

ENERGY AUDIT OF RESIDENTIAL BUILDING TO OBSERVE SAVING
PRACTICALLY ACHIEVED FROM LOW COST IMPROVEMENTS

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DEDICATION

This thesis is dedicated to my father, my mother, my families and Akhmal Ashraf.

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ABSTRACT

Energy consumption in Malaysia has been increasing due to high demand on the electrical energy and increase of electrical equipment usage in residential buildings. There are a lot of appliances that contribute to the high energy consumption of a building such as lighting, cooling and heating appliances. However, high demand of energy contribute to increase of greenhouse gases and lead to high cost of utility bill. The energy saving practice in a building can be achieved in many ways and the effectiveness can be determined through an energy audit of the building. In this project, the energy audit is done in a single-storey residential building in the size of 60 ft X 60 ft with 6 rooms. This energy consumption of the building will be monitored for 1 month for before result and 1 month for after result throughout the project. All appliances are listed and compared in terms of electrical usage. The energy saving practices are done by implementing low cost improvements and monitoring the usage of electricity consumption of the appliances such as air conditioner, dryer, washing machine, automatic gate and water heater. The low cost improvement is done by reducing the usage of appliances in terms of duration and frequents, and reduce temperature setting of appliances such as air conditioner, dryer and water heater. The habit of the occupants when using the electricity is also important where the appliances need to be switch off when not in use, use water heater only in morning, wash and dry all clothes at one time, reduce usage of lighting during daylight, insulate rooms that use air conditioner and use the appliances only when needed according to weather, surrounding temperature and situation. The data are simulated in HOMER pro software and compared to the actual utility bill cost. After energy saving practices are implemented, the energy consumption of the building and the utility bill cost is reduced determined by energy audit compared to before implementing the energy saving practices.

ABSTRAK

Penggunaan tenaga di Malaysia semakin meningkat kesan daripada permintaan yang tinggi dan penggunaan barang-barang elektrik di bangunan kediaman. Terdapat pelbagai jenis perkakas elektrik yang menyumbang kepada penggunaan tenaga yang tinggi seperti pekakas pencahayaan, penyejukan dan pemanasan. Walaubagaimanapun, permintaan tinggi terhadap tenaga menyumbang kepada peningkatan pengeluaran gas rumah hijau dan bil elektrik yang tinggi. Praktis penjimatan elektrik sesuatu bangunan boleh diamalkan dengan pelbagai cara dan keberkesannya boleh ditentukan melalui audit tenaga bangunan tersebut. Dalam projek ini, audit tenaga dilakukan di sebuah rumah satu tingkat bersaiz 60 kaki X 60 kaki dengan 6 bilik. Penggunaan tenaga elektrik bangunan tersebut akan diperhatikan selama sebulan untuk hasil sebelum dan sebulan untuk hasil selepas sepanjang projek ini dijalankan. Semua perkakas elektrik akan disenaraikan dan dibandingkan dari segi penggunaan elektrik. Amalan penjimatan elektrik akan dilakukan dengan cara menerapkan penambahbaikan berkos rendah dan pemerhatian terhadap penggunaan elektrik pekakas tersebut seperti penghawa dingin, pengering, mesin basuh, pagar automatik dan pemanas air. Penambahbaikan berkos rendah dilakukan dengan cara mengurangkan penggunaan pekakas dari segi masa dan kekerapan, dan mengurangkan tetapan suhu perkakas seperti penghawa dingin, pengering dan pemanas air. Tabiat penghuni semasa menggunakan elektrik juga penting dimana pekakas hendaklah ditutup ketika tidak digunakan, menggunakan pemanas air hanya pada waktu pagi, basuh dan keringkan semua pakaian pada satu masa, mengurangkan penggunaan lampu pada waktu siang, melindungi bilik yang menggunakan penghawa dingin dan menggunakan pekakas elektrik mengikut cuaca, suhu sekitar dan situasi. Semua data disimulasikan dalam perisian HOMER pro dan dibandingkan dengan bil elektrik yang sebenar. Setelah praktis penjimatan elektrik dilakukan, penggunaan tenaga dan bil elektrik bangunan tersebut telah dikurangkan ditentukan melalui audit tenaga berbanding sebelum menerapkan praktis penjimatan elektrik.

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LIST OF ABBREVIATIONS

NPI	-	Normalized Performance Indicator
BEP	-	Building Energy Performance
EI	-	Energy Intensity
ASHRAE	-	American Society of Heating, Refrigeration and Air conditioning Engineers
PEA	-	Preliminary Energy-use Analysis
ECI	-	Energy Cost Index
EEM	-	Energy Efficient Measures
EUI	-	Energy Utility Index
TNB	-	Tenaga Nasional Berhad

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CHAPTER 1

INTRODUCTION

1.1 Research Background

Energy consumption in Malaysia has been increased from day to day. This is due to high demand on the electrical energy and increasing of electrical equipment and technologies used in the daily life. The consumption of energy varies according to the type of sector, type of building and size of the building. Part of the energy consumption is contributed by residential and commercial buildings. The commercial and residential buildings had consumed about 14% of the total energy consumption that increase to 70% of the electricity consumption in Malaysia. Therefore, the building sector is an important area that need to be studied in terms of energy performances while improving the thermal and visual comfort to enhances the energy security.

