Cairo University
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GREENING THE EXISTING BUILDINGS AS A PRIORITY FOR TACKLING CLIMATE CHANGE AND ENERGY CRISIS

"DEVELOPING A METHODOLOGY FOR ASSESSING THE APPLICABILITY OF GREEN TECHNOLOGIES AND STRATEGIES ON OFFICE BUILDINGS IN EGYPT"

By

Arch. Shereen Omar Mohamed

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
In
Architectural Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
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Dedication

I would like to dedicate this thesis to my family. A special feeling of gratitude to my loving mother and sister.

I also would like to dedicate this thesis to my father's Soul — who is always in my heart.

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Abstract

The building sector has the highest potential for energy savings, greenhouse gas (GHG) emissions mitigation and the use of renewable energies. What is even more important: buildings also have the highest mitigation potential with no-cost and low-cost measures, e.g. by just improving the building design and applying well-known technologies such as insulation, solar-water heaters, efficient lighting, etc.

This study reviews the climate change and energy consumption issues, the basics of green architecture and its rating systems locally in Egypt and globally and focuses on the most common rating system for the existing buildings. Review for the most recent green building technologies that can be implemented on existing building for optimizing the building performance and the tenants comfort. Introducing the drivers and the barriers to greening the existing building and the steps that should be taken to overcome these barriers, for example incentive programs to encourage greening existing buildings and increasing the awareness.

The study aims to develop a program –guidelines- that can help in greening any existing building through analyzing international successful case studies all over the world, and to develop a methodology for assessing the applicability of green strategies and technologies in Egypt.

Keywords	Existing buildings – Green technologies – Green strategies – Sustainability – Green Architecture – Office buildings – Operational phase - Climate Change – Incentive Programs – Application in Egypt.

A. Introduction

Now the time has certainly come to focus on existing buildings, which after all represent the great majority of all buildings. *The building sector contributes up to 30% of global annual greenhouse gas emissions and consumes up to 40% of all energy primarily through the operational phase, both in developed and developing countries*. Given the massive growth in new construction in economies in transition, and the inefficiencies of existing building stock worldwide, if nothing is done, greenhouse gas emissions from buildings will more than double in the next 20 years. Therefore, if targets for greenhouse gas emissions reduction are to be met, it is clear that decision-makers must tackle emissions from the building sector.

Over 80% of the buildings that will be consuming energy in the first Kyoto compliance period (2008-2012) [1]have already been built, so effective response must include both new and existing buildings.

In many ways the challenges of greening existing buildings are far greater than greening new buildings; we are not starting with a blank slate, as with new buildings, but with an existing edifice and set of operating practices. In many situations, it is not easy or cheap to change the building envelope, it may not be economical to change out the HVAC equipment, and a significant percentage of building's energy use already determined by scale, mass, and orientation.

The challenge lies in identifying the barriers of greening existing buildings in Egypt and investigating the drivers to it. Through pursuing the benefits especially the economical and health benefits, it is easy to overcome the barriers.

Benefits if greening buildings are infinite; economical and financial benefits in energy and water savings, environmental benefits, cultural and social benefits, and political ones.

But beyond savings in energy, water, and waste management expenses, the real gains in greening existing buildings lie in the seemingly "soft" benefits: improvements in health, comfort, and productivity of buildings occupants; enhanced marketing and public relations; risk mitigations, improved recruitment and retention, and greater employee morale.

There are countless green technologies and strategies that could be implemented on existing buildings, but how to assess their applicability in Egypt. This confirmed the need to develop a methodology for assessing the applicability of these green technologies in Egypt; thus avoid applying a strategy that is not efficient, affordable, or available in Egypt.

[1] The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change. The major feature of the Kyoto Protocol is that it sets binding targets for 37 industrialized countries and the European community for reducing greenhouse gas (GHG) emissions .These amount to an average of five percent against 1990 levels over the five-year period 2008-2012. The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997 and entered into force on 16 February 2005. (URL: http://unfccc.int/kyoto_protocol/items/2830.php , accessed June 19, 2012).

B. The Research Problem

Existing Buildings operation and maintenance phase is a neglected part of the buildings' lifecycle; that is due to the lack of awareness of the green building benefits, and the lack of government policies, codes and incentive programs that encourage applying green strategies and technologies in the building sector. And that there is large number of green technologies and strategies that one could not be able to define the applicable or the suitable ones in Egypt.

C. The Research objectives:

This paper aims to ensure that greening existing buildings is the preferred option for decision makers for tackling climate change and energy crisis, and to develop a methodology for assessing the applicability of green technologies and strategies in Egypt. This is achieved through:

1. Investigating how to maximize the operational efficiency while minimizing environmental impacts.
2. Investigate the barriers to greening existing building and the drivers to overcome them, and the business case of the Egyptian market.
3. Explaining some incentive programs that encourage exploiting green strategies on existing buildings.
4. Studying international examples that applied certain strategies on existing buildings.
5. Develop a program –guidelines- that can help in greening any existing building.
6. Illustrate the role of the government, architects, the private sector, owners, and tenants to enhance the greening of the existing buildings in Egypt.

D. The Research Scope

The selected scope of the study is ***Existing office buildings*** as they are big consumers of energy due to its large requirements of electricity used in lighting, air conditioning … etc. Another reason is that office buildings consume nearly twice as much energy than residential buildings per square foot. This large consumption tells us that there were more efficient ways for operating and maintaining office buildings.

E. The Research Methodology

The research methodology embraces a mixed strategy that is needed to investigate different components of the study. It comprises literature review, survey, data collection, analysis. As well as applying the methodology on the analyzed case studies to detect the applicability of the green strategies implemented on these buildings in Egypt. The following methodologies will be adopted; the theoretical method, the comparative - analytical method, and the deductive method.

- **The Theoretical Approach:** This includes reviews of sustainability definitions and climate change current situation, effect of buildings on climate change and vice versa, principles of green architecture and its rating systems and tools. The challenge of greening existing buildings, the incentive programs and policies that encourage greening of buildings. This will be in chapters 1, 2, and 3.

- **The Comparative - Analytical Approach:** Analyzing and processing collected data, analyzing international and local examples that implemented green strategies on existing buildings. This will be mainly in Chapter 4, and part of chapter 3.

- **The Deductive Approach**: Through a published on-line survey to examine the current situation in Egypt towards applying green strategies and to develop a methodology for assessing the applicability of green technologies in Egypt. Determine the top applicable technologies and strategies based on the methodology and apply the on an office building in Egypt. This will be in chapter 5.

