A PRACTICAL FRAMEWORK FOR PROMOTING ENERGY EFFICIENCY AT THE RESIDENTIAL SECTOR

By

Eng. Sherin Hisham Sameh

A thesis submitted to the

Faculty of Engineering at Cairo University

in Partial Fulfilment of the

requirements for the Degree of

DOCTOR OF PHILOSOPHY

in

Architecture and Environmental design

FACULTY OF ENGINEERING, CAIRO UNIVERSITY

GIZA, EGYPT

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Title of Thesis:

A PRACTICAL FRAMEWORK FOR PROMOTING ENERGY EFFICIENCY AT THE RESIDENTIAL SECTOR (AN EGYPTIAN CASE STUDY)

Key Words:
Power Crisis, Energy Efficiency, End Users, Green Retrofitting, Residential Buildings.

Summary:

The power crisis in Egypt has become a demanding challenge facing the government in the past few years. Consequently, promoting energy efficiency for end-users becomes an effective solution to tackle this crisis from the usually neglected but equally important demand side. This study focuses on drawing an adequate governmental framework that can solve the power crisis in Egypt at its highest demand, presumed by the residential sector. Combining policy generation and tools like green retrofitting in order to promote energy efficiency, implement it and help solve the power crisis on the long run.

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Abstract

The problems resulting from the electricity shortage and the daily blackouts have become a common scenario in the life of many Egyptians, and a demanding challenge facing the government in the past few years. This problem is mainly generated from gas and fuel shortage, and is projected to surge in the coming future, unless properly dealt with.

To solve the electricity problem in Egypt both the supply side, and the demand side should be properly addressed, while employing adequate energy efficiency techniques on both sides. However, most of the efforts taken so far have concentrated on the supply side, without sufficiently addressing the other side of the problem, that of the demand side, and hence it becomes the focus of this study.

The residential sector in terms of demand is recorded as the highest consumer of electricity, and hence it plays a very important role in addressing the current power crisis. Consequently, promoting energy efficiency for end-users becomes an effective alternative and a promising solution to tackle this crisis.

On the other hand, energy efficiency promotion should not be left only to the industry, or to the household users, as these sectors are not adequately informed. Moreover, if they are not sheltered under the umbrella of an inclusive environmental policy, their impact will be minor and ineffective.

This study focuses on drawing an adequate governmental framework able to solve the power crisis in Egypt at its highest demand, presumed by the residential sector. Combining policy generation, and tools like green retrofitting in order to promote energy efficiency, implement it, and help solve the power and energy crisis on the long run.

The same approach could be also adapted and used to tackle other sectors influenced by the power crisis, and later specify a strategy for sustainable development as a national, and an international anticipated target in Egypt.

Key Words: Energy Efficiency, Energy Problem, End Users, Green Retrofitting, Electricity Consumption.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

1.1 Overview

The call for designing green sustainable buildings that consumes less energy has lately been very popular. All over the world, buildings are urged to implement the principles of sustainability, which initially developed as environmentalism, later as sustainable development (Gardiner L., 2009), and more recently as ecological modernisation.

Energy Efficiency is fast becoming an integral part of the building industry and the built environment. Buildings and infrastructure represent principal assets of any national economy as well as prime sources of environmental degradation. Making them more sustainable represents a key challenge for the construction, planning, design industries, and governments at all levels. The rapid urbanisation of the 21st century has made this key challenge global.

Buildings over their life cycle account for a large share of global greenhouse gas emissions. According to the World Business Council for Sustainable Development (WBCSD), the building sector by itself is responsible for around 40% of the world's energy use (The World Business Council for Sustainable Development, 2009). Then again, the European Commission reports that buildings are responsible for the largest share of the EU's final energy consumption (42%), and for about 35% of all greenhouse gas emissions as seen in Figure 1-1, (Andrew, 2010)). Alternatively, buildings energy consumption in the US is even higher, and accounts for around 48% of the total consumption, as seen in Figure 1-2**,** (Peter, 2009)**.**

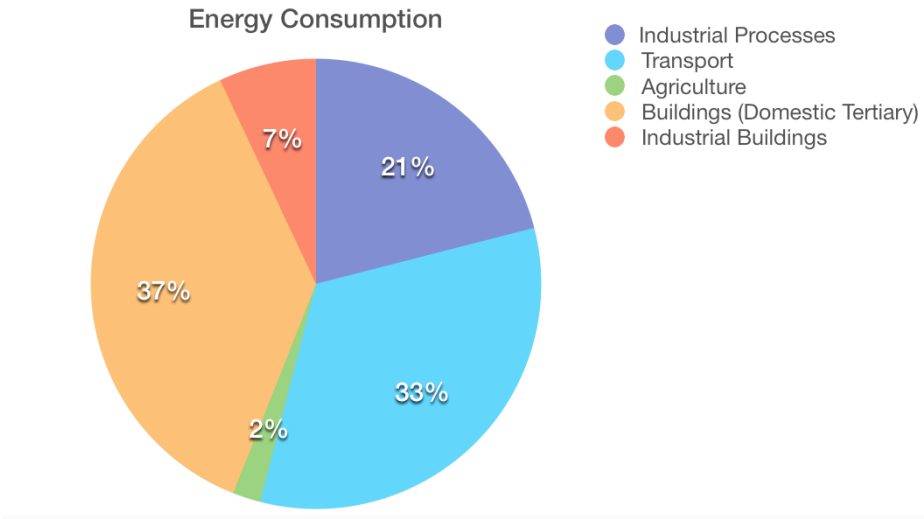

Figure 1-1: The Share of The Total EU's Energy Consumption, (Andrew, 2010)

