DEVELOPMENT OF THE AUDIT ENERGY SOFTWARE FOR OFFICE BUILDING BY USING VISUAL BASIC

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"I hereby, declare this thesis is result of my own research except as cited in the references"

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To my beloved family

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ABSTRACT

In this project, audit energy software for office building by using Visual Basic Software has been developed. Audit energy is used to minimize the cost of energy usages of a building. The aim of this project is to design simply new audit energy software and gain information about office building and its energy consuming on equipment and systems. In order to predict the energy (cooling load) required for an office building, there are many information of building aspect that need to be collected. The simplified new software tool was implemented by using **VISUAL BASIC.Net** programming language. Finally in this paper, it was shown a comparison result between manual calculation and computer software tool- Audit energy software. In overall, loads predicted by the methods were reliable and equal to calculated version

ABSTRAK

Dalam projek ini, tenaga audit perisian dibina untuk bangunan pejabat dengan menggunakan perisian "*Visual Basic*". Tenaga audit digunakan untuk meminimumkan penggunaan kos tenaga dalam sebuah bangunan. Tujuan projek ini adalah mereka satu tenaga audit perisian yang baru dan mudah bagi memperolehi maklumat tentang bangunan pejabat dan peralatan serta sistem-sistem tenaganya. Untuk meramalkan tenaga (beban pendinginan) yang diperlukan untuk sesebuah bangunan pejabat, banyak maklumat aspek perlu dikumpulkan bagi sesebuah bangunan. Ia perlu mengumpul semua maklumat tentang ciri-ciri operasi dan pelbagai peralatan serta sistem-sistem teknikal dalam sesebuah bangunan. Alat perisian yang baru dan mudah dibina dengan menggunakan bahasa pengaturcaraan *VISUAL BASIC.NET*. Akhirnya, projek ini menunjukkan perbandingan hasil jawapan antara menggunakan secara pengiraan manual dan alat perisian komputer- Tenaga audit perisian. Secara keseluruhan, hasil beban pendinginan yang teramal adalah boleh dipercayai dan hampir sama.

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LIST OF ABBREVIATION

MIEEIP	Malaysian Industrial Energy Efficiency Improvement Project
DOE 2	Designs of Experiments 2
BLAST	Building Loads Analysis and System Thermodynamics
RFM	Response Factor Method
WFM	Weighting Factor Method
CLTD	Cooling load temperature difference
SCL	Solar cooling load factor
CLF	Cooling load factor
TFM	Transfer Function Method
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
CTF	Conduction transfer factors
WF	Weighting factors
ECOs	Energy-conserving opportunities
AHUs	Air handling units
VAV	Variable air volume device
CAV	Constant air volume device
ADO.Net	ActiveX Data Objects
XML	Extensible Markup Language
ODBC	Open Database Connectivity
OleDb	Object Linking and Embedding, Database
SHGC	Solar heat gain coefficient

LIST OF SYMBOLS

Q_{rs}	=	Sensible cooling load from roof (W)
A	=	Area (m^2)
U	=	Overall heat transfer coefficient ($W/m^2.\ ^{\circ}C$)
Q_{les}	=	Sensible heat released from electric lights (W)
F_{use}	=	Use factor defined as the ratio of wattage
F_{al}	=	Special allowance factor for fluorescent fixtures
Q_{ps}	=	Space sensible for people (W)
Q_{pl}	=	Latent cooling loads for people (W)
n	=	Number of people in the conditioned space
SHG	=	Sensible heat gain per person (W)
LHG	=	Latent heat gain per person (W)
Q_s	=	Sensible loads from power equipment and appliances (W)
Q_l	=	Latent loads from power equipment and appliances (W)
$Q_{s,v}$	=	Sensible heat transfer due to the ventilation and infiltration (W)
$Q_{l,v}$	=	Latent heat transfer due to the ventilation and infiltration (W)
N	=	Number of people in/out per hour (m^3)
k_c	=	Infiltration air constant (m^3/hr/ person)
$(T_o - T_i)$	=	Temperature difference (ºC)
$(W_o - W_i)$	=	Indoor and outdoor humidity ratio
CFM	=	Air flow rate
V	=	Volume (m^3)

