare that the work in this project report is my own except for quotations and summaries which have been duly acknowledged.

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Date : ……

Supervisor : ……

DR. KOK BOON CHING

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ABSTRACT

Energy efficiency becomes important matter due to correlate to sustainability and money. The ministry of Education Malaysia has urged all education center to conserved energy. Energy wastage tends to occur in Malaysian universities mainly due to inefficient use of energy and lack of awareness among building users. In this research, the researcher has analyse the building energy consumption and identify potential energy improvement that can be made in Faculty Technical and Vocational Education Universiti Tun Hussein Onn Malaysia. Suitable method to reduce energy consumption have been proposed without compromising user comfort in order to improve energy efficiency. The options of the proposed improvement method have been simulated using DIALUX and MATLAB/SIMULINK before the selection is done. This research have found that the most efficient lighting system for FPTV is using LED T8 replacement. The power factor correction have calculated and simulated. The researcher also has proposed the suitable method on management perspective to improve energy efficiency.

ABSTRAK

Kecekapan tenaga menjadi perkara penting kerana berkait rapat dengan kemampanan dan wang. Kementerian Pelajaran Malaysia telah menggesa semua pusat pendidikan untuk mengambil langkah-langkah kearah penjimatan tenaga. Pembaziran tenaga adalah cenderung untuk berlaku di universiti-universiti Malaysia terutamanya kerana penggunaan yang tidak cekap dan kekurangan kesedaran di kalangan pengguna. Dalam kajian ini, pengkaji telah menganalisis penggunaan tenaga di dan mengenal pasti potensi penjimatan tenaga yang dapat dilakukan di Fakulti Teknikal dan Vokasional Universiti Tun Hussein Onn Malaysia. Kaedah yang sesuai untuk mengurangkan penggunaan tenaga telah dicadangkan tanpa menjejaskan keselesaan pengguna untuk meningkatkan kecekapan tenaga. Pilihan kaedah penambahbaikan yang dicadangkan telah disimulasikan menggunakan DIALUX dan MATLAB / SIMULINK sebelum pemilihan dilakukan. Kajian ini telah mendapati bahawa sistem lampu yang paling berkesan untuk FPTV menggunakan penggantian LED T8. Pembetulan faktor kuasa telah dikira dan dilakukan simulasi. Penyelidik juga telah mencadangkan kaedah yang sesuai dalam aspek pengurusan untuk meningkatkan kecekapan tenaga.

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LIST OF SYMBOLS AND ABBREVIATIONS

AC	-	Alternating current
BEMS	-	Building Energy Management System
CAFM	-	Computer Aided Facilities Management
CFL	-	Compact fluorescent lamp
CRI	-	Color rendering index
DC	-	Direct current
EEI	-	Energy Efficiency Index
HVAC	-	Heating, Ventilation and Air conditioning
kWh	-	Kilowatt hour
LED	-	Light emitting diode
LPW	-	Lumen per watt
m	-	meter
UV	-	Ultra violet
UTHM	-	Universiti Tun Hussein Onn Malaysia
UTM	-	Universiti Teknologi Malaysia

CHAPTER 1

INTRODUCTION

1.1 Project Background

Electrical energy plays an important role in the developments of Malaysia economics. It is widely used in sectors such as industrial, domestic, commercial, government building, public lighting and mining sectors. Growth in these sectors has been indebted for the increase in energy consumption. The increase in the number of commercial buildings and residential area development projects has a great impact to the national development but it also increases the energy demand [1]. Recognising that the development should run in parallel with environmental sustainability, various policies and methods are made available to help preserve the environment. Since the energy crisis in 1970, engineers, architects and building developers are better equipped to design and maintain buildings more efficiently to reduce energy consumption and electricity usage [2]. To encourage sustainable building practice, The Malaysian Standard MS 1525:2007, Code of Practice on Energy Efficiency and use of Renewable Energy for Non – Residential Buildings has been introduced. The Standard briefly describes the engineering, architectural, landscaping and site planning aspects in designing to optimize the energy efficiency of a non-residential building [2].