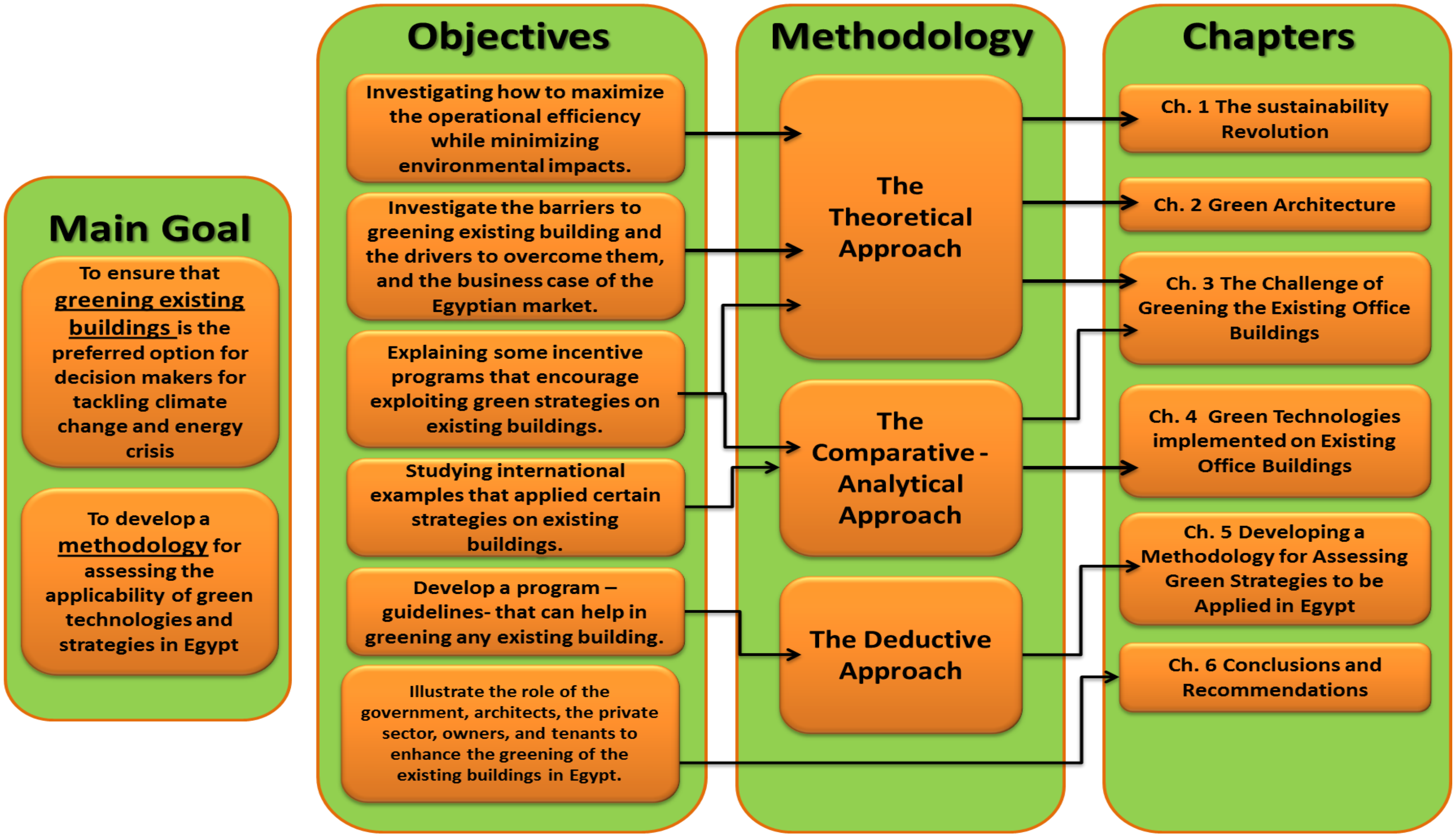

Figure A The Research Structure
Source: The Researcher

Introduction

The steady growth of carbon dioxide concentrations in earth's atmosphere, to levels unseen in hundreds of thousands of years, with attendant global warming, makes the transition to a future based on renewable, non-carbon energy sources ever more urgent, and a serious challenge; since residential and non-residential buildings contribute about 40 percent of the world's carbon dioxide emissions[1], and the building sector accounts for up to 30 percent[2] of all the global annual greenhouse gas emissions. In existing research on energy consumption, buildings, world- wide, account for as much as 45 percent of primary energy resources and that makes building the biggest single contributor to total energy consumption[3]. Thus the focus of carbon reduction and energy efficient policies, programs, and actions must necessarily be on the built environment.

We need to improve the environmental performance and energy efficiency in buildings, and we need to transform our buildings to green. Upgrading existing buildings not only helps to preserve the character of a place; it is an optimal solution for owners, tenants, the community and the environment.

This Sustainability revolution responds to the great environmental crises of the early 21st century—global warming, species extinction, droughts, and severe floods and hurricanes (or typhoons), all of which are affecting our world in unprecedented ways. This revolution is further fueled by the knowledge that the world has little time to respond to the growing dangers of climate change, especially global warming, and that buildings play a huge role in causing carbon dioxide emissions that drive global climate change.

This chapter deals with the Sustainability Revolution, Energy Consumption globally and locally in Egypt, and the effect of architecture process on environment and climate change and vice versa (the effect of climate change on buildings), enhancing the role of the buildings sector as a major part of the solution for carbon problem and climate change.

1.1 The Sustainability Revolution

For about the past 15 years, interest in sustainable buildings and sustainable building operations has been growing globally; and the number of Green building councils worldwide is increasing rapidly as shown in (Figure 1.1).

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[1]Hartke, J. et al, (2012), Innovative Financing for Green Building at the City Level - Public, Private and Multilateral presentation, RIO +20 United Nations Conference on Sustainable Development, USGBC Activity, June 17, 2012 , URL: http://www.usgbc.org/DisplayPage.aspx?CMSPageID=2124 , accessed December 4, 2012.

[2]UNEP(United NationEnvironment Programme), URL: http://www.unep.org/climatechange/ClimateChangeConferences/COP18/Booklet/MAKINGTHEBUILDINGSECTORCLIMATEFRIENDLY/tabid/105673/language/fr-FR/Default.aspx , accessed February 22, 2013.

[3]Iwaro, J., Mwasha, A., (2010), A review of building energy regulation and policy for energy conservation in developing countries, Energy Policy Journal, Volume 38, Issue 12, December 2010, Pages 7744–7755. Online version via ScienceDirect, accessed on February 5, 2013.

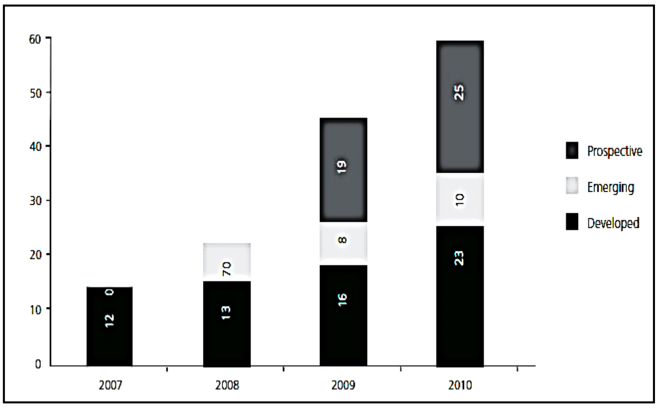

Figure 1.1 Growth of Member Councils Worldwide (2007-2010)
Source: Henley, J., (2010), Thinking global Acting local presentation, Conference on Promoting Green Building Rating in Africa, Nairobi, Kenya, WORLD GREEN BUILDING COUNCIL.

In the United States, this interest is the ultimate, finding direct expression in both manufacturing and building design, construction, and operations. This interest is dated to the founding of the U.S Green Building Council (USGBC) in 1993[1] by a group of business people and designers influenced by the 1992 U.N. conference on the Environment and Development.

The USGBC is a consensus-based group consisting solely of other organizations: companies, government agencies, universities, primary and secondary schools, nonprofits, environmental groups, and trade associations. Its membership growth has been rapid, as shown in (Figure 1.2). From a base of about 150 companies in 1998, the USGBC has grown 50-fold, to 7,500 companies, as of early 2007.[2]

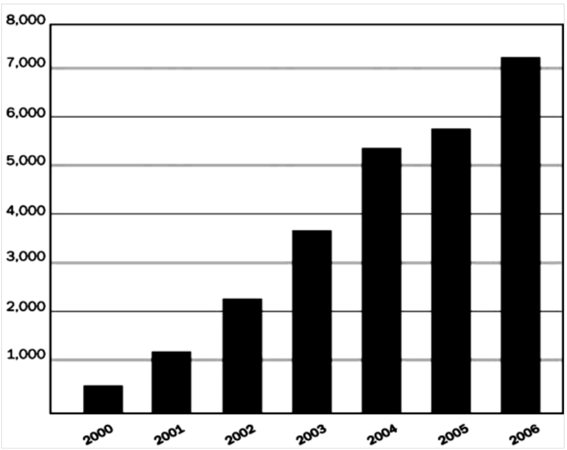

Figure 1.2 USGBC membership growth. Data courtesy of USGBC, redrawn with permission.
Source: Yudelson, J. (2008), The Green Building Revolution, Island Press, Washington.

The late 1990s saw the establishment of the Kyoto Protocol[3], an amendment to the U.N. Framework Convention on Climate Change that represented the first attempt to regulate greenhouse gas emissions on a global scale. More than 170 countries, which,

[1] Yudelson, J. (2010), Greening existing buildings, McGraw-Hill books, USA.
[2] Yudelson, J. (2008), The Green Building Revolution, Island Press, Washington.
[3] URL: http://en.wikipedia.org/wiki/Kyoto_Protocol , accessed December 4, 2012.

together produce more than 55 percent[1] of global greenhouse gas emissions (but not including the U.S.), have so far signed and ratified the protocol.

In 2000, the USGBC unveiled the Leadership in Energy and Environmental Design (LEED) Green Building Rating System for public use[2]. LEED was the first rating system in the United States to hold commercial projects up to scrutiny for the full range of their effects on energy and water use, municipal infrastructure, transportation energy use, resource conservation, land use, and indoor environmental quality. Prior to LEED, most evaluation systems, such as the Environmental Protection Agency's Energy Star® program, had focused exclusively on energy use.

- **United Nations Environment Programme (UNEP)**

In 1972, UNEP (United Nations Environment Programme) was established[3]; it acts as a catalyst, advocate, educator to promote the wise use and sustainable development of the global environment. To accomplish this, UNEP works with a wide range of partners, including United Nations entities, international organizations, national governments, non-governmental organizations, the private sector and civil society.

The mission of the UNEP is to provide leadership and encourage partnership in caring for the environment by inspiring, informing and enabling nations and peoples to improve their quality of life without compromising that of future generations[4]. In 2011, UNEP had mobilized over $200 million-worth of clean energy investments, up from $100 million in 2009 and exceeding the indicator target[5].

UNEP has lots of publications and reports on climate change, Carbon Dioxide Emissions, Green buildings, Green Economy, and many other publications related to our environment. World Environment Day -5 June- (WED) is the biggest, most widely recognized and celebrated UN-led global day for positive environmental action across all sectors of society, the 2011 theme for WED was Forests: Nature at Your Service. The day aimed to raise global recognition of the role and value of forests in the transition to a Green Economy; this resulted in pledges to plant a mini forest, based on activities registered worldwide.

1.1.1 What is Sustainability

Sustainability means many things to many people. What is sustainable building, and sustainable enterprise, and how it is connected to the design and operations of buildings and facilities? The most commonly cited definition of sustainability is that of the United Nations' Brundtland Commission on Environment and Development of 1987, which states:

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[1] Ibid.
[2] URL: http://en.wikipedia.org/wiki/Leadership_in_Energy_and_Environmental_Design , accessed November 19, 2012.
[3] URL: http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=43&ArticleID=3301&l=en , accessed November 20, 2012.
[4] UNEP annual report, Rio 2012, URL: http://www.unep.org/pdf/UNEP_ANNUAL_REPORT_2011.pdf , accessed November 20,2012.
[5] Ibid.