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CHAPTER 1

INTRODUCTION

1.1 Background Study

Energy auditing is a proven effective energy management tool and has been practiced by energy professionals in Malaysia since the 1980s. However, many industries are not aware of the benefits of audits energy and it was less development on the audit energy software for office building. Energy audit is a systematic study or survey to identify how energy is being used in a building or a plant. It is also a useful procedure to find out the best options for energy conservation. Audits energy provides an analysis of the amount of energy consumed during a given period in the form of electricity, gas, fuel, oil or steam. By using that information, it is able to list how the energy was used according to the various processes in a plant or at the various outlets in a building. It is to reduce waste of energy and money to the minimum permitted by the climate the building is located, its functions, occupancy schedules, and other factors. It establishes and maintains an efficient balance between a building's annual functional energy requirements and its annual actual energy consumption. By identifying and implementing the means to achieve energy efficiency and conservation, not only can energy savings be achieved, but also equipment/system services life can be extended. Office buildings have the potential to consume substantial amounts of energy and other resources. Inefficient business practices can lead to excess waste. The goal of an environmental audit is to identify these wasteful practices and suggest ways to improve.

The role of an environmental auditor is to show participating offices the link between actions taken in the office and their effect on the environment. All these mean savings in money. Thus in this paper, it would like to propose audit energy software for office building by using Visual Basic Software in order to minimize the cost of energy usages. Betweens the design software will be work in rapid, accurate and cost-effective energy-auditing.

1.2 Problem Statement

Building cooling load components are; direct solar radiation, transmission load, ventilation and infiltration load and internal load. Calculating all these loads individually and adding them up gives the estimate of total cooling load. The load, thus calculated, constitutes total sensible load. Manual calculation step by step procedure has been carried out. There are a lot of times and energy is wasted when estimating the cooling loads in complex and intricate buildings of modern time. Besides that, the building characteristic have been describe such as type of material roof and wall for a building, daily indoor or outdoor temperature, area of each room, location latitude of building, operating hours, types of electrical component used and others in the building. So in this research develop the audit energy software for office building by using Visual Basic, to handle simple, intricate and dynamic nature of load estimate in Malaysia.

1.3 Objectives

a) To understand the principles, standard of theories through a literature study.
b) To understand the fundamental of energy audit/management of office building.

c) To complete develop of audit energy software for office building.
d) To understand the function of visual basic.

1.4 Scope

This project will focus on a literature review on the principle and standard of theories, the algorithm of model for audit energy software, development of the window interface forms used in energy audit software design and execuction of apply the developed software.

CHAPTER 2

LITERATURE REVIEW

Building energy simulation has become a useful tool for predicting cooling, heating and electrical loads for facilities. Simulation models have been validated throughout the years by comparing simulation results to actual measured values. The simulations have become more accurate and changed to be more comprehensive in their ability to model building features. This paper addresses several examples which proven audit energy software can be minimizing the cost of energy usages. By performing an energy and demand balance is the initial step energy analyst when starting to evaluate the energy use at a facility. These balances allow us to determine what the largest energy users are in a facility and to find out whether all energy uses have been identified. The energy usage in a building is dependent on construction, weather, and hours of operation as well as the individual systems that work to cool and heat the building. Models of energy usage must adequately reflect the influence of these factors. It will discuss several common energy-savings measures which are frequently recommended by energy auditors. Some of these may not actually save as much energy or demand as expected, except in limited circumstances.

2.1 Audit Energy

Energy audits are a systematic study or survey to identify how energy is being used in a building or a plant. It is also a useful procedure to find out the best options for energy conservation. Energy audits provide an analysis of the amount of energy consumed during a given period in the form of electricity, gas, fuel, oil or steam. Using that information, it is possible to list how the energy was used according to the various processes in a plant or at the various outlets in a building (Ibrahim, 2001).

The Malaysian Industrial Energy Efficiency Improvement Project (MIEEIP) has successfully conducted energy audits for 48 factories from eight energy intensive sectors in Malaysia making it the largest ever national-based energy audit program. An analysis of the audit findings from 43 out of the 48 energy audits conducted by the MIEEIP were available showed that these 43 factories consumed approximately 31.78 million GJ of energy a year, or about 13.1 percent of the final energy commercial demanded by the eight targeted industries. The recommendation put forth by the audit team range from the improvement in housekeeping for existing equipment, retrofitting or replacing key equipment or process, to the installing of cogeneration plants. According to the energy audits, if all measures recommended are implemented by each factory, electricity usage will be reduced by 5.6 percent and fuel demand by 26.7 percent annually that will result total energy savings of 22.3 percent per annum for all 43 factories.