The development of Malaysia has also led to the development and growth of higher education institutions to accommodate the growing number of local as well as international students. Currently, each state in Malaysia has at least one public or

private higher education institution. The Malaysian Ministry of Education (MOE) and The Malaysian Ministry of Higher Education (MOHE) has urged all education centers to play their role to save the electric energy [3]. This is in line with the efforts of the Ministry of Energy, Green Technology and Water (MEGTW) to initiate energy-saving programmers' in all government departments [4]. For efficient use of energy, all parties should support the program initiated by the authorities and the continuous improvement program to sustain the initiative.

At present, environmental sustainability is seen as the way forward by various parties to make life better without polluting the environment. The sustainability concept has been introduced widely in various sectors such as government, private sector and also in education [5]. The awareness of the sustainability concept in Malaysia especially in the higher education institutions is gaining momentum [6] and awareness programs have been initiated in Malaysia with a view towards creating a sustainable environment.

1.2 Problem Statements

Energy wastage tends to occur in Malaysian universities mainly due to inefficient use of energy and lack of awareness among building users [3]. Inefficient used of energy include the use of high energy consumption appliances, the use of appliances that can cause low power factor to the electrical installation system.

In the university context, energy wastage can cause high expenses on electrical energy. Energy waste is money waste. It's not only involving the money but waste of energy means contribute to environmental damage such as global warming without any payback to citizen.

In this context, energy efficiency initiative should be taken so that the high efficient of energy usage can be achieve. It's is not only can contribute to the sustainable development but there's some cost saving on energy usage can be made and it's become the motivation factor to this project.

1.3 Project Objectives

The main objective of this research is to conduct a feasibility study and data collection on current energy usage, building load profiling, power factor and the possible power quality events for FPTV building. Using these inputs, the researcher will suggest the method to improve the energy efficiency of the building. Its measurable objectives are as follows:

a) To analyse the building power consumption
b) To improve the overall power factor of the building
c) To propose proper energy saving methods on management perspective

1.4 Project Scopes

This project is primarily concerned with the building energy efficiency in public Universities in Malaysia. However the researcher will only concentrate the building energy efficiency improvement at Faculty of Technical and Vocational Education, Universiti Tun Hussein Onn Malaysia. The scopes of this project are:

a) To reduce energy consumption by replacing the ineffective loads as well as the number of the loads. There are three categories of loading to be focused in this project:
    i. Lighting
    ii. Air conditioner
    iii. Office appliances
b) To improve power factor of the systems installation base on:
    i. Reducing Q consumption
    ii. Compensate Q in the system
c) To propose energy saving method by considering the user behaviour such as:
    i. Switch ON and OFF the lighting
    ii. Switch ON and OFF air conditioner
    iii. Switch ON and OFF computer

CHAPTER 2

LITERATURE REVIEW

2.1 Energy efficiency

Energy efficiency refers to the physical performance of specific end uses or energy services such as lighting, heating, cooling, and motor drive. Energy efficiency is usually measured by the output quantity per unit of energy input (miles per gallon or lumens per watt, for example). Because energy is one of several factors of production (labor, capital, and materials are others), energy efficiency improvements contribute to greater energy productivity and economic efficiency [4]. Greater energy efficiency is achieved by replacing load from conventional to energy efficient product, upgrading electrical system to energy efficient system, or maintaining existing equipment to reduce the amount of energy needed.

2.2 Energy efficiency index

Energy Efficiency Index (EEI) is a tool used to track the performance of energy consumption. The measurement of EEI depends on the use of energy in a particular application[1]. Generally, the EEI can be defined in terms of an energy component and a factor related to the energy using component of the organization as given in equation (1). Examples of factors related to energy use are as listed below:

i) Weight of product produced

ii) No. of item produced

iii) Weight of raw material used

iv) Period of production

v) Period of plant usage

vi) Floor area of building

vii) No. of in-patient bed per night (hospital building)

viii) No. of occupied room per night (hotel building)

$$EEI = \frac{Energy\ Input}{Factor\ Related\ to\ the\ Energy\ Using\ Component} \quad (2.1)$$

