

## **SUPERVISOR DECLARATION**

“I hereby declare that I have read this thesis and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Thermal-Fluids)”

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**ENERGY AUDIT AND CONSERVATION OF ENERGY IN MELAKA CASE  
STUDY OF LIBRARY**

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**This thesis submitted in accordance with requirement of the Universiti Teknikal  
Malaysia Melaka (UTeM) for the Bachelor Degree of Mechanical Engineering  
(Thermal-Fluid) with Honours.**

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## **DECLARATION**

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

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**Date** :

*Special dedicated to:*

*Mom and Dad*

*My Beloved Family*

*“THANKS FOR ENCOURAGING AND SUPPORTING ME”*

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## **ABSTRACT**

This study aims on auditing energy consumption at UTeM's main library. The scope of research in this study is to quantifying the energy use by mechanical and electrical equipment so as the water consumption. The method applied is by investigating the building energy profile by analysing previous utilities bill, several instruments for the sake of energy auditing and calculation by using equation such as the cooling load equation. More information related to energy policies and Malaysian Standard will be covered in chapter two where the relation between energy audit and Malaysia energy policy can be seen. Apart from that, the detail on audited energy will give a perspective for what type of recommendation at the end of this project. From the energy audit it is found that the maximum power consumption per day is 2141.35 kWh and the minimum is 1912.28 kWh. The recommendation for energy conservation step that can be implemented is based on the target of increasing the energy efficiency of the daily usage by retrofit existing lighting by phase and the implementation of VRF system for stable and better energy conservation.

## ABSTRAK

Kajian ini bertujuan mengaudit penggunaan tenaga di perpustakaan utama UTeM. Skop penyelidikan bagi kajian ini adalah untuk mengukur penggunaan tenaga oleh peralatan mekanikal dan elektrik serta penggunaan air. Kaedah digunakan adalah dengan menyiasat profil tenaga bangunan dengan menganalisis bil utiliti, menggunakan instrument khas untuk pengauditan tenaga dan pengiraan dengan menggunakan persamaan seperti persamaan beban penyejukan. Maklumat lanjut berkaitan dengan dasar tenaga dan Standard Malaysia akan dibincangkan dalam bab dua di mana hubungan antara audit tenaga dan dasar tenaga Malaysia dapat dilihat. Selain itu, perincian pada bahagian tenaga yang telah diaudit akan memberikan perspektif untuk cadangan penjimatan tenaga pada akhir projek ini. Daripada audit tenaga didapati bahawa penggunaan kuasa maksimum sehari adalah 2141,35 kWh dan minimum adalah 1912,28 kWh. Untuk langkah penjimatan tenaga yang boleh dilaksanakan adalah berdasarkan kepada sasaran peningkatan kecekapan tenaga penggunaan harian oleh pengantian lampu sedia ada secara berfasa dan pelaksanaan sistem VRF untuk pemuliharaan tenaga yang lebih stabil dan baik.

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## LIST OF ABBREVIATION

ACMV	-	Air-Conditioning and Mechanical Ventilation System
ASHRAE	-	American Society of Heating, Refrigerating and Air-Conditioning Engineer
AWER	-	Association of Water and Energy Research
BAS	-	Building Automation System function
BSEEP	-	Building Sector Energy Efficiency Project
CIBSE	-	Chartered Institution of Building Services Engineers
CO <sub>2</sub>	-	Carbon Dioxide
COP15	-	15th Conference of Parties
DB	-	Distribution Board
dBA	-	Decibel
DC	-	Direct Current
DOE	-	Department of Energy
DOL	-	Direct On Line
ECO	-	Energy-conserving opportunities
EMS	-	Energy management system
GHG	-	Green House Gasses
GWh	-	GigaWatt-hour
HP	-	Horse Power
HVAC	-	Heating Ventilation and Air-Conditioning
ISO	-	International Organization for Standardization
kWh	-	kiloWatt-hour

LFL	-	Linear Fluorescent Lamp
LED	-	Light Emitting Diode
MCB	-	Miniature Circuit Breaker
MCCB	-	Moulded Case Circuit Breaker
PMV	-	Predicted Mean Vote
PVC	-	Polyvinyl Chloride
RM	-	Ringgit Malaysia
ROI	-	Return on Investment
SIRIM	-	Standards and Industrial Research Institute of Malaysia
SPAN	-	Suruhanjaya Perkhidmatan Air Negara
SSO	-	Switched Socket Outlet
TNB	-	Tenaga Nasional Berhad
UTeM	-	Universiti Teknikal Malaysia Melaka
U.S	-	United States
VRF	-	Variable Refrigerant Flow
WEPLS	-	Water Efficient Product Labelling Scheme

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# CHAPTER 1

## INTRODUCTION

### 1.1 Project Background

By managing the energy one can determine the waste and implementing energy efficient. Nowadays, there is an increasing need in industry to be effectively managed in energy consumption so that they able to track down the distribution of energy for the specific building/industry. One of the main reasons that energy need to be conserved is to make sure the continuity supply of energy source for the future used. Ensuring the environmental resources last in a long duration of time will also ensure both sustainable human progress and survival. Besides that from the usage of excessive energy especially fuel based energy can lead to rapidly depletion of the non-renewable energy source mainly.