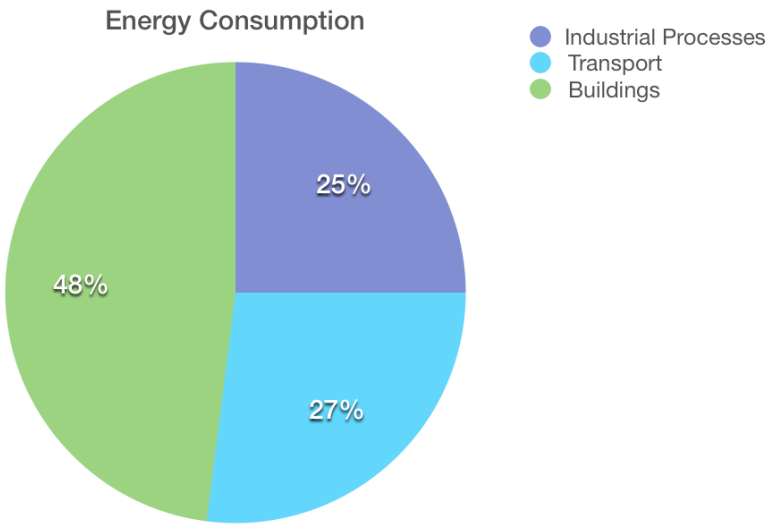

Figure 1-2: The Share of the Total US Energy Consumption, (Peter, 2009)

In addition, in 2007, the IPPC Working Group on Mitigation of Climate Change has found that there is a global potential to cost-effectively reduce approximately 29% of the projected baseline emissions by 2020, in the residential and commercial building sectors, which are the highest among all sectors studied in their report (Metz, 2007). The IEA report (2010) points out that reducing overall energy demands in buildings, and improving energy efficiency could result in possible mitigation of 12.6 giga-tonnes (Gt) of CO2 emissions, and energy saving of 1,509 million tonnes of oil equivalent by 2050 (IEA, 2010).

This, in return, has driven many countries to concentrate their efforts on finding effective solutions to increase the energy efficiency of the building sector in general, and the residential sector in particular, in order to make it more sustainable. Accordingly, many laws and regulations have been generated in many countries as incentives to encourage users to decrease their energy consumption, and to make them alert and more aware of their role in the required dialogue. Yet, the dilemma does not lie in the shortage of those generated laws and regulation. Rather, it lies in carrying them through by end users.

End-users play a vital role in implementing the generated rules, and pushing them forward, in order to actually and effectively decrease the energy consumption of buildings, and make them more sustainable on the long run.

It is usually noticeable that end-users tend to either misuse, or completely shy away from sustainability applications, due to the general lack of sustainability awareness, or the misinterpretation of these applications (Basil Kamel, 2012).

It is even more obvious in developing countries like Egypt, where the application of sustainability is still a struggle in many sectors. The situation has become even more critical in light of the current political instability.

1.2 Problem Definition

The continuous rising global demand on energy is a major challenge facing sustainability and its applications all over the world in general, and for this reason, "Energy efficiency becomes the need of the hour", (MAHBOOB, 2012).

Previous research has indicated four different aspects as the main triggers behind the energy problems. These four factors are categorized as, (Low Sheau Ting, 2011);

1. Energy Economy
2. Energy Security
3. Energy Environment
4. Energy Social

Energy economy is related to the increasing energy trading prices that have been going up the charts, and hence, affecting the energy production and affecting the global economy.

The energy security threat is usually related to future energy supply, and the uncertainty of energy future. It is estimated that the reserve of fossil fuel would be depleted in around 40 to 200 years, during which oil reserve is estimated to last around 40 years, natural gas around 70 years, and coal around another 200 years, (IEA, 2016). This threat is apparent nowadays in the Egyptian crisis, where the government is struggling to secure enough energy sources to fulfil the rising demand in the power sector.

Energy environment is said to be related to climate change and pollution resulting from fossil fuel combustion.

Energy social is related to the expanding increase in population, and food prices. It is noted in the international energy outlook 2009 that, within the year 2005 and to the year 2030, the growth population increases about 3.9%-6% per every five years (IEA, 2009). Yet again, this threat is apparent in Egypt along with the energy security aspect. With the two put together, they are apparently igniting the energy crisis facing the country and causing many problems in different sectors and levels.

In Egypt the energy problem becomes very relevant to what is mentioned above. Accordingly, the energy crisis in Egypt could be deduced as a result of three main aspects, energy economy, energy security and energy social, with less regards given to the energy environment, and so it is left out of the scope of this research. Within the recent few years the Egyptian government and the whole society have been facing a real dilemma due to this energy shortage. Electricity black outs, long queues in front of petrol stations, as well as outlets of cooking gas cylinders, have become a common scenario in the Egyptians everyday life, and a demanding challenge facing any new government, (Khaled, 2016). Needless to say that many other factors are contributing to that like; the increasing population, the expanding development, and the rising demand for energy.

This brings the focus back on energy generation in Egypt, with special regards to electricity generation in particular. It is noted that most electrical power plants in Egypt are powered by natural gas (Razavi, 2012). On the other hand, the local production of natural gas is not capable of covering the increase in consumption, despite of the new discoveries. Even more, natural gas production has actually declined by an annual average of 3% for the years 2009 to 2013, as seen in Figure 1-3: