

POTENTIAL ENERGY AND CARBON DIOXIDE REDUCTION IN  
COMMERCIAL SECTOR IN MALAYSIA

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*To my dearest*

*Father and Mother*

*Makmor Maarob and Azizah bt Ujang*

*Brothers and Sisters*

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## ABSTRACT

Electricity generation is one of the contributors of CO<sub>2</sub> production. Malaysian government is enhancing the use of coal up to 50% by 2030. On the other hand, this will give an impact of the emission pattern in Malaysia, which will lead to pollute the environment. This thesis focuses on the estimation of energy use in government building in peninsular Malaysia. Potential impacts of energy efficiency and DSM program to electricity consumption and generation is estimated. It analyzes the CO<sub>2</sub> emission in generation before and after replacing the standards practice condition. Ultimately, these impacts will affect the national benefits if inefficient appliances for commercial sector are not replaced. Air conditioners are shown to be the major energy users (57%) in government building, followed by lighting (19%) and other equipments (24%). In order to show the effectiveness of the energy efficient appliances, four scenarios have been discussed. It is estimated that 1072 GWh can be save and a whopping of 1200 million kg of emission of CO<sub>2</sub> can be achieved by employing these energy efficient (EE) appliances. These estimations rely on a bottom-up model of the energy system LEAP. The presented work shows that the Demand Side Management (DSM) programs and energy efficiency measures can reduce the growth of greenhouse gases.

## ABSTRAK

Penjanaan elektrik merupakan salah satu penyumbang kepada penyebaran karbon diaoksida (CO<sub>2</sub>). Kerajaan Malaysia telah meningkatkan penggunaan arang batu sehingga 50% sebelum 2030. Walaubagaimanapun, penggunaan arang batu member kesan kepada corak taburan CO<sub>2</sub> di Malaysia yang menyumbang kepada pencemaran alam sekitar. Tesis ini bertujuan menganggar penggunaan tenaga oleh bangunan kerajaan di semenanjung Malaysia. Potensi kesan kecekapan tenaga dan program DSM terhadap penjanaan dan penggunaan tenaga elektrik telah dianggarkan. Anggaran ini menganalisa penyebaran CO<sub>2</sub> disebabkan oleh penjanaan elektrik sebelum dan selepas penggantian peralatan biasa. Kesan ini akan mempengaruhi kepentingan nasional jika peralatan yang tidak cekap tenaga tidak diganti. Penyaman udara adalah pengguna terbesar tenaga elektrik (57%) dalam bangunan kerajaan, diikuti oleh lampu (19%) dan peralatan lain (24%). Bagi menunjukkan kesan yang lebih baik terhadap penggunaan peralatan yg cekap tenaga, 4 senario dibincangkan. Dianggarkan sebanyak 1072 GWh dan pengurangan penyebaran sebanyak 1200 juta kg CO<sub>2</sub> mampu dijimatkan dengan menggunakan peralatan yang cekap tenaga. Analisis ini menggunakan program sistem tenaga LEAP. Hasil kerja ini menunjukkan program DSM dan pengukuran kecekapan tenaga mampu untuk mengurangkan peningkatan kesan rumah hijau.

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## LIST OF SYMBOLS

%	-	Percentage
$\sum_n^i AEC$	-	sum of energy consumption of equipment i to n
$AEC^\alpha$	-	annual energy consumption of equipment $\alpha$ in MWh

## LIST OF ABBREVIATIONS

CO <sub>2</sub>	- Carbon Dioxide
DSM	- Demand Side Management
GWh	- Giga Watt-hour
MW	- Megawatt
BAU	- Business as Usual
LEAP	- Long-range Energy Alternatives Planning System
m <sup>2</sup>	- Square meter
kWh	- Kilowatt-hour
T&D	- Transmission and Distribution
TED	- Technology and Environment Database
SEI	- Stockholm Environment Institute
UNFCCC	- U.N Framework Convention on Climate Change
EI	- Energy intensity
PTM	- Pusat Tenaga Malaysia
CFL	- Compact Fluorescent Lamp
GLS	- General Lighting service
HVAC	- High Voltage Alternating Current
HEM	- High Efficient Motor
EE	- energy efficiency
UBBL	- Uniform Building By-laws
TNB	- Tenaga Nasional Berhad
CEB	- Central Electricity Board
SEB	- Sabah Electricity Board
SESCO	- Sarawak Electricity Supply Corporation
IRP	- Integrated Resource Planning
RMK-9	- Rancangan Malaysia ke-9
GHG	- Greenhouse Gases

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## **CHAPTER 1**

### **PROJECT OVERVIEW**

#### **1.0 Introduction**

Energy is a crucial input for the social and economic development in any country in the world. As increasing of activities of industrial and others, the demand for energy is also increasing. Due to growth in population, increasing pressure for building services, and enhanced comfort level, the rising trend in energy demand will continue in the future. The rapid growth of energy use, worldwide, has already raised concerns over the problem of supply, the exhaustion of energy resources and relentless environmental impact i.e ozone layer depletion, global warming and climate change.

Worldwide, 30-40% of all energy is used in buildings. The major part of this energy is burned during the operational phase of building for heating, cooling, lighting and appliances. Efficient use of energy will play a big role in order to reduce the usage of energy and emissions released to the atmosphere. Saving energy is an essential force in reducing the greenhouse gasses emissions. Energy policy can play an important function in any country's sustainable development. Improving of energy efficiency in commercial sector is one of the most cost-effective measures for reducing carbon dioxide (CO<sub>2</sub>) emission.

In the ninth Malaysia plan (RMK-9), the government had planned to reduce highly depend on gas and increased the use of coal as a fuel in electricity generation in our country. Two new coal-based power plants were commissioned in Tanjung

Bin in Johor and Jimah in Negeri Sembilan to achieve this target. Electricity generation can contribute to the green house gases (GHG) in the atmosphere. Coal generation has high rate of Carbon Dioxide (CO<sub>2</sub>) per Kilowatt hours compared to other generations. The decision to increase coal will contribute to more CO<sub>2</sub> emission in the world.

The government should take essential move in order to reduce the energy consumption and minimize the negative impact to the environment, it is necessary to take effective measures to save energy and reduce environmental pollution. By implementation of energy efficiency and DSM programs, it could help reducing the CO<sub>2</sub> impact.

### **1.1 Problem Statement**

The global warming problem has been recognized as one of the most important policy issues to be solved for prevention of the global environment impact. Electricity generation is one of greenhouse gases producer of the world. The main contributor of increasing carbon dioxide concentration is the combustion of fossil fuels in generating electricity for commercial uses. Increasing of using coal as a source of power generation can produce more carbon dioxide (CO<sub>2</sub>) in the atmosphere. It is because, coal-fired generation has highest output rate of carbon dioxide per kilowatt compare to others. Hence, saving energy is an essential in reducing our greenhouse gases impact.

Meanwhile, high economic growth in Malaysia has led to the dramatic increase in energy consumption in recent year, especially in commercial and non-residential building, consuming almost half of total electricity generated. Rising GDP will increase the demand for electricity. The government needs to reduce energy consumption in order to minimize these negative environmental impacts.



## **1.2 Objectives**

The objectives of the project are:

1. To obtain the status of energy consumption in commercial sector in Malaysia.
2. To estimate the energy consumption for the future with and without energy efficiency and DSM in commercial sectors.
3. To give an indication of how much Malaysia can contribute in saving energy and reducing pollution in line with the global community.

## **1.3 Scope**

In order to estimate how the energy consumption and reduction in commercial sector, LEAP (Long-range Energy Alternative Planning system) had been used. This software is used to estimate electricity demand, generation, and CO<sub>2</sub> emission. The impact of applying energy efficiency and DSM program in commercial sector in Malaysia was analyzed.

## **1.4 Thesis Outline**

Five major chapters have been divided for this thesis. Chapter one (1), the contents included a short brief introduction to the project, problem statement, objectives, scope and thesis outline.

Chapter two (2) is dedicated for literature review. The chapter will elaborate on energy consumption in Malaysia and will narrow to commercial sector. The

contents also will discuss about the electricity generation, energy efficiency, demand side management and global warming.

Chapter three (3) consists of will elaborate about the methodology and flow of the entire project. It also will describe how the software of the project has been used in projection of energy demand, electricity generation in future and about CO<sub>2</sub> emission in Malaysia based on incremental on demand in commercial sector.

Chapter four (4) discusses about the result for the project where several scenarios applied in commercial sector.

Finally, chapter five (5) will gives conclusions and recommendations for further improvement in electricity consumption, generation and CO<sub>2</sub> emission prediction by using LEAP analysis.