In facts, the usage of fuel itself is not very green in perspective and it also contribute to the greenhouse effect by releasing greenhouse gases such as carbon dioxide and methane into the atmosphere which may lead to pollution and unwanted phenomenon such as gradual global warming. This greenhouse effect may by early next century have increased average global temperatures of the world enough to shift

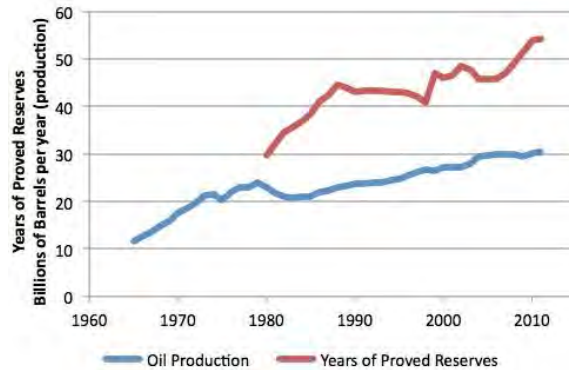
agricultural production areas, raise sea levels to flood vulnerable area, thus disrupt national economies (Brundtland, 1987).

As a matter of facts, the Malaysia Energy Efficiency Action Plan suggest a strategy for a well coordinated and cost-effective implementation of energy efficiency measures in the industrial, commercial and residential sectors, which will lead to reduced energy consumption and economic savings for the both side consumers and the nation.

## **1.2 Problem Statement**

On average, the energy consumption in office building is 70-300 kWh/m<sup>2</sup> which is 10-20 times bigger than residential sectors (Yang, 2008). It has been found that air conditioners are the major energy consumer (57%) in commercial building followed by lighting (19%), lifts and pumps (18%) and others equipment (6%) (Saidur R, 2009). However, there have been some concerns about energy consumption and its implications for the environment. Energy efficiency programs were once implemented after the global oil crisis of the 1970s, although many of these measures were not maintained after the crisis passed. But with high economic growth result an increasing energy consumption particularly electrical energy use in commercial sector.

The combustion of fossil fuels from electricity generation for commercial and domestic use somehow contributed to the increasing atmospheric carbon dioxide (CO<sub>2</sub>) concentration. Thus, increase energy demand will consequently increase carbon dioxide concentration in the atmosphere (Anon, 2006).



**Figure 1.1:** Global oil production & years of proved reserves 1965-2011 (Anthony Watts, 2013)

Based on the previous data shows that energy consumption needs to be used wisely and monitored, for that purpose energy audit is one of the ways that can keep track on distribution of energy in building which for this case is UTeM's library itself. For instance with every saving made can be channel to increase the productivity and some improvement in term of it service consequently, students of UTeM may benefit from it indirectly.

### 1.3 Objective

For this project of energy audit, there are three objectives that need to be accomplished which are:

- 1) To understand the basic knowledge and application of energy audit and energy management applied on library.
- 2) To analyze the energy consumption rate in library building and give suggestion on energy saving method.
- 3) To quantify the energy use and misuse for data analysis.

#### **1.4 Scope and Limitation**

This project will focus on the act of quantifying the energy use and misuse in mechanical and electrical equipment so as water consumption at UTeM's Library specifically by obtaining the information from building blueprint and room data of air conditioning, lighting and plug load and potential heat load contributor. A survey on thermal environment and comfort in UTeM's Library was conducted to gather information from the perspective of regular occupant and make a conclusion based on real condition out of it. Apart from that, after energy auditing process it will come to the part where some evaluation on the opportunities in reducing operating cost through energy conservation and planning can possibly being made. However, there is limitation on this project as such as for certain room temperature cannot be guaranteed as occupant may influence the room energy balance by internal heat gains and sun shading.

## **CHAPTER 2**

### **LITERATURE REVIEW**

In this chapter the content will covered more on the basic concept which applied for energy audit which is based on idea and article related by previous researchers in the same field range. The discussion is focussed on the study of energy conservation so as energy efficient approach that can be recommended for utilized after an audit of UTeM's library.

#### **2.1 Energy Audit**

Basically, energy audit aim to analyze total energy consumption, the ideal energy consumption for comparison purposes and to discover a suitable way for an energy saving method. The study should reveal to the owner or management team of the building the option available for reducing energy waste, the cost involved, and the benefits achievable from implementing those energy-conserving opportunities, ECO's (Wong, 2001). This is adapted based on the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) which defines three levels of audit's step that can be performed to get a reliable result. As a matter of facts, each audit level

builds on the previous level of the audit itself. As audit complexity increases, so does thoroughness of the site assessment (U.S DOE, 2013).

The amount of data collected and the detail provided in the final audit report can be use for future reference thus, this will contribute to a higher energy savings. It provide the information on how energy is used in the building, establish accurate baseline information, and identify options available for reducing energy waste such as the costs involved, and the benefits achievable from implementing those energy conserving opportunities in a long term (U.S DOE, 2013). Energy conservation means reduction in energy consumption without making any sacrifice of quantity or quality and as a matter of fact, successful energy management programs begin with energy conservation; it will lead to adequate rating of equipments, using high efficiency equipment and change of habits which causes enormous wastages of energy (Singh *et al.*, 2012). Through the audit process the prioritize conservation potential as well as several low cost operational and maintenance opportunities can be identify.

## **2.2 Energy Policy**

In Malaysia there is an official national policy and regulation for energy efficiency standard. This recent years several guideline and regulation have been designed to fulfil the goal as in reducing nation's Green House Gasses (GHG) emissions intensity of Gross Domestic Product (GDP) by up to 40 % based on 2005 levels by the year 2020 as announced by the Malaysia's Prime Minister during the 15th Conference of Parties (COP15). By necessity, national policies for energy efficiency have their own role in 10th Malaysian plan itself. It tended to focus on product standards which affect the efficiency profile of products and investments that enter the market. For example, national policies include appliance efficiency standards, vehicle efficiency standards, and green tax incentives. As in Malaysia Budget 2014 “.to strengthen the development of green technology, the government will provide

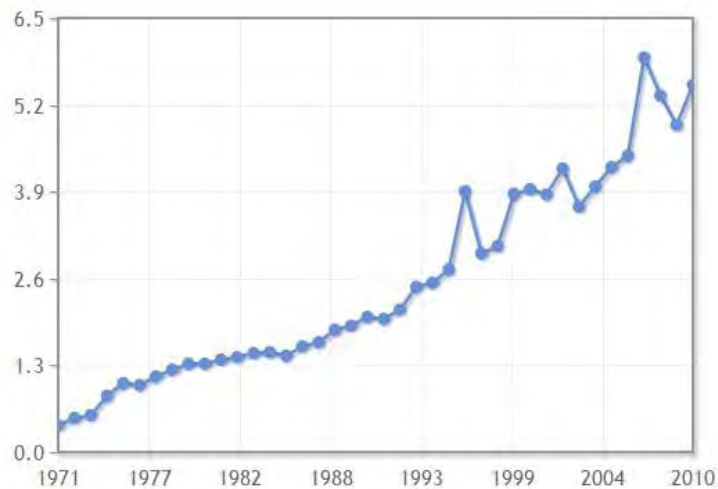
investment tax allowance for the purchase of green technology equipment and income tax exemption on the use of green technology services and system...”.

As matter fact, under the Energy Commission Act 2001 Malaysian Government has established the Energy Commission to enhance the performance of the energy supply industry, security, improve efficiency and quality in utility services and increase the private sector's participation in infrastructure development. Subsequently, under Energy Commission several act and regulation on energy efficient and management such as efficient management of electrical energy regulation 2008 is established. In this regulation it state that any installation which receives electrical energy from a licensee or supply authority with a total electrical energy consumption equal to or exceeding 3,000,000 kWh as measured at one metering point or more over any period not exceeding six consecutive months need to register under Energy Commissions and it will be on certain term such as requirement for electrical distribution auditing. Besides that, the Electricity Supply Act 1990 which entitled to promote the efficient use of electricity by determine the standards, specifications, practices and measures for the efficient use of electricity. It starts from as early as the installation to meet requirements in respect of the efficient use of electricity and equipment to meet requirements in respect of the efficient use of electricity (Suruhanjaya Tenaga, 2014).

### **2.2.1 Energy Consumption and Carbon Footprint**

A carbon footprint is the total set of greenhouse gases (GHG) emissions caused by an organization, event, product or person. Studies by Association of Water and Energy Research (AWER) has shown that in Malaysia, every 1 kiloWattour (kWh) of electricity releases about 0.67 kg of carbon dioxide (CO<sub>2</sub>) equivalent at 35% electricity supply efficiency. In addition, based on 2009 energy commission report a total of 90838 GigaWattour (GWh) of electricity was sold in Malaysia. The value for CO<sub>2</sub> emissions from residential buildings and commercial and public services (million metric tons) in Malaysia was 5.49 as of 2010. As the graph below shows, over the past 39 years this

indicator reached a maximum value of 5.90 in 2007 and a minimum value of 0.40 in 1971. Energy policy plays an important role in any country's sustainable development. Improving energy efficiency in buildings is one of the most cost-effective measures for reducing CO<sub>2</sub> emission, which is recognised as one of the main causes of global warming (International Energy Agency, 2007).



**Figure 2.1:** Graph of CO<sub>2</sub> emissions from residential buildings and commercial and public services (million metric tons)

### 2.3 Malaysian Standard

The Department of Standards Malaysia is the national standardisation and accreditation body which advancing the national economy, promoting industrial efficiency and development, benefiting the health and safety of the public, protecting the consumers, facilitating domestic and international trade and furthering international cooperation in relation to standards and standardisation. Malaysian Standards provide the criteria and minimum standards for energy efficiency in the design of new buildings, retrofit of existing buildings and methods for determining compliance with these criteria