Ain Shams University

Faculty of Engineering

Mechanical Power Engineering Department

Investigation of Energy-Efficient Alternatives for Commercial Buildings in Egypt

A Thesis submitted in partial fulfillment of the requirements of the degree of Master of Science in Mechanical Engineering

(Mechanical Power Engineering)

By

Fady Emil Mikhael Youssef

Master of Science in Mechanical Engineering

(Mechanical Power Engineering)

Faculty of Engineering, Ain Shams University, November 2018

Supervised by

Prof. Nabil Abdel Aziz Mahmoud

Prof. Ahmed Mohamed Reda El Baz

Dr. Aya Khairy Diab

Cairo - (2018)

Ain Shams University

Faculty of Engineering

Mechanical Power Engineering Department

Investigation of Energy-Efficient Alternatives for Commercial Buildings in Egypt

By

Fady Emil Mikhael Youssef

M. Sc. in Mechanical Power Engineering Department

Faculty of Engineering – Ain Shams University

EXAMINERS COMMITTEE

Name and Affiliation	**Signature**
1. Prof. Dr. Salah M. El Haggar Department of Mechanical Engineering American University in Cairo.	…………….
2. Prof. Dr. Raouf Nassif Abdel-Messih Department of Mechanical Power Engineering Ain Shams University, Faculty of Engineering	…………….
3. Prof. Dr. Nabil Abdel Aziz Mahmoud Department of Mechanical Power Engineering Ain Shams University, Faculty of Engineering	……………..
4. Prof. Dr. Ahmed Mohamed Reda El Baz Department of Mechanical Power Engineering Ain Shams University, Faculty of Engineering	…………….

Date: 24/11/2018

Statement

This thesis is submitted as a partial fulfilment of Master of Science in Mechanical Engineering (Mechanical Power Engineering), Faculty of Engineering, Ain Shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

Signature

....

Student Name

Fady Emil Mikhael Youssef

Date: 24/11/2018

Researcher Data

Name	Fady Emil Mikhael Youssef
Date of birth	04/06/1987
Place of birth	Cairo, Egypt
Last academic degree	Bachelor of Science.
Field of specialization	Mechanical Power Engineering
University issued the degree	Ain Shams University
Date of issued degree	June 2010
Current job	Senior Mechanical Design Engineer

List of Publications

Twelfth International Conference of Fluid Dynamics (ICFD12) 19-20 December 2016, Le Méridien Pyramids Hotel, Cairo, EGYPT

Paper No.: ICFD12-EG-5020

Paper Title: "Investigation of the Impact of Using Daylighting for Rationalization of Energy Consumption of an Office Building in Egypt"

Abstract

Given the rising living standard, population growth and global warming, buildings have been consuming energy and resources at an ever-increasing rate worldwide. To face this problem, energy saving techniques have been recently adopted in the framework of high-performance buildings, also known as zero-energy buildings. In Egypt, electricity consumption has witnessed significant increase of 55.22% since 2006 [1] of which residential and commercial buildings have the biggest share (66% to 74%). Hence, it is timely for Egypt to adopt energy saving techniques in its building construction code. This thesis investigates the effects of applying energy saving techniques for commercial buildings in Egypt. As a case study, a virtual building based on the Mechanical Engineering Department building at the Faculty of Engineering Campus of Ain Shams University, was modeled using EnergyPlus as a sample of non-residential buildings. A number of energy saving techniques have been assessed and compared to reach an improved building envelop and improved HVAC system with minimum energy needs (energy rationalization). Subsequently, a solar system is sized to cover these energy needs, thus transforming the sample building into a zero-energy building. Results of the study showed that Zero-energy buildings are applicable in Egypt and constructions recommended by international standards can be replaced by cheaper and more effective alternatives. Study also introduced simple design guidelines to achieve the Zero-Energy state for commercial buildings in Egypt.

Key words:

Zero-Energy buildings, High-Performance buildings, Energy saving, Energy conservation, EnergyPlus, Energy simulation

Acknowledgement

I would like to express my deepest appreciation to the committee members for their inspirational instructions. Without their guidance and support, I couldn't have completed this work.

I would like to express my gratitude to my academic advisors, Prof. Nabil Abdel-Aziz, Prof. Ahmed El-Baz, and Dr. Aya Diab for their guidance and motivation during this study.

Finally, I sincerely thank my mother and my family who deserve all the credit for the encouragement in carrying out this work.

Table of Contents

List of Tables

List of Figures