UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ENERGY MANAGEMENT IN NON-RESIDENTIAL BUILDING

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology (Industrial Power) With Honours.

by

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Tajuk**: Energy Management in Non-Residential Building**

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This report is submitted to the Faculty of Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Industrial Power) With Honours. The member of the supervisory is as follow:

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ABSTRAK

Bangunan komersial atau dengan erti lain harta tanah tanpa penduduk mempunyai penggunaan tenaga yang saksama serta terkandung dengan gas rumah hijau (GRH) dalam kalangan stok harta bangunan di dunia ini. Dengan adanya jenis harta bangunan demikian yang dapat menghasilkan impak yang berkekalan terhadap kemampanan sosial, alam sekitar serta ekonomi, tumpuan utama penyelidik-penyelidik baru-baru ini telah beralih kepada kajian peningkatan pretasi tenaga dan juga kecekapan di dalam bangunan. Dengan ini, matlamat utama kajian ini adalah untuk mengkaji konsep pengurusan tenaga dalam bangunan komersial dengan teliti disamping mencari kaedah yang berbeza yang dapat diambil untuk meningkatkan pretasi tenaga dan kecekapan operasi bangunan yang dikaji secara keseluruhan. Langkah awal audit ini di SJKC YOK BIN akan memulakan pertemuan dengan semua kakitangan dan guru di sekolah untuk mengumpulkan dan mengumpulkan semua maklumat dan data, juga untuk menyiasat maklumat latar belakang sekolah. Berjalan melalui audit adalah langkah seterusnya yang perlu diproses, untuk pengumpulan data tapak dan pengumpulan data di luar tapak. Kita mesti tahu setiap peralatan elektrik telah dipasang atau digunakan di SJKC YOK BIN untuk data perbandingan antara tujuan tenaga sebenar dan dikira. Bil bulanan elektrik dari Januari 2018 hingga Disember 2018 dikumpulkan dari pentadbir sekolah untuk analisis dan pengiraan data. Sistem pencahayaan menggunakan elektrik tertinggi di sekolah kerana tingkah laku penghunian. Terdapat tingkah laku tenaga aktif dan pasif dari penghunian seperti pembukaan tingkap, tingkap ditutupi dengan tirai, yang menyekat lampu semula jadi dari memasuki bilik, membazirkan tenaga lampu di bilik darjah dan koridor dan pelajar yang digunakan untuk menghidupkan lampu ketika lux tahap cukup untuk kawasan tersebut.

ABSTRACT

Commercial buildings or non-residential property has had its fair share of energy consumption and greenhouse gas (GHG) emissions among all the building stock in the world. With these type of buildings producing a lasting impact on social, natural and economic sustainability, the primary focus has recently been shifted to the improving of energy performance as well as the efficiency in existing buildings. With this in mind, the main aim of this paper is to thoroughly review the concept of energy management within commercial buildings as well as the different approaches that can be taken to improve the overall energy performance and efficiency of operating these buildings. The first step of this audit in the SJKC YOK BIN is start the kick off meeting with all the staff and teacher in the school to collect and gather all the information and data, also to investigate the background information of the school. Walk through audit is the next step we need to be process, for site data collection and offsite data collection. We must know every single electrical equipment have been installed or used in the SJKC YOK BIN for the comparison data between actual and calculated energy purpose. The monthly electricity bills from January 2018 to December 2018 is collect from the admin of the school for the data analysis and calculation. The lighting system consume the highest electricity in the school due to the occupancy behavior. There have an active and passive energy behavior from occupancy such as window opening, windows were covered by curtain, which blocked the natural lights from entering the rooms, waste in lighting energy at classroom and corridor and student used to switch on the lighting when the lux level is enough for the area.

DEDICATION

Specially dedicated to my family, beloved supervisor and friends:

For being the wonderful you, enough said,

Thank you.

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I would like to express my special thanks of gratitude to University Teknikal Malaysia Melaka (UTeM) for giving me the opportunities to purse my Degree in Electrical Engineering Technology. I would also like to offer my sincerest appreciation to my thesis supervisor Madam Emy Zairah Binti Ahmad and Madam Rohaina Binti Jaafar who gave me the golden opportunity to do this wonderful project, which also helped me in doing a lot of research and I came to know about so many new things I am really thankful to them. Secondly I would also like to thank my panels Madam Nurbahirah Binti Norddin and Ahmad Idil Bin Abdul Rahman for their warm hearted and kind soul. My gratitude also extends to all my fellow colleagues and others who have provided assistance at various occasions. Their views and tips are useful indeed. Last but not least, I would like to thank my very own wonder wall; my family. Without their supports, I would not have been able to finish my research project.