> *"Sustainable development is development that meets the needs of present without compromising the ability of future generations to meet their own needs"*[1]

This means that we must learn to live within the flows of sun, wind, and water, as well as biomass growth, and reduce wastes and pollution to levels that can be rendered harmless by natural systems.

Sustainability encompasses economic, social, and ecological perspectives of conservations and change. (Table 1.1) shows a conceptual diagram of the three dimensions of sustainability.

Table 1.1 Three dimensions of sustainability
Source: http://www.arch.hku.hk/research/BEER/sustain.htm, accessed October 24, 2012.

Economic dimensions of sustainability:	**Environmental dimensions of sustainability**	**Social dimensions of sustainability**
• Creation of new markets and opportunities for sales growth • Cost reduction through efficiency improvements and reduced energy and raw material inputs • Creation of additional added value	• Reduced waste, effluent generation, emissions to environment • Reduced impact on human health • Use of renewable raw materials • Elimination of toxic substances	• Worker health and safety • Impacts on local communities, quality of life • Benefits to disadvantaged groups e.g. disabled

For the past two decades, the corporate social responsibility (CSR) movement[2] has emphasized the social impacts of business practices, many have seen a focus on CSR as a major strategic business initiative and essential element in maintaining competitiveness. Combining this concern with economic and environmental impact yields the "triple bottom line" approach (Figure 1.3) that focuses equally on economic, social, and environmental impacts of business practices.

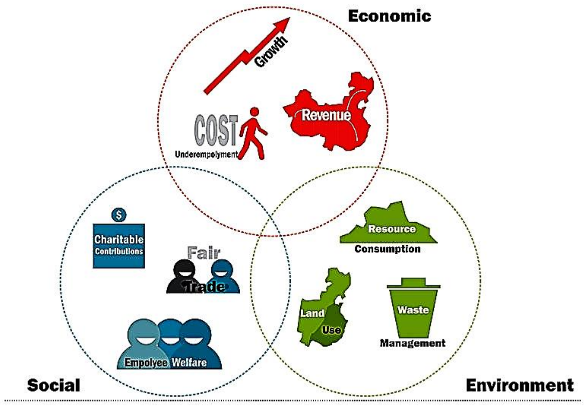

Figure 1.3 The triple bottom line is a convenient way of thinking about integrating economic, ecological, and social equity concerns into corporate actions.
Source: http://en.wikipedia.org/wiki/File:Triple_Bottom_Line_graphic.jpg, accessed October 15, 2012.

[1] Yudelson, J. (2010), Greening existing buildings, McGraw-Hill books, USA.
[2] Corporate social responsibility is now an established agenda for large companies, with a new profession emerging that engages in the social and environmental contribution of business. URL: http://www.greenleaf-publishing.com/productdetail.kmod?productid=2767 , accessed October 31, 2012.

An IBM survey of 224 global business leaders released in 2009 shows that 60 percent believe corporate social responsibility (CSR) has increased in importance over the past year. Only 6 percent say it is a lower priority[1].

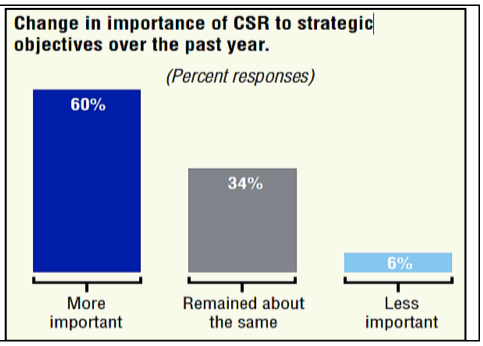

Figure 1.4 Change in importance of CSR to strategic objectives over the past year.
Source: IBM Institute for Business Value 2009 CSR Study.

To be sustainable, businesses are embracing a relatively new objective: Optimizing their operations to minimize environmental impact and improve social outcomes while maximizing performance.

1.1.2 Energy Consumption and Climate Change

Consumption of energy and many other critical resources is consistently breaking records, disrupting the climate and undermining life on the planet, according to the latest World watch Institute report, Vital Signs 2007-2008.[2] The 44 trends tracked in Vital Signs illustrate the urgent need to check consumption of energy and other resources that are contributing to the climate crisis.

In the end, it is society that must bear the effects of economic damage caused by climatic change. Due to the rising number of environmental catastrophes, there was an increase of 40% between the years of 1990 to 2000 alone[3], when compared to economic damage sustained between 1950 and 1990 (Figure 1.5). Without the implementation of effective measurements, further damage, which must therefore still be expected, cannot be contained.

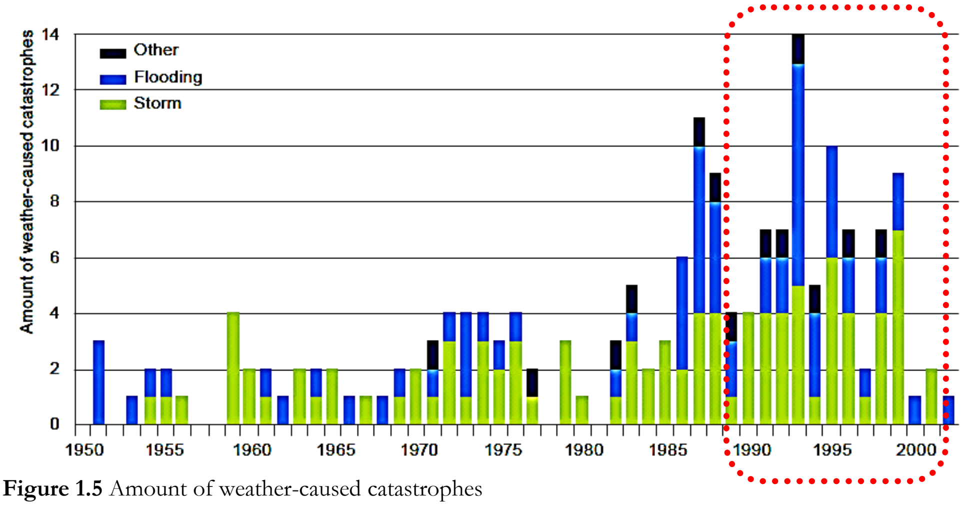

Figure 1.5 Amount of weather-caused catastrophes
Source: Bauer, M., Mösle, P., Schwarz, P., (2007), Green Building – Guidebook for Sustainable Architecture, Springer Heidelberg Dordrecht, London New York.

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[1] IBM corporation, (2009), Leading a sustainable enterprise Leveraging insight and information to act, URL:http://public.dhe.ibm.com/common/ssi/ecm/en/gbe03230usen/GBE03230USEN.PDF, accessed October 19, 2012.
[2] ScienceDaily, (2007), Energy Consumption Fueling Catastrophic Climate Change, Report Warns, URL: http://www.sciencedaily.com/releases/2007/10/071021114258.htm , accessed October 24, 2012.
[3] Bauer, M., Mösle, P., Schwarz, P., (2007), Green Building – Guidebook for Sustainable Architecture, Springer Heidelberg Dordrecht, London New York.

The latest was Hurricane Sandy –October 2012- , the largest Atlantic hurricane on record, as well as the second-costliest Atlantic hurricane in history, only surpassed by Hurricane Katrina in 2005[1]. After Sandy: A Note from USGBC stated that they are working towards a built environment of the future that helps make decisions that make them stronger and in the face of weather, may help us bounce back faster[2].

Figure 1.6 Left: Hurricane Sandy on October 25, 2012, with winds of 90 mph and a pressure of 954 mbar. Right: aerial views of the damage caused by Hurricane Sandy to the New Jersey coast taken during a search and rescue mission by 1-150 Assault Helicopter Battalion, New Jersey Army National Guard, Oct. 30, 2012. **Source:** http://en.wikipedia.org/wiki/Hurricane_Sandy , accessed November 11, 2012.

The complex mechanisms of climate change involve the balance of carbon in the atmosphere, in the oceans and in all living things. The main mechanism is the greenhouse effect, by which levels of greenhouse gases in the atmosphere affect the heat balance of the earth[3].

The major greenhouse gases are carbon dioxide, nitrous oxide and methane. A recent report by the United Nations Intergovernmental Panel on Climate Change (IPCC) confirms that global greenhouse gas emissions increased by 70% and carbon dioxide emissions by 80% between 1970 and 2004[4]. It is estimated that at present, buildings contribute as much as one third of total global greenhouse gas emissions, primarily through the use of fossil fuels during their operational phase[5].

The effects of climate change are complex. They include:

- Increased average temperatures
- Rising sea levels (because of the melting of glaciers and of polar ice caps)
- Increased precipitation
- More frequent extreme weather events.[6]

(Figure 1.7) illustrates the possible secondary effects of climate change, including impacts on human health, agriculture, forestry, water resources, coastal areas and species and their habitats.

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[1] URL: http://en.wikipedia.org/wiki/Hurricane_Sandy , accessed November 11, 2012.
[2] URL: https://new.usgbc.org/articles/after-sandy-note-usgbc , accessed November 10, 2012.
[3] Rickaby, P., Cartmel, B., Warren, L., Willoughby, J., Wilson, R., RIBA (Royal Institute of British Architects) Climate Change Briefing Executive Summary, Beacon Press, London.
[4] Ibid.
[5] Huovila, P., Juusela, M., Melchert, L., Pouffary, S., Cheng, C., Urge-Vorsatz, D., Koeppel, S., Svenningsen, N., and Graham, P. (2009), Buildings and Climate Change Summary for Decision-Makers, United Nations Environment Programme UNEP, Paris. http://www.unep.org/sbci/pdfs/SBCI-BCCSummary.pdf, accessed June 6, 2012.
[6] Rickaby, P., Cartmel, B., Warren, L., Willoughby, J., Wilson, R., RIBA (Royal Institute of British Architects) Climate Change Briefing Executive Summary, Beacon Press, London.

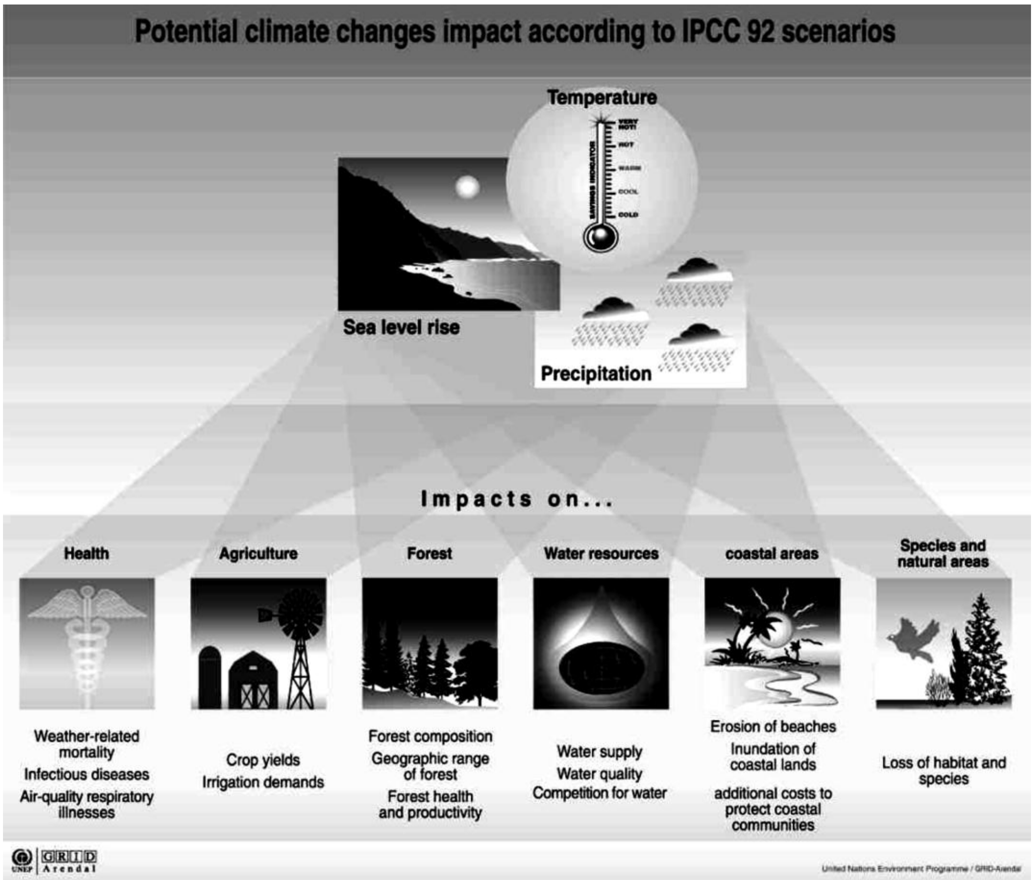

Figure 1.7 Potential climate changes impact according to IPCC 92 scenarios.
Source: United States Environmental Protection Agency (EPA), Philippe Rekacewicz.

Some of the current environmental issues in Egypt are:

"Agricultural land being lost to urbanization and windblown sands; increasing soil salination below Aswan High Dam; drowning of Delta; desertification; oil pollution threatening coral reefs, beaches, and marine habitats; other water pollution from agricultural pesticides, raw sewage, and industrial effluents; limited natural freshwater resources away from the Nile, which is the only perennial water source; rapid growth in population overstraining the Nile and natural resources"

Figure 1.8 Estimated Water rise over the Delta in Egypt as a direct result of climate change and global warming.
Source: URL: http://geology.com/sea-level-rise/nile-delta.shtml , accessed October 12, 2012.

1.1.2.1 Energy Consumption Globally

There has been an enormous increase in the global demand for energy in recent years as a result of industrial development and population growth. Supply of energy is, therefore, far less than the actual demand (Figure 1.9).

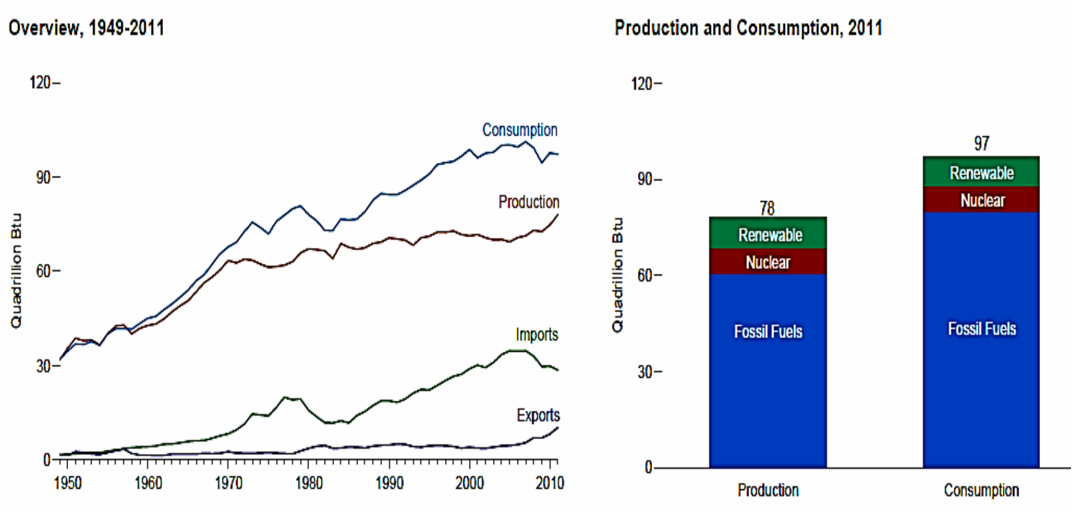

Figure 1.9 Primary energy overview (production and consumption), 2011.
Source: U.S. Energy Information Administration / Annual Energy Review 201.

World marketed energy consumption grows by 53 percent from 2008 to 2035[1]. Total world energy use rises from 505 quadrillion British thermal units (Btu) in 2008 to 619 quadrillion Btu in 2020 and 770 quadrillion Btu in 2035 (Figure 1.10). Much of the growth in energy consumption occurs in countries outside the Organization for Economic Cooperation and Development (non-OECD nations) where demand is driven by strong long-term economic growth. Energy use in non-OECD nations increases by 85 percent in the Reference case, as compared with an increase of 18 percent for the OECD economies.

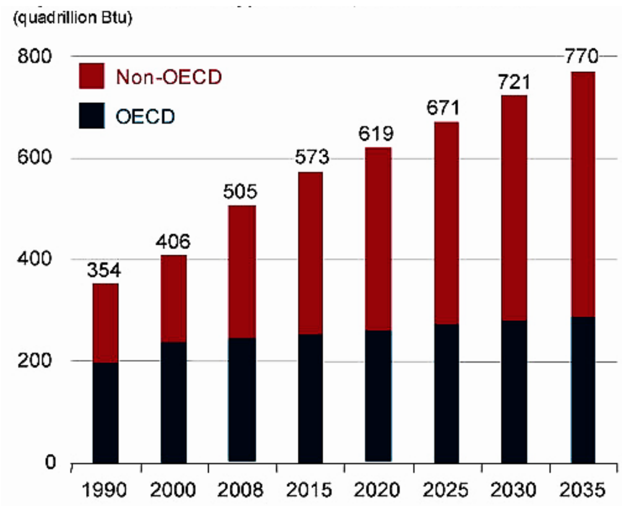

Figure 1.10 World energy consumption, 1990-2035.
Source: http://www.eia.gov/forecasts/ieo/index.cfm, October19, 2012.

[1] http://www.eia.gov/forecasts/ieo/index.cfm , accessed October 19, 2012.

The main energy use categories are taken as transport, industry, and buildings (residential-commercial). (Figure 1.11) and (Figure 1.12).