In February 2003, DANIDA and ECO-Energy Systems conducted an energy audit on the office of Novozymes Malaysia Sdn. Bhd. office building in Technology Park Malaysia. In 2002, the 987 m^2 single storey office consumed 232,050 kWh giving it an energy consumption index of 235 kWh/m^2/year. The breakdown was 64% for air conditioning, 12% lighting and 24% general equipment. Using Energy-10, DANIDA carried out energy modelling on the building. And came up with 7 energy saving measures. When implemented the energy consumption index was reduced to 181

kWh/m^2/year. The 2003 audit confirmed the accuracy of the Energy-10 computer simulation.

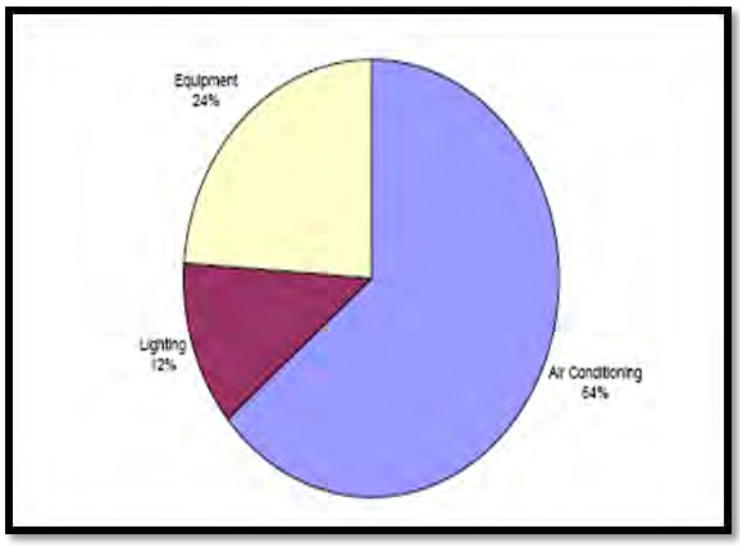

Figure 2.1: Novozymes Office Building Energy Load
(Source: Chan, (2004))

2.1.1 Factors Affecting Energy Use in Buildings

The building related factors influencing energy requirements are numerous and complex. They can be classified under the following heading (Chan, 2004).

1. Size and Shape
2. Orientation
3. Planning and Organization
4. Thermo physical properties – thermal resistance & thermal capacity
5. Window systems
6. Construction detailing

2.1.1.1 Size and Shape

Generally, a larger building will require more energy to cool than a smaller building because of the larger of space to be cooled. The larger buildings need less energy per unit size because of their smaller surface area per unit size and thus lower heat gain per unit size. Based on this theory they said “The larger a building, and the nearer to spherical in shape, the less are its energy needs because of the simple reduction in the ration of surface area to volume”. They conclude that “The architectural fad for angular protrusions of buildings is an energy wasting form”.

2.1.1.2 Building Orientation

Building orientation affects the air conditioning / heating energy requirements in two respects by its regulation of then influence of two distinct climatic factors.

- Solar radiation and its heating effects on walls and rooms facing different directions.
- Ventilation effects associated with the relation between the direction of the prevailing winds and the orientation of the building.

Solar influence on energy is the most significant in the tropics and is extensively covered by many others.

2.1.1.3 Planning & Layout

It is not possible to generalize or quantify the complex implications that planning and layout of spaces will have on air conditioning and lighting requirements. Some areas where the layout will influence are listed below.

1. Grouping of spaces
2. Interaction of spaces
3. Ceiling height and space volume

2.1.1.4 Window Systems

The size, location, shape and orientation of glazed areas in a building will have a critical effect on both the heat gains and solar gains of a building because glazed areas have the highest hat gain per unit area and the major proportion of solar gains are also through windows.

2.2 Software

Energy simulation program is an important tool in any energy audit of building projects. It is an integral part of a complete energy audit. Most energy auditing experts suggest that the implementation of some sort of simulation program is required to achieve a precise and thorough audit. By applying such a tool, energy auditors can predict the savings obtained from any future measure taken in the building. (ALGHIMLAS 2000). In general, energy auditing has been an effective tool that can assist facility managers to develop their energy saving plans and to achieve their energy saving goals. Computer-based simulation is accepted by many studies as a tool for evaluating building energy. There are many different types of computer-based simulation tools that are available for performing whole-building simulation, for example, the application of Design of Experiments - DOE 2 Software, and an expert system for supporting energy auditing, eQUEST, is most up-to-date complete building energy use simulation and a quick energy simulation tool developed by DOE- 2.com, is