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LIST OF ABBREVIATION AND SYMBOLS

kWh	-	kilowatt hour
GHG	-	Green House Effect
Mtoe	-	Million tons of oil equivalents
SEA	-	South East Asian
CO_2	-	carbon Dioxide
Gt	-	Giga tonnes
BEI	-	Building Energy Index
HVAC	-	Heating, Ventilation, Air conditioning
EMGS	-	Energy Management Gold Standard
BMPs	-	Best Management Practices
Ft	-	Feet
MEIH	-	Malaysia Energy Information Hub
AEMAS	-	ASEAN Energy Management Scheme
ESCOs	-	Energy Service Companies
SEU	-	Significant Energy User
EPBD	-	Energy Performance Building Directive
PJ	-	Petajoule
Toe	-	One Tonne of Oil Equivalent
ISO	-	International Organization for Standardization
ECBC	-	Energy Conservation Building Code
EEMs	-	Energy Efficiency Measure
PDAC	-	Plan Do Act Check
EnPIs	-	Energy Performance Indicators
SPV	-	Solar Photovoltaic

LED	-	light-emitting diode
GSHP	-	Ground Source Heat Pumps
MMD	-	Meteorological Department
US	-	United State
BAS	-	Building Automation System
AHU	-	Air Handling Unit
VAV	-	Variable Air Volume
PID	-	Proportional Integral Derivative
MPC	-	Model Predictive Control
SQP	-	Sequential Quadratic Programming
EU	-	European Union
PIR	-	Passive Infrared
TNB	-	Tenaga Nasional Berhad
hp	-	Horsepower

CHAPTER 1
INTRODUCTION

Chapter 1 will provide the details about the introduction of this project, problem lead to this study, objective research, the scope and limitations of the study.

1.1 Introduction

Commercial buildings are a significant indicator of the sosio-economic development of any nation. Despite the continuous advancements in construction technology and the provision of numerous benefits in mankind, a surge in this field of development have seen many environmental and social consequences arise throughout the operational phase of these buildings. With continuous consumption of energy, water and resources as well as the emission of greenhouse gases (GHG), a forecast in the energy use has seen an expected rise in the future energy consumption portion of commercial buildings. Hence, it can be reasonably suggested that these buildings will inevitably create a lasting effect on the environment, economy, and even the society during the years to come. This is mainly due to the fact that majority of the society tends to spend their time in buildings, by being involved in indoor activities.

With commercial buildings being an evident existence in the modern world, the demand for high-performance buildings with reduced energy consumption and increased efficiency has rocketed over the past decade. In fact, recent legislation and standards in certain countries have urged the construction industry to transcend towards more sustainable and energy

efficient buildings. This would give both new and existing commercial building developers an opportunity to venture into a high-performance and sustainable development track.

All in all, this study will look into the various approaches that can be taken in order to achieve energy efficiency and reduced energy consumption in commercial buildings. A further analysis will be adopted to determine the ideal literature to be reviewed, all of which will incorporate full details of the relevant topics for this study. Proper insights on the systematic approach towards the attainment of a 'green' building from a research point of view will also be provided.

1.2 Problem Statement

In the modern world, commercial buildings have become a dominant feature that consumes up to 40% of the total global energy. With its continuous growth, the energy consumption rate is expected to increase to 50% in the year 2030. In Malaysia, buildings consume 48% of the total electricity generated nationwide, with the energy demand being expected to reach 116 Million tons of oil equivalents (Mtoe) in the year 2020. In a study of energy efficiency measures, the carbon dioxide emissions per capita in Malaysia has somewhat rocketed over the past couple of decades, which is brought about by the increment of energy consumption. Figure 1.1 depicts the carbon dioxide per capita in a few South-East Asian (SEA) countries, whereby Malaysia ranks the highest compared to Thailand and Indonesia.

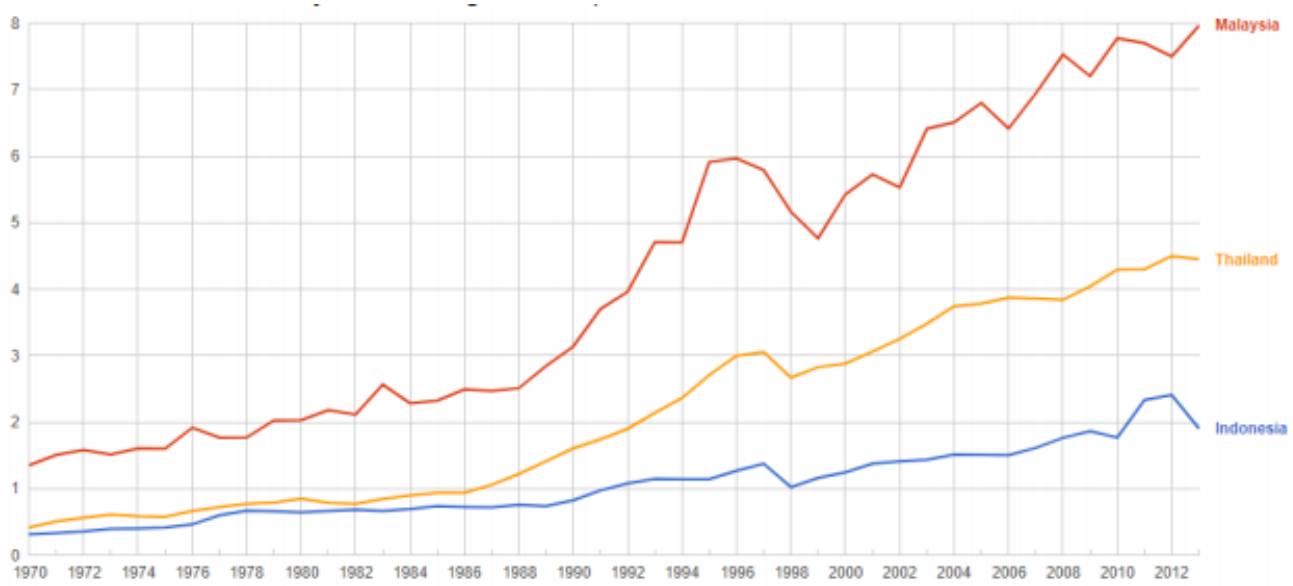

Figure 1. 1: Carbon emissions per capita in Malaysia, Thailand and Indonesia. (Source: World Data)

The main factor behind such an increment in carbon emissions is due to the electrical energy in Malaysia being generated through the burning of fossil fuels at an alarming rate of 82%, whereby this country is still heavily dependent on non-renewable energy sources for the generation of electricity as compared to Europe which thrives on water and other renewable energy sources for their electricity generation. Hence, the solution to introduce well-designed buildings with high energy efficiency and reduced power consumption has to be put forward in order to address the issues with excessive carbon emission rates in Malaysia.

In addition, commercial buildings around the world also account for one third of the total Greenhouse Gas (GHG) emissions. The rapid increase in these GHG emissions leads to severe environmental effects such as the greenhouse effect whereby the GHG absorbs heat energy rising from the Earth's surface and re-emits some of that heat back to the ground, thus trapping heat within the atmosphere and causing unnatural warming to the Earth. Statistics have shown a gradual increment in the emission of the most prominent greenhouse

gas, Carbon Dioxide (CO_2) over the past decade. This is fully depicted in Figure 1.2. Whereby the emission rate of CO_2 hit an all-time peak of 32.53 Gigatonnes (Gt) in 2017.

Figure 1. 2: Annual Carbon Dioxide (CO_2) Emissions Globally from the Year 2008-2017.

With such high rates of GHG emission and a major portion of those coming from commercial buildings, it is vital for this situation to be addressed immediately in order to resolve the environmental problems associated with greenhouse gases. Through continuous efforts to reduce power and energy consumption in commercial buildings, the GHG emission rates can be subsequently lowered and the environmental problems can be somewhat mitigated.

Apart from this, the Building Energy Index (BEI) which measures the energy consumption in buildings has seen the average BEI for Malaysia reaching a magnitude of 269 kWh/m^2/year. This figure is comparatively higher than the South East Asia (SEA) average which measures at 233 kWh/m^2/year. Hence, guidelines and standards had to be revised in order to reduce the energy consumption and pollution whilst encouraging the use of renewable energy sources.

Furthermore, a study carried out on the relationship of energy consumption with occupancy in buildings revealed that commercial buildings (e.g. office and university buildings) are classified among the buildings with the highest energy consumption, presumably due to the fact that it maintains a high occupancy throughout the day. Factors which affect the energy consumption in buildings include temperature, environment, indoor environmental conditions, building structure, operating hours, people, etc. Hence, these factors have to be taken into account when implementing measures to reduce the energy consumption within a building.

1.3 Objective of Research

1. To carry out energy audit for the commercial building.
2. To improve overall energy performance and efficiency of selected building through sustainable energy management program.
3. To analyses the energy management system in commercial building.

1.4 Scope of Research

Even though there are several targets and objective upon completing this research, it has its own scope and limitations. This study will be focus and target in non-residential building (commercial building) to doing the energy management. The main factor that affected the building energy performance and highest energy consumption in a building is the heating, ventilation and air conditioning (HVAC) system and lighting system consumes approximately 15% of the whole building energy demand. In the scope, it will improved the