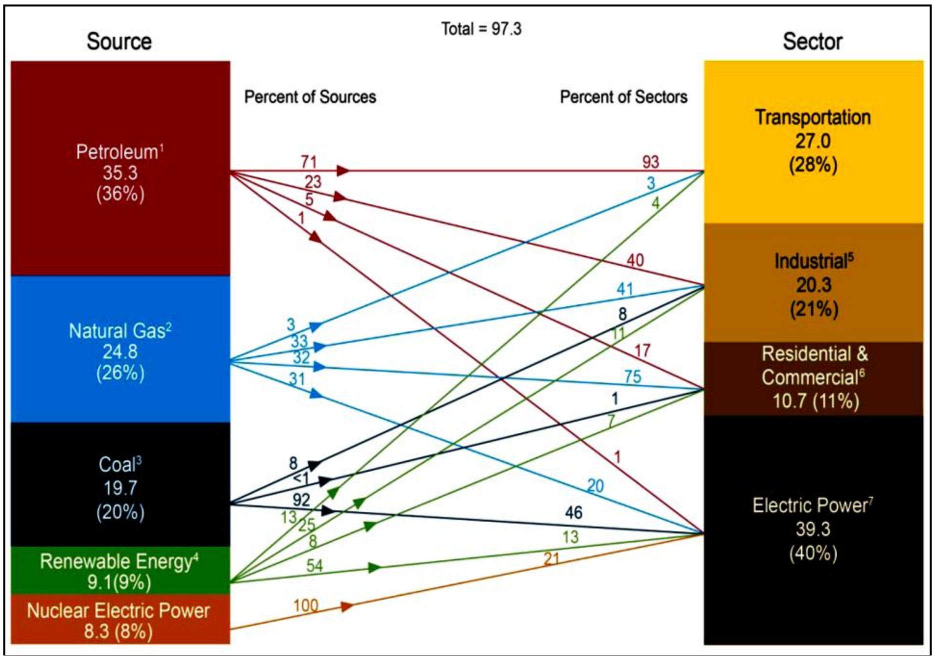

Figure 1.11 Primary Energy Consumption by Source and Sector, 2011.
Source: U.S. Energy Information Administration / Annual Energy Review 2011.

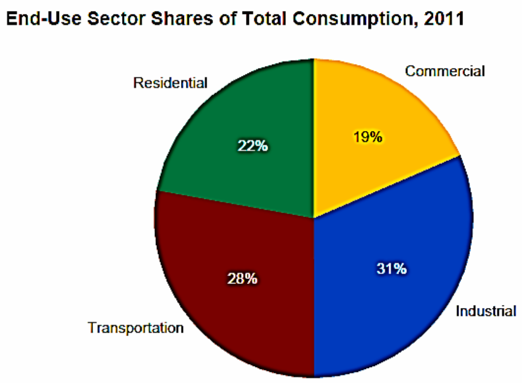

Figure 1.12 Energy Consumption Estimates by Sector Overview
Source: U.S. Energy Information Administration / Annual Energy Review 2011.

The building sector (Residential-Non residential) consumes about 40 percent of the world's total energy consumption.

In most countries the residential sector accounts for the major share of total primary energy consumption. Nevertheless, the energy consumption in non-residential buildings such as offices, public buildings and hospitals is also significant and growing. China for example is expected to add the equivalent of twice the current U.S. stock of office buildings by 2020[1]. In terms of international averages, most residential energy in developed countries is consumed for space heating (60%, although not as important in some developed countries with a warm climate, but in

[1]Huovila, P., Juusela, M., Melchert, L., Pouffary, S., Cheng, C., Urge-Vorsatz, D., Koeppel, S., Svenningsen, N., and Graham, P. (2009), Buildings and Climate Change Summary for Decision-Makers, United Nations Environment Programme UNEP, Paris. http://www.unep.org/sbci/pdfs/SBCI-BCCSummary.pdf, accessed June 6, 2012.

this case energy may be used for cooling purposes) with this application followed in order by water heating (18%) and domestic appliances (6% for refrigeration and cooking, 3% for lighting) with other uses accounting for 13%[1]. In hotter climates, much less or no energy is used for space heating but a significant proportion of energy may be used for cooling purposes. However, the relative share of different energy applications varies from country to country, as well as from household to household. This is partly explained by differences in income levels and behavior of building occupants.

Consequently, there are many opportunities to fight climate change within the building sector, I have chosen to focus on opportunities within office market and actions to do to enhance the idea of greening the office buildings for three main reasons:

1. Although residential buildings as a whole consume more energy than commercial buildings as seen in (Figure 1.12), office buildings consume nearly twice as much energy than residential buildings per square foot. See (Table 1.2), this high energy consumption per square foot, tells that there were more efficient ways for operating and maintaining office buildings.

Table 1.2 Table of energy consumption (BTU) per square foot
Source: U.S. Energy Information Administration

Principal Building Activity	Consumption per Sq Ft. (BTU)	Number of Buildings (Thousand)	Total Sq Ft	Total Energy Consumption (Btu)
Residential[11]	46,683	107,000	211,325,000,000	9,865,400,000,000,000
Commercial				
Education	83,046	386	9,874,000,000	820,000,000,000,000
Food Sales	200,000	226	1,255,000,000	251,000,000,000,000
Food Service	258,162	297	1,654,000,000	427,000,000,000,000
Health Care	187,796	129	3,163,000,000	594,000,000,000,000
- **Inpatient**	249,343	8	1,905,000,000	475,000,000,000,000
- **Outpatient**	94,594	121	1,258,000,000	119,000,000,000,000
Lodging	100,078	142	5,096,000,000	510,000,000,000,000
Retail (Non-Mall)	73,893	443	4,317,000,000	319,000,000,000,000
Office	92,889	824	12,208,000,000	1,134,000,000,000,000
Public Assembly	93,932	277	3,939,000,000	370,000,000,000,000
Public Order & Safety	115,596	71	1,090,000,000	126,000,000,000,000
Religious Worship	43,420	370	3,754,000,000	163,000,000,000,000
Service	77,037	622	4,050,000,000	312,000,000,000,000
Warehouse & Storage	45,247	597	10,078,000,000	456,000,000,000,000
Other	164,556	79	1,738,000,000	286,000,000,000,000

2. Office buildings amount to 12.2 billion total square feet in second place after residential buildings with 211 billion square feet. (Table 1.2).

3. Energy uses in officebuildingsisabout70–300kWh/m2 per annum,10–20times that of residential buildings[2].
4. More than any other non-owner occupied building type, multi tenanted office buildings are being upgraded to green building standards specially Leadership in Energy and Environmental Design- Existing Buildings Operations and Maintenance (LEED-EBOM), and currently there is a push to green other existing building types.

[1] Ibid.
[2]Iwaro, J., Mwasha, A., (2010), A review of building energy regulation and policy for energy conservation in developing countries, Energy Policy Journal, Volume 38, Issue 12, December 2010, Pages 7744–7755. Online version via ScienceDirect, accessed on February 5, 2013.

- **Improving Energy Productivity could cut Energy Demand Growth by at least Half**

There is a great opportunity to reduce worldwide energy demand growth to less than one percent[1] annually simply by using energy more productively. The most substantial improvement opportunity is in the residential sector, which is also the world's greatest consumer of energy with 25 percent[2] of global end use demand. By implementing available technologies such as compact florescent lighting, and high efficiency water heating. This alone would reduce sector's energy demand 5 percent of global end use energy demand by 2020. See (Figure 1.13).

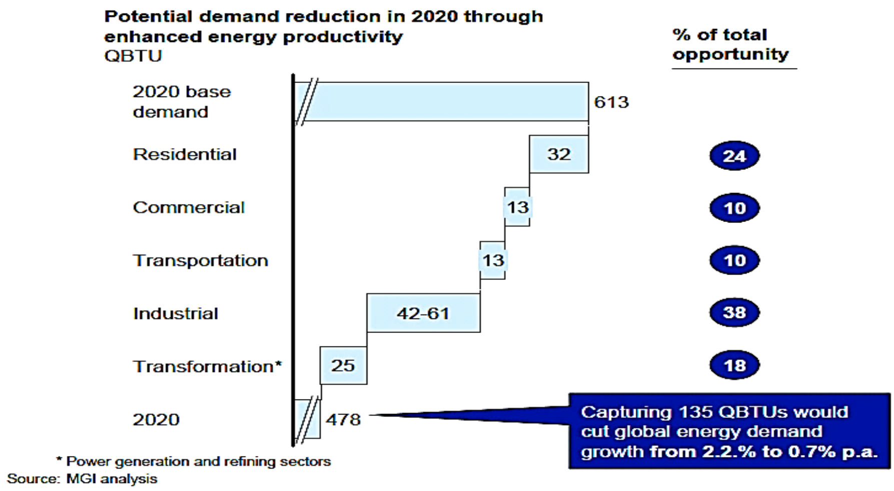

Figure 1.13 Large Opportunities for improving energy productivity are available across sectors
Source: URL: http://www.mckinsey.com/tools/Wrappers/Wrapper.aspx?sid={C3B2C1C5-DA7A-42FF-8577-7B0AE3B8D700}&pid={F6397EA6-3393-4514-BA23-45C193BBE190} , accessed January 17, 2013.

1.1.2.2 Energy Consumption in Egypt

Egypt is the largest non- OPEC (Organization of the Petroleum Exporting Countries) oil producer in Africa and the second largest natural gas producer on the continent following Algeria[3]. Almost all of Egypt's 3.4 quadrillion British thermal units (Btu) of energy consumption in 2009 was met by oil (47 percent) and natural gas (48 percent)[4]. Oil's share of energy consumption mix is mostly in the transportation sector, but with development of compressed natural gas (CNG) infrastructure and vehicles, the share of natural gas in the transportation sector is likely to continue to grow.

One of Egypt's challenges is to satisfy increasing domestic demand for oil in the midst of falling domestic production. Although in recent years, oil output has experienced moderate increases from new production at smaller fields. Domestic oil consumption has grown by over 30 percent over the last decade from 550.000 bbl/d in 2000 to 815.000 bbl/d in 2011. (Figure 1.14).

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[1] McKinsey & Company, (2007), Curbing Energy Demand Growth, The Energy Productivity Opportunity Report, URL: http://www.mckinsey.com/Insights/MGI/Research/Natural_Resources/Curbing_global_energy_demand_growth , accessed January 17, 2013.
[2] Ibid.
[3] Energy Information Administration Country analysis brief Egypt, (2012), URL: http://www.eia.gov/cabs/Egypt/pdf.pdf, accessed October 20, 2012.
[4]Ibid.

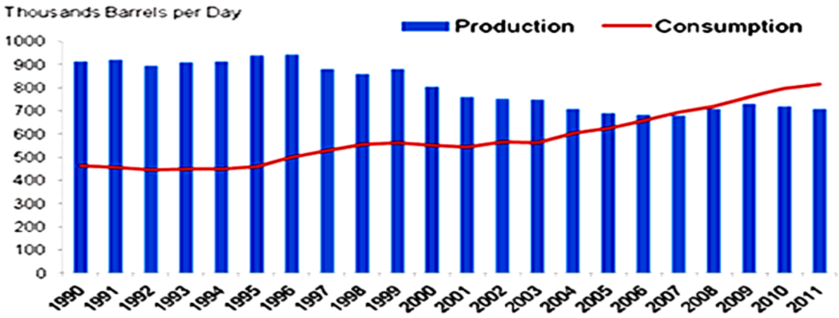

Figure 1.14 Total oil production and consumption in Egypt 1990-2011.
Source: U.S. information Administration. International energy statistics.

Egypt's natural gas sector has been increasing rapidly, as production has more than tripled from 646 billion cubic feet (Bcf) in 2000 to 2.2 Tcf in 2010.[1] Natural gas is likely to be the primary growth engine of Egypt's energy sector. However, growing domestic demand supported by government subsides, has caused the government to regulate the amount of gas exports (Fig. 1.15).

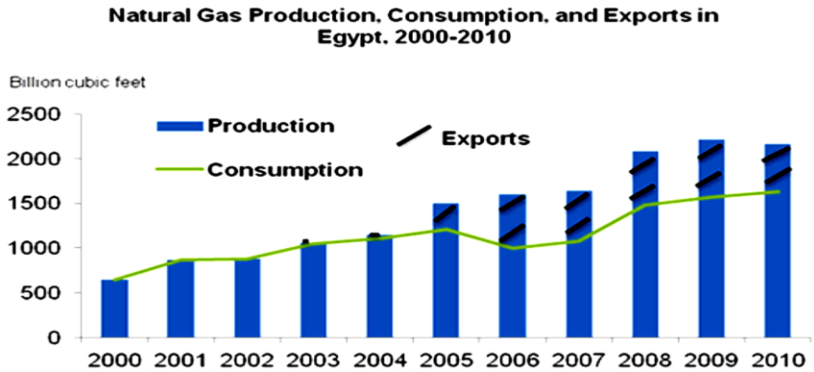

Figure 1.15 Natural gas production, consumption and exports in Egypt 2000-2010.
Source: U.S. information Administration. International energy statistics.

(Figure 1.16) Shows the total energy consumption by sector according to the ministry of electricity and energy report 2010/2011and 2011-2012. The building sector (Residential-Non residential) consumes more than 50 percent of the Egypt's total energy consumption.

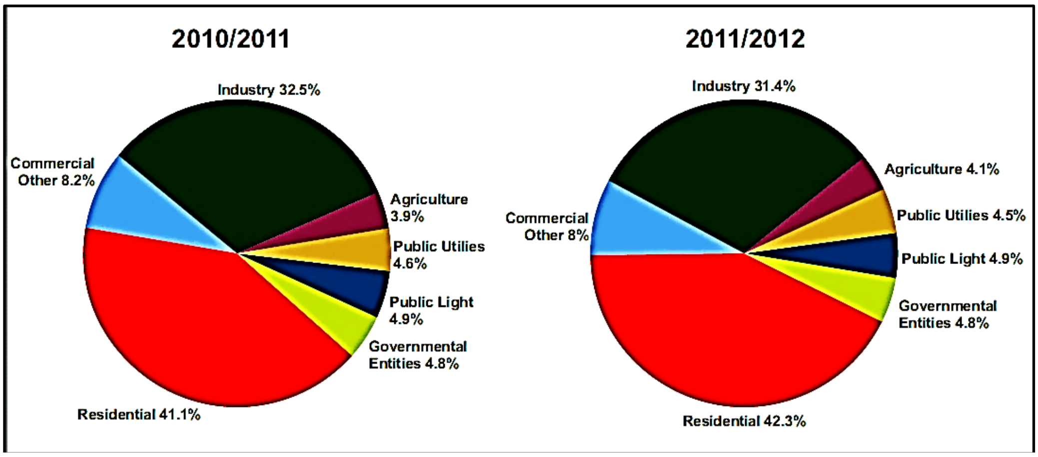

Figure 1.16 Energy consumption in Egypt overview by sector 2010/2011.
Source: Ministry of electricity and energy in Egypt. URL:
http://www.moee.gov.eg/english_new/EEHC_Rep/2011-2012.pdf , accessed September 20, 2013.

[1] Ibid.

The considerable growth in household loads in comparison with industry and other purposes was due to the expansion of residential compounds and new communities in addition to the widespread use of domestic appliances especially air conditioners in household due to hot weather during summer days.

- **Energy Challenges Facing Egypt in the 21st Century**

- The increase in population (1.3m/y)[1]
- Over concentration of population on 5% of total area (two main agglomeration Cairo and Alexandria)
- An extra infrastructure system for about 60 million people (2035) needed concentrated most probably in the desert; and this requires a big amount of embodied energy as well as operating energy
- The limitation of conventional energy resources in Egypt
- Old technology as well as the use of high intensive energy industrial construction for the production of building materials

1.1.2.3 Global Carbon Problem

Certainly a core issue for building owners is the continuing growth of global carbon emissions from fossil fuel combustion and a myriad of other human activities. (Table 1.3) shows the growth in world CO_2 emissions of more than 30 percent between 1990 and 2005[2].

Table 1.3 Energy related carbon dioxide emissions, 1990 and 2005.
Source: Yudelson, J. (2010), Greening existing buildings, McGraw-Hill books, USA.

Country/Region	CO_2 Emissions (Billion Metric Tons)		CO_2 Emissions (Per Capita)		CO_2 Metric tons per GDP (current dollars, Millions PPP)	
	1990	2005	1990	2005	1990	2005
United States	4.9	5.8	19.6	19.7	858.0	479.9
China	2.3	5.6	2.0	4.2	1.471.8	592.6
European Union	4.2	4.1	8.7	8.4	626.3	330.1
India	0.6	1.2	0.7	1.1	542.6	336.2
Japan	1.1	1.2	8.9	9.8	469.4	319.4
World	21.1	27.5	4.0	4.2	786.5	451.0

Gross Domestic Product (GDP): is the market value of all officially recognized final goods and services produced within a country in a given period of time. GDP per capita is often considered an indicator of a country's standard of living; GDP per capita is not a measure of personal income.
(PPP) represents Purchasing Power Parity

To Understand the CO2 emissions globally, and the contribution of each Nation by percent, see (figure 1.17). According to earlier estimates of the year 2003, the United States was at the first place before china with 25.2% [3]of emission. According to estimates of 2008, China is at the first place then the United States at the second place with 18.27%.

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[1]ElDemirdash, M., Mosallam, A., Bahnsawy, H., Fakhry, S., ElZahaby, K., (2009), Road to energy efficient and environmentally friendly affordable construction systems report, Kickoff meeting and round table on Egyptian green building council (EGBC) initiation, Housing and building national research center (HBRC), Cairo, Egypt.
[2]Yudelson, J. (2010), Greening existing buildings, McGraw-Hill books, USA.

[3] Climate analysis indicator tool, World Resource Institute, URL: http://www.nationmaster.com/red/pie/env_co2_emi-environment-co2-emissions , accessed February 22, 2013.

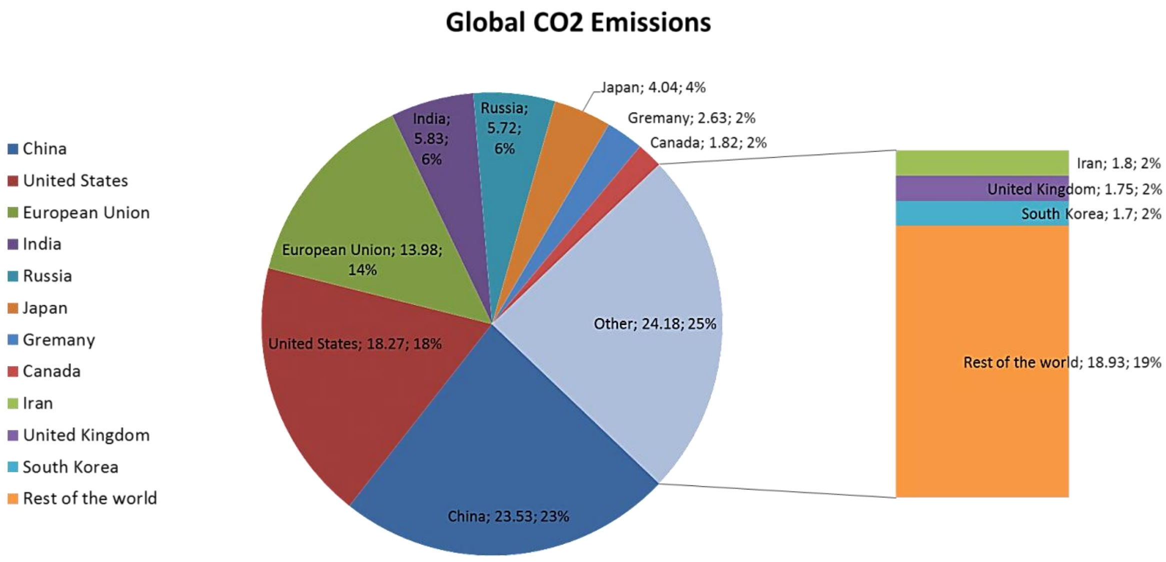

Figure 1.17 Distribution of CO2 Emissions by World Nations for the Year 2008.
Source: URL: http://en.wikipedia.org/wiki/List_of_countries_by_carbon_dioxide_emissions , accessed February 22, 2013.