The energy consumption of a building may also vary according to the loads and appliances used. There are a lot of power electronic appliances that may decreased the power quality and consumed high electrical energy hence reduce the electrical efficiency of the system. There are a lot of appliances that contribute to high energy consumption of a building per day such as lighting, cooling appliances such as air-conditioner and refrigerator, and heating appliances such as heater and water heater.

However, the high demand of the electrical energy has affected the energy supplies to increase. The increasing of energy production has contributed to the increase of greenhouse gases as combustion is the one of the main energy generation method in this country. In Malaysia, about 42.5% of energy production sources is from combustion of coal, 40.3% from combustion of natural gas and diesel, and others from renewable energy sources such as hydro power and solar system. The

increasing of greenhouse gases has affected the environment that cause global warming and climate change phenomenon. The increasing of climate change has resulted in increasing of temperature and heat surrounding hence the increase of cooling demand about 70% and decrease heating demand to 30%. In this cases, energy demand of residential cooling system such as air conditioning in South Asia has increase for about 50%. Other than that, energy supply will be vulnerable when the situation is getting worse, water shortages lead to less winter snowfall to fill up summer stream and higher demand of fresh water will affect the hydro power production. Therefore, the energy conservation in building need to be implemented in order to reduce the emission of greenhouse gases.

In order to implement the energy conservation plan in a building or green building practices to decrease the negative impact to the environment and energy demand, energy efficiency practices need to be done. Green building practices can be described as sustainable building principles and eco-friendly building's design that significantly reduce the negative impact to environment. This can be achieved by efficiently used of natural and renewable energy resources in the operational stage of the building. The energy efficiency in a building can be achieved in many ways and effectiveness of the green building practices can be determined through an energy audit.

Energy audit of a building will consist evaluation of energy consumption patterns and identification of specific energy saving measures. These two characteristics are important in energy management activity. It includes the process of detecting system operation issues, improving surrounding comfort and optimize or reduce the energy consumption of the existed building. There are two different types of energy audit which is walk through audit and detailed audit. Energy audit also needed in order to improve the electrical bill which can reduce the cost of energy consumed through energy saving. The process can be done through series of surveys and inspections and detailed analysis of energy flows in order to find the total amount of utility cost of the building. Several software such as HOMER Pro can be used in order to analyse the energy performances of a building. This method had been founded to be useful in order to understand the energy performance and energy consumption pattern by different utilities used in the building.

1.2 Problem statement

The increasing of energy consumption in a residential building has contributed to high cost of utility bill of the building. To improve or reduce the cost of the utility bill, several energy saving practices has been suggested and implemented in the buildings to reduce the energy consumption. However, some electricity consumers tend to overlooked the energy saving practices while implemented them. Consumers think that to apply the energy saving practices, some investment is needed which is high cost improvement such as changing to green technology appliances. However, the implementation of the low cost improvement of energy saving practices also can reduce the energy consumption of the building therefore reduce the cost of the utility bill.

1.3 Objectives

The main objectives of the project are as follows:

1. To analyse energy consumption in a residential building through an energy audit.
2. To implement energy saving measures to reduce energy consumption and improve utility bills of the residential building.
3. To benchmark the efficiency of the electrical energy in the residential building by compare the result before and after implementing the energy saving.

1.4 Scope of study

1. The energy audit will be done in HOMER Pro software environment. In this audit, the energy consumption of the residential building and utility bill per month will be analyse within 2 months. The usage and energy consumption of all loads and appliances will be monitor daily.
2. The data of time and duration of appliances usage will be recorded daily and the energy consumption of an appliances will be calculated monthly.

3. The low cost energy saving measure to improve the energy efficiency will be implemented and simulation result before and after will be compared in terms of energy usage and utility cost with actual result.

1.5 Significance of study

This project is considered vital and important in many aspects as follows:

1.5.1 Technical aspect

Having a good energy efficiency in a residential building is important as it may help to reduce the energy consumption and utility bill. Using different type of appliances that may be polluted the power system and need a lot electrical energy to operate will increase the power consumption of a house. Therefore, the need of energy audit is to analyse the electricity usage of appliances to composite the high energy consumption problem and improve the energy efficiency of a residential building.

1.5.2 Environment aspect

The high consumption and demand of the electrical energy can affect the energy supply and generation to increase, therefore electrical energy need to be used efficiently. Due to the rise of generation of energy, emission of greenhouse gases increased by combustion of fossil fuels. This can affect the environment by global warming and climate change. As the production of fossil fuels is decreasing, the usage of fossil fuels to generate electricity also need to be reduced. This will also help to implement green building policies in a residential building.

1.5.3 Economical aspect

The high electrical energy consumption can affect the utility bill. If the electrical energy consumption is high, electrical user will face problem

with high utility bill of building. High electrical energy consumption of appliances can be reduced by implementing energy saving measures of low cost improvements, therefore reduce the total electrical energy consumption and cost of utility bill of the building.

1.6 Report Structure

The report of the project consists of 5 chapters:

- Chapter 1: The explanation about the introduction of the reports that reviews of overall view of the project, problem statement, objectives, scope of works and significance of study.
- Chapter 2: Previous research done related to this project will be covered. Type and level of energy audit, various type of appliances contributed to energy consumption will be discussed further in this chapter.
- Chapter 3: It includes the proposed research methods and project flow before running the project. This chapter also discuss about the formula and software that will be used during the research.
- Chapter 4: It present the result obtained from the research. A few discussion and analysis also be conducted in this chapter.
- Chapter 5: This chapter concludes the overall results from this project as well as some recommendation for future improvement.

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