



**TOTAL ENERGY MANAGEMENT OF A
UNIVERSITY ENGINEERING BUILDING
THROUGH AUDIT**

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**MASTER OF MECHANICAL ENGINEERING
(ENERGY ENGINEERING)**

2020

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ENGINEERING BUILDING THROUGH AUDIT**

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**A thesis submitted
In fulfillment of the requirements of the degree of Mechanical
Engineering (Energy Engineering)**

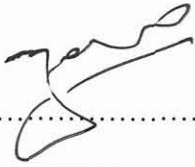
Faculty of Mechanical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2019

DECLARATION

I declare that this project which is entitled "Total Energy Management of A University Engineering Building through Audit" is the result of my own research except as cited in the references. The project has not been accepted for any degree and it is not concurrently submitted in the candidature of any other degree.

Signature : 

Name : ZAEEM SHEZAD

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APPROVAL

I hereby declare that I have read this report and in my opinion, this thesis is sufficient in terms of scope and quality for the award of Master of Engineering in Mechanical Engineering (Energy Engineering).

Signature : *Anuar*

Supervisor Name : Dr Shamsul Anuar Bin Shamsudin

Date : *06/02/20*

DEDICATION

This report is dedicated to my beloved mother, father and my brothers for their endless love, support and encouragement. They have always encouraged me to do what I like and that is the main source of motivation for this project.

ABSTRACT

As the demand for energy use is growing day by day and the need for good indoor environment quality has been motivated to find the alternative way to find the solution for energy efficiency for all the indoor activity and electrical consumption. In this study, different attempts have been made to measure and evaluate the existing conditions of the Fakulti Kejuruteraan Elektrik (FKE) which is located in the main campus of UTeM. Some physical parameters for the energy consumption were measured which include, operating temperature, air velocity, relative humidity, lighting intensity and air flow which were compared to the current Malaysian standards for building (Malaysian Standard 1525:2014). This project results were gathered by the physical parameter which were collected with the electronic instrument which includes lux meter, air velocity meter and temperature and the results were compared with the Malaysian standards, for instance the results are based on the survey which was done for couple of days to collect all the required data from 9:00 am to 5:00 pm in the FKE building block D and E, the average temperature which was recorded for all the levels is ranging from 21 – 26 (°C) which is within the Malaysian standard MS 1525:2014 (23-26 °C). The average relative humidity was ranging from 51% to 57% and is within the standard followed by the air velocity 0.3 – 0.5 m/s. The average lighting intensity was recorded was ranging from 0.3m/s to 0.5m/s Lux. In addition to this, the Building Energy Index (BEI) for 2017/2018 is 134.37 kWh/m²/year which is slightly lower if compared to the MS 1525:2014 standard which is 135 kWh/m²/year. Finally all these physical analysis was done and compared with the Malaysian standard some of them were satisfying and those results which were not matching to standard or how can we improve the results, some important suggestion like retrofit were suggested on how to conserve energy measure in terms of replacement of lamps and installation of new ventilations.

ABSTRAK

Memandangkan permintaan untuk kegunaan tenaga berkembang dari hari ke hari dan keperluan untuk kualiti persekitaran dalaman yang baik telah termotivasi untuk mencari cara alternatif untuk mencari penyelesaian untuk kecekapan tenaga untuk semua aktiviti dalaman dan penggunaan elektrik. Dalam kajian ini, pelbagai percubaan telah dibuat untuk mengukur dan menilai keadaan sedia ada Fakulti Kejuruteraan Elektrik (FKE) yang terletak di kampus utama UTeM. Beberapa parameter fizikal untuk penggunaan tenaga diukur termasuk, suhu operasi, halaju udara, kelembapan relatif, intensiti pencahayaan dan aliran udara yang dibandingkan dengan standard Malaysia semasa bangunan (Malaysian Standard 1525: 2014). Hasil projek ini dikumpulkan oleh parameter fizikal yang dikumpulkan dengan instrumen elektronik yang termasuk meter lux, meter dan suhu udara dan keputusannya dibandingkan dengan piawaian Malaysia, contohnya hasilnya berdasarkan kajian yang dilakukan untuk pasangan hari untuk mengumpulkan semua data yang diperlukan dari 9:00 pagi hingga 5:00 petang di blok bangunan FKE D dan E, suhu purata yang dicatatkan untuk semua peringkat adalah dari 21 - 26 (° C) standard Malaysia MS 1525: 2014 (23-26 ° C). Kelembapan relatif purata adalah dari 51% hingga 57% dan berada di dalam standard diikuti oleh halaju udara 0.3 - 0.5 m / s. Keamatan pencahayaan purata dicatatkan adalah dari 0.3m / s hingga 0.5m / s Lux. Di samping itu, Indeks Tenaga Bangunan (BEI) untuk 2017/2018 adalah 134.37 kWh / m ² / tahun yang sedikit lebih rendah jika dibandingkan dengan MS 1525: 2014 standard iaitu 135 kWh / m ² / tahun. Akhir sekali semua analisis fizikal ini telah dilakukan dan dibandingkan dengan piawaian Malaysia sebahagian daripadanya memuaskan dan hasil yang tidak sepadan dengan piawai atau bagaimana kita dapat memperbaiki hasilnya, beberapa cadangan penting seperti pengubahsuaian telah dicadangkan bagaimana untuk menjimatkan tenaga penggantian lampu dan pemasangan ventilasi baru.

ACKNOWLEDGEMENT

First and foremost, all praise and thanks to Allah (swt), for giving me strength, patience and opportunity to complete my thesis, after all the hard work with some difficulties and challenges. Apart from this I would like to thank my supervisor Dr. Shamsul Anuar bin Shamsudin from the faculty of Mechanical Engineering at the Universiti Teknikal Malaysia Melaka (UTeM) for his essential encouragement, supervision and support towards the completion of my thesis.

I would also like to thank all the professors and lecturers in University Teknikal Malaysia Melaka (UTeM) for their motivation, guidance and their valuable input. They deserve all the appreciations and supporting all the students by contributing to help and build their thesis through different technical talks, conferences and workshops.

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LIST OF SYMBOLS

M/s	-	Meter per second
Hr	-	Hour
M	-	Meter
%	-	Percentage
W/m ²	-	Watt per meter square
KW	-	kilowatt
°C	-	Degree Celsius

CHAPTER 1

INTRODUCTION

1.0 Energy

This is the first chapter that focuses about brief background for on the energy project process, energy management as well as description on the scope of the project along with its objectives.

1.1 Background

The 20th and 21st centuries saw an exponential growth in technological sector. New innovation, new discoveries and increase in consumer demands have been a major factor for the growth. Following the advancement, the world becomes more and more reliant on technology. Subsequently the demand for the energy has increased during past years. Currently Energy can be classified as one of the most significant resources to sustain our lives. The world depends mostly on fossils fuels

and other such non-renewable energy resources. Due to the economic and environmental difficulties faced by Businesses, Industries and Government Organizations, they are looking elsewhere for an alternative aimed at reducing Fossil Fuel usage.

One way to tackle the issue is to rely more on Renewable Energy resources for energy production. Even though the use of resources such as Solar, Nuclear, Hydro and Wind are more environment friendly, the world needs more time to adapt and develop these technologies for extensive use. In this situation Energy management is the critical needs in any countries in the world. Energy management has been an important tool to help organizations meet these critical objectives for their short term survival and long-term success.

1.1.1 Energy Management

Energy management can be understood in many different ways. In the book by Capehart, Turner and Kennedys Guide to Energy management it is defined as "The judicious and effective use of energy to maximize profits (minimize costs) and enhance competitive positions" (Capehart, 1997). Another way to define it would be as "The strategy of adjusting and reducing the energy, using systems and procedures so as to reduce energy requirements per unit of the total energy which has been used while holding or reducing total costs of producing the output from these systems".

1.1.2 Energy Audit

Energy Audit is defined as "the verification, monitoring and analysis of use of energy including submission of technical report containing recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption". It attempts to balance the total energy inputs with its use, and serves to identify all the energy streams in a facility. In most of the industries one of the top operating expense has been the cost of Energy. Audit will help to understand more about the ways energy and fuel are used in any industry, and help in identifying the areas where waste can occur and where scope for improvement exists.

1.1.3 ISO 50001

International Organization for Standards has come up with ISO 50001 which provides organizations an internationally recognized framework to manage and improve their energy performance. The ISO 50001 is a framework that helps companies manage their energy systems and plan better to save energy and to reduce pollution as well as costs. ISO estimates these standards can reduce global energy consumption by 60 percent (ISO 50001 Energy management. 2017).

The standard addresses the following:

- Energy use and consumption
- Measurement, documentation, and reporting of energy use and consumption
- Design and procurement practices for energy-using equipment, systems, and processes

- Development of an energy management plan and other factors affecting energy performance that can be monitored and influenced by the organization.

1.1.4 Need for ISO 50001

Need to minimize fossil fuel use and mitigate Green House Gas: Fossil fuels such as coal, petroleum, and, their consumption is a major source of greenhouse gas emissions, leading to concerns about global warming if not used efficiently. Need to adopt Energy Management: With the worlds demand for energy growing, the need to adopt alternative approaches (like increased energy efficiency, renewable energy, etc.) to meet energy demand is also growing. Just in this respect, “Energy Management and ISO50001” comes on the scene.

1.2 Problem Statement

As the demand increases for the electrical energy in the buildings which is also continuously, increasing day by day due to new technology for example electrical cattle, personal fan (Singh et al., 2012). Its advancement it is very essential to achieve the minimum energy performance by reducing the cost by the waste of energy and how to improve the lightening system, air conditioning and efficiency of air quality.

1.3 Objectives

The main objectives of Energy management are:

- To investigate the use of energy for the building

- To perform comprehensive energy performance analysis
- To suggest for efficient energy procurement improvement

1.4 Project Scope

The project assigned concludes coming up with the energy audit report for classes and labs of Faculty of Electrical Engineering (FKE) in Universiti Teknikal Malaysia Melaka because there has been no energy audit done on this building before. With the help of energy audit instruments reading are taken for the assigned period for all the floors. Three phase power analyser is used to check the power consumption for the floor and Luminosity reader is used to find the luminosity readings of the floor for improvement in lighting systems.

1.5 Report Structure

The structure of the reports is as the following:

1. Chapter 1: Introduction to the project, contains project scope, objectives and brief definitions on energy auditing and energy management.
2. Chapter 2: This chapter shows the methodology for the auditing, it includes flow chart, preparatory stage explanations and inventory data collections.
3. Chapter 3: This chapter of the report involves in load inventory data analysis, along with the load analysis from fluke data logger for one week, power consumption analysis and finally illuminance analysis.
4. Chapter 4: Focuses on the energy efficiency measures, proposed suggestions and solutions to the energy demand of the classes and labs of (FKE).

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Energy audit is the lighting audit, which is performed during the premises assessment process that includes a visit to the premises in order to identify areas of the Energy Conservation process. Electrical energy is very important in human life, but much its content is wasted by inefficiencies of the energy conservation and distribution processes. Building's energy-use accounted for the largest share of the final energy use by the commercial and residential sector. Air conditioners are the major energy users (57%) in office buildings, followed by lighting (19%), lifts and pumps (18%) and other equipment (6%) (Saidur and Masjuki, 2008).

The global contribution of buildings towards energy consumption, both residential and commercial, has steadily increased, reaching figures between 20% and 40% in developed countries. The growth in population, increasing demand for building services and comfort levels, together with the rise in time spent inside buildings, assures the upward trend in energy demand will continue in the future. For this reason, energy efficiency in buildings is today a prime objective for energy policy at regional, national and international levels (Pérez-Lombard, Ortiz and Pout, 2008).

An energy audit is an inspection, survey and analysis of energy flow for energy conservation in an industry, process, reduce the amount of energy input into the system without negatively affecting of the output. An energy audit is a testing and analysis of how the enterprises and other organizations use energy. According to national energy conservation laws and regulations for energy consumption, investigation and energy audit management (Zhang, et al, 2011).

Audit activities in general order include:

- Identification of all energy (lighting) systems.
- Evaluation of conditions of the systems.
- Analysis of impact of improvement to those systems.
- Preparation of energy audit report.

2.2 Energy Audit Definition

There are several relatively similar definitions of an energy audit. In its guidebook, Canadian industry program for energy conservation (2002) defines energy auditing as a systematic, documented verification process of objectively obtaining and evaluating energy audit evidence, in conformance with energy audit criteria and followed by the communication of results to the client.

The evaluation process to know whether a building spends the energy and specify the EEMs to energy and communications standards followed by the results to the client. Reduce energy consumption can be achieved by an energy audit, which can be defined as a systematic process (Thumann, & Younger, 2008). An Energy audit is an essential energy management service which applies energy analysis methods to evaluate the profile of

energy utilization to develop energy efficiency measures EEMs in buildings (Randolph, & Masters, 2008).

Energy audit identifies several measurements of energy saving which can be undertaken within the company to decrease the power spending by reducing losses and developing the energy efficiency. To achieve optimal energy performance in buildings, it is necessary to reduce energy wastes and improve the energy efficiency of the lighting and air conditioning equipment. Finally, the audit will develop the EEMs measures in the buildings they are able to for achieving the benefits of energy and cost saving (Singh, et al, 2012).

Basically the levels of energy audit are focusing on the aim to gather the data and make Improvements to the academic building. The three levels of energy audits are as below (Thumann, & Younger, 2008):

Level 1: Walk through energy audit.

Level 2: Energy data analysis.

Level 3: Standard energy audit.

2.2.1 Walk Through Energy Audit

On a walk through energy audits, readily-available data are mostly used for a simple analysis of energy use and performance of the plant. This type of audit does not require a lot of measurement and data collection and normally known as pre-audit step.

These audits take a relatively short time and the results are more general, providing common opportunities for energy efficiency. A proper observation in the academic building first and second floor based on visual verifications such as the lighting system