(Table 1.3) offers some hope; the world has reduced its CO_2 emissions per unit of gross domestic product (a standard measure of economic output) by 43 percent over a recent 15 years period. As an example, in one Swedish city, Vaxjo, between 1993 and 2008, gross domestic product grew 30 percent while CO_2 emissions fell by 20 percent[1], through a combination of renewable energy, energy efficiency retrofits, a focus on encouraging bicycle travel and use of public transportation, and many other smaller measures that created a cumulative large effect. (Nevertheless, because of rapid economic growth in various countries, total world carbon emissions still increased by 36 percent over that period.)

(Table 1.4) shows the level of emissions in 2005 and two likely scenarios through 2050, assuming a 37 percent growth in world population.

To meet the demands of the "2050 Stabilization Scenario," carbon emissions would be only 50 percent of 2005 levels, implying a massive reduction in fossil fuel energy use through reliance on renewable energy, energy conservation, and carbon sequestration. To accommodate anticipated world population growth, per capita emissions in 2050 would fall by about 65 percent from 2005 levels.

Table 1.4 Global energy and carbon dioxide emissions, 2005, and possible scenarios for 2050.
Source: Yudelson, J. (2010), Greening existing buildings, McGraw-Hill books, USA

Indicator	2005 (Actual)	2050 (Business As Usual) BAU	2050 (Stabilization Scenario)
CO2 emissions (Gt)	28	62	14
World population (billions)	6.5	9.3	9.3
Change in CO2 emissions	-	+130%	-50%
CO2 emissions per capita (metric tons)	4.3	6.7	1.5

[1] Yudelson, J. (2010), Greening existing buildings, McGraw-Hill books, USA.

1.1.2.4 Green House Gas (GHG) Emissions in Egypt

Egypt is 92% dependent on fossil fuels (oil and natural gas)[1]. The energy sector is the main source of GHG emissions, the agricultural sector is the second largest GHG source, followed by industrial emissions of CO_2 from the steel and cement industries.See (Fig. 1.18). From 2000 till 2010 there has been an Emission Increasing Rate: 5.1 %, Egypt Carbon Dioxide Emissions is at a current level of 223.85M, up from 212.60M one year ago. This is a change of 5.29%.[2] (Fig. 1.19). Population Increasing Rate: 1.7 – 2.3 %[3].

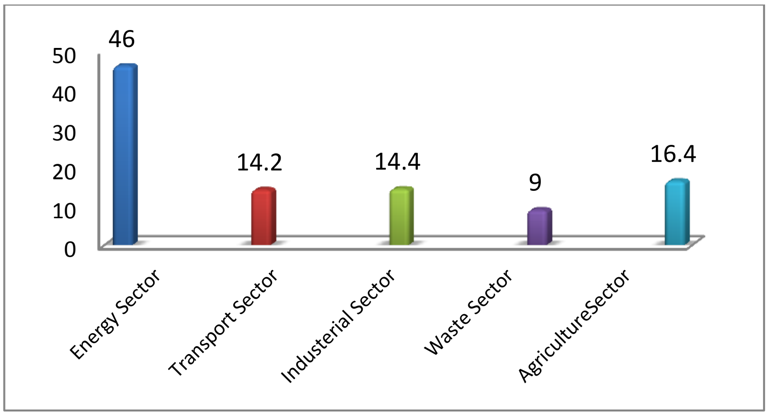

Figure 1.18 Contribution of GHG emissions by Sector (2010)
Source: Egyptian Environmental Affairs Agency , URL: http://www.eeaa.gov.eg/english/reports/CC/Estimated%20GHG%20Inventory%20in%20Egypt.pdf , accessed February 22, 2013.

Egypt contributes to the world CO2 emissions by 0.7%[4], occupying rank 27 globally, rather than it is not a developed country; this is mainly due to the uncontrolled burning of agricultural wastes, cement and brick industries, and the huge number of wrecked cars that are cruising big cities. These factors collaborate to create the phenomenon widely known in Cairo to be "the Black Cloud" which reoccurs every year in falls and early winters[5].

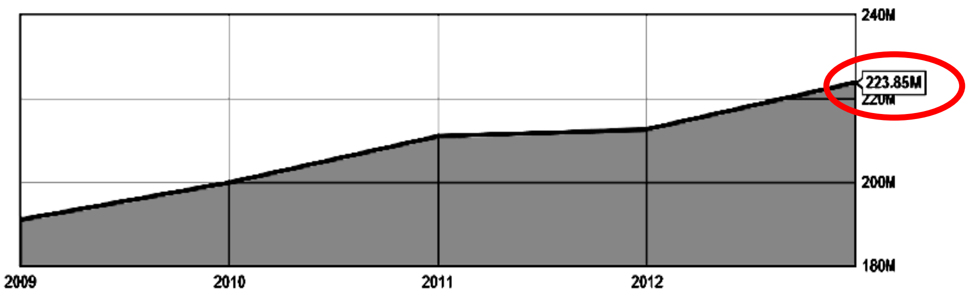

Figure 1.19 Egypt Carbon Dioxide Emissions Chart (**Updated:** Jun 27, 2013).
Source: URL: http://ycharts.com/indicators/egypt_carbon_dioxide_emissions , accessed February 23, 2013.

[1] Egyptian Environmental Affairs Agency (EEEA), URL: http://www.eeaa.gov.eg/ecc/ClimateGHG.htm , accessed February 22, 2013.
[2] URL: http://ycharts.com/indicators/egypt_carbon_dioxide_emissions , accessed September 23, 2013.
[3] Egyptian Environmental Affairs Agency , URL: http://www.eeaa.gov.eg/english/reports/CC/Estimated%20GHG%20Inventory%20in%20Egypt.pdf , accessed February 22, 2013.
[4] URL: http://en.wikipedia.org/wiki/List_of_countries_by_carbon_dioxide_emissions#cite_note-11 , accessed February 23, 2013.
[5] El Dahan, Maha (2011), Caching in on Egypt's Black Cloud, URL: http://af.reuters.com/article/topNews/idAFJOE7A80HE20111109 (accessed November 9, 2012)

1.1.3 Climate change and buildings

Buildings provide an interface between the outdoor environment, which is subject to climate change, and the indoor environment, which needs to be maintained within a range that keeps the building occupants safe and comfortable, and which is suitable for any key processes that are taking place within the building[1].

1.1.3.1 The Effect of Climate Change on Buildings

The columns in (Figure 1.20) contain, from left to right: (a) climate change as a driving force; (b) the environmental effects of climate change that pertain to buildings; (c) the likely impact of those environmental effects on specific buildings; and (d) potential consequences for building occupants and key processes taking place in buildings. [2]