For a building, the definition of EEI is tied to the size of the building and is generally considered as energy used per unit of building floor area which can be determined using Equation (2.2). EEI is expressed in kWh/m^2.

$$EEI = \frac{Total\ energy\ used\ (kWh)}{Gross\ Floor\ Area\ (m^2)} \quad (2.2)$$

The EEI is important in energy efficiency improvement program as it is used as a key performance indicator. EEI is used by Universiti Teknologi Malaysia as a key performance indicator for their energy management programmes [1]. Figure 2.0 show the EEI at UTM.

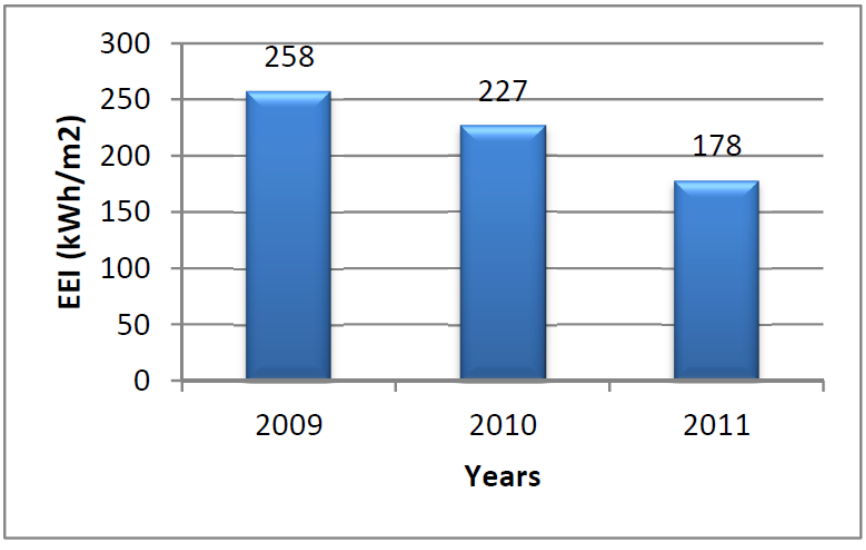

Figure 2.1. Energy Efficiency Index (EEI) in UTM

2.3 Energy efficient product

There are a lot of energy efficient product in the market. It can be divided by at least four main categories for building application:

i. Lighting
ii. Cooling and ventilation
iii. Heating
iv. Monitoring system

2.3.1 Efficient Lighting Systems

Light emitting diodes (LEDs) are semiconductor diodes that emit light when current flows through them. They are available as narrowband light sources in "colors" ranging from the infrared to the near UV, and, with the addition of a phosphor coat, as a white light source with color temperatures ranging from 3200 to 12,000 °K and color rendering index CRI values ranging from 60 to over 90. Rated efficacies range up to 30 LPW for white LEDs, which is superior to that of incandescent lamps.

Light emitting diodes have advantages over small incandescent lamps that are leading to their increasing dominance for battery operated lighting. Their usable life ranges from 6000 to 50,000 h (at 70% lumen maintenance). Small standard flashlight bulbs have thin filaments and can only manage 8-l0 LPW and 15-30 h of lamp life.

Light emitting diodes are durable, require less expensive optics for good beam control, and are available with high color temperatures, which lead to higher perceived brightness and better visibility in low light conditions. The power supplies used in the more expensive lights significantly increase the fraction of battery power available to provide useful amounts of light. LED bike lights and flashlights have battery lives that are a factor of 10 greater than those of comparable standard incandescent lights, and a factor of 3-5 greater than those of halogen lamps. The use of a flashing mode can increase this advantage even further.

Light emitting diodes are also relplacing incandescent lamps in traffic signal lights and dynamic sign and color displays. Light emitting diodes have the advantage over incandescent lamps in these applications because filtering incandescent lamps to produce colors reduces their efficacy to the 2-3 LPW range, while switching on and

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