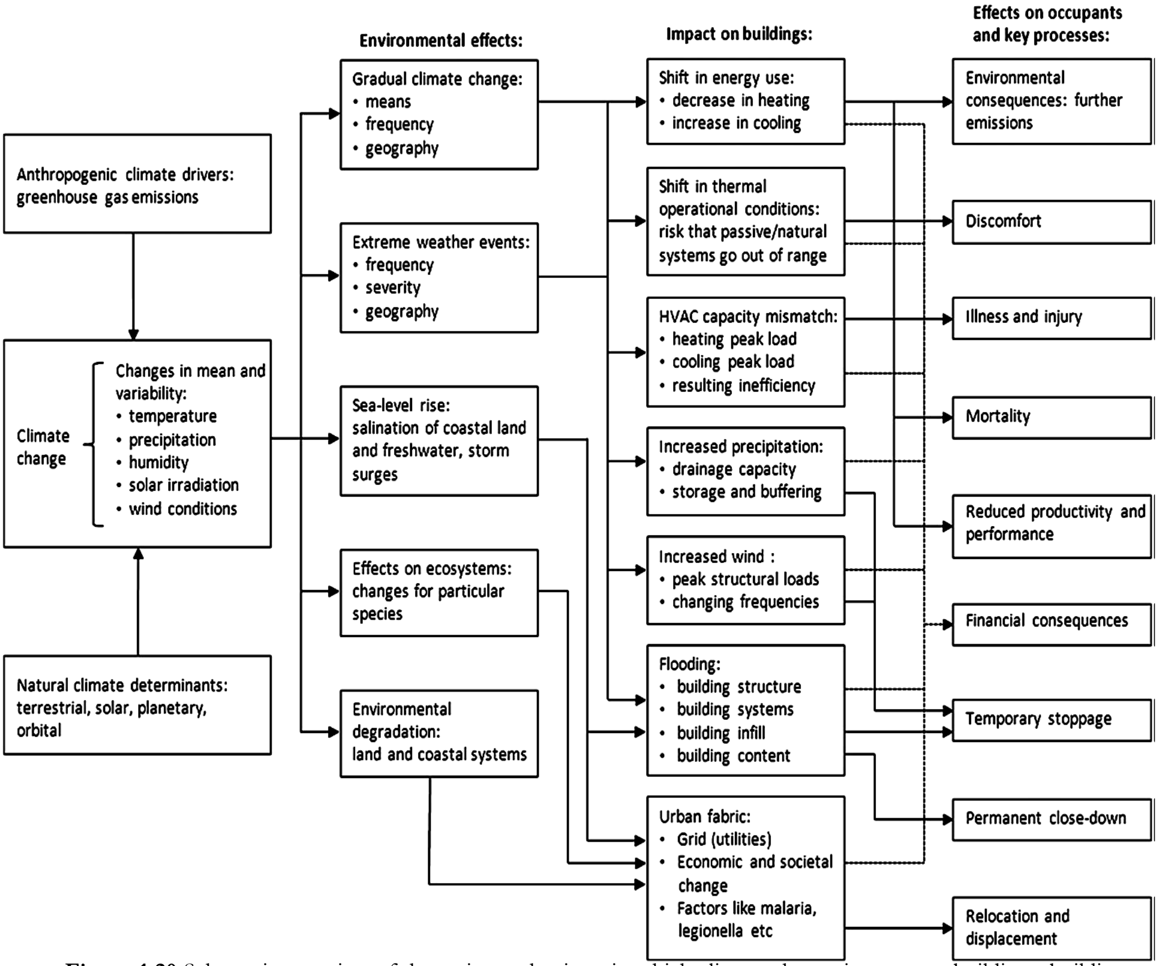

Figure 1.20 Schematic overview of the main mechanisms in which climate change impacts on buildings, building occupants, and the key processes taking place in buildings. Depicting the relation between climate change and health effects, but expanded to include the building as interface, as well as comfort and Key processes taking place in buildings.
Source: de Wilde, P., Coley, D., (2011), The implications of a changing climate for buildings, Building and Environment Journal, Volume 55, September 2012, Page 2. Online version via ScienceDirect. accessed on August 11, 2012.

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[1] de Wilde, P., Coley, D., (2011), The implications of a changing climate for buildings, Building and Environment Journal, Volume 55, September 2012, Pages 1–2. Online version via ScienceDirect. accessed on August 11, 2012. URL: http://www.sciencedirect.com/science/article/pii/S0360132312001060 .
[2] Ibid, P1-2.

Climate change drives changes at a regional or local level. In (Figure 1.20) these are presented as environmental effects. From a building point of view, these effects range from slight gradual changes (for example a slight rise in average ambient temperature) to extreme events (for example flooding). Additionally, climate change might impact the context in which buildings are positioned. For instance, in terms of ecosystems this might have implications for specific animal or plant species, and thus for land use (for example farming or the spread of disease) and the urban fabric (for example consequences leading to economic and societal change).

1.1.3.2 The Contribution of Buildings to Climate Change and Carbon Dioxide Emissions

Contrary to common belief, the term architecture does not refer simply to the end product. It involves a long process with various stages; each of these stages has its impact to climate change and carbon dioxide emissions.

- **Complex Building Construction Process and Life Cycle of Buildings**

The construction process (Figure 1.21) starts with mining, drilling, and extracting the materials. Excavating minerals ores for construction requires the stripping of topsoil and rocks. This separation requires energy primarily from fossil-based resources, an activity that can cause much greater harm than the benefits of excavation[1]. This stage of the construction process is especially harmful for the relevant ecosystem, as it initiates the destruction of the existing settlements, plant and animal habitats, land erosion, water pollution, and deformation.

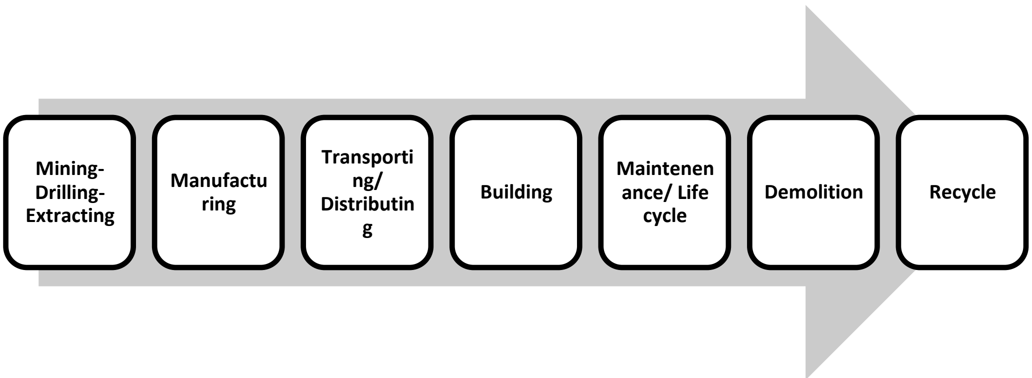


Figure 1.21 The construction Process.
Source: Attmann, O., (2010), Green Architecture Advanced technologies and Materials, McGraw Hill books, United States of America.

Manufacturing of construction materials requires more energy, produces waste, and pollutes natural resources. The distribution and transportation of construction materials and technology also impacts the environment by using additional energy to transport them from manufacturing point to the point of assembly and building.

Construction activities necessary to complete a building contribute to air pollution, including: land clearing, engine operations, demolition, burning, and working with toxic materials. In fact all construction sites generate high level of pollutants, mostly

[1] Attmann, O., (2010), Green Architecture Advanced technologies and Materials, McGraw Hill books, United States of America.

from concrete, cement, wood, stone, and silica. Construction dust in particular is a serious issue. (Table 1.5).

Table 1.5 Environmental impacts of construction process stages
Source: Attmann, O., (2010), Green Architecture Advanced technologies and Materials, McGraw Hill books, United States of America.

Activity	Energy Consumed	Environmental impacts
Mining/Drilling/Extracting		• Deforestation • Destruction of plant and animal habitat • Existing settlements • Land erosion • Water pollution
Manufacturing/Assembly	Embedded or Embodied Energy	• Energy consumption (impacts of producing energy) • Waste generation
Transportation/Distribution	Grey Energy	• Energy consumption • CO_2 emission • Resource use (packaging)
Building	Induced Energy	• CO_2 emission • Pollution and radiation from the materials and technologies (exposed to chemical and climatic activities) • Pressure and damage
Maintenance/Life cycle	Operational Energy	• Energy consumption • CO_2 emission • Resource use and replacement • Wear and tear • Chemical contamination (material loss- from roofs, pipes) • Water pollution
Demolition		• Chemical contamination • Toxicity • Environmental poisons
Recycle/waste		• Landfill decomposition • Groundwater contamination • Methane gas production

The building and construction sector takes the largest share of natural resources, both for land use and material extraction. Buildings use 50 percent of the world's raw materials[1] - many of which are non renewable resources- and they are responsible for 36 percent of all waste generated worldwide[2]. Buildings also account for one third of global greenhouse gas (GHG) emissions, both in developed and developing countries. In absolute terms, the Fourth Assessment Report of the IPCC estimated building-related GHG emissions to be around 8.6 million metric tons CO_2 eqv in 2004. Carbon dioxide emissions, including through the use of electricity in buildings, grew from 1971 to 2004 at an annual rate of 2%, – about equal to the overall growth rate of CO_2 emissions from all uses of energy. CO_2 emissions for commercial buildings grew at 2.5% per year and at 1.7% per year for residential buildings during this period[3].

In the United States many studies have indicated that all forms of buildings, residential and non-residential, contribute nearly 50 percent of the total carbon

[1] Attmann, O., (2010), Green Architecture Advanced technologies and Materials, McGraw Hill books, United States of America.
[2] Ibid.
[3] URL:http://www.ipcc.ch/publications_and_data/ar4/wg3/en/ch6s6-2.html , accessed October 20, 2012.

emissions[1] (Figure 1.22). This use is split about half between residential uses and half non-residential, including industrial, commercial, recreational, retail, education, and all the various types of buildings and uses.

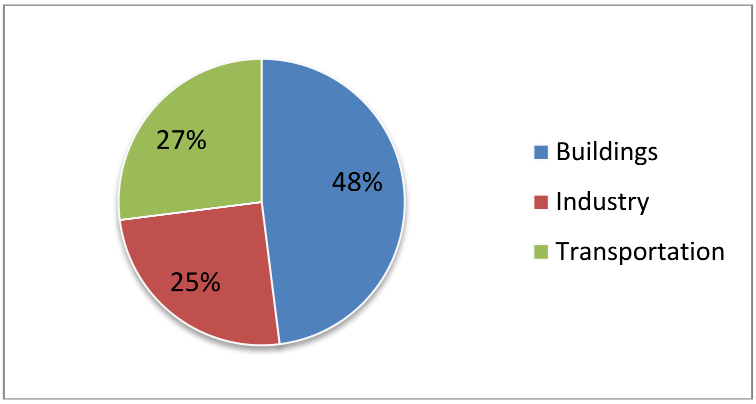


Figure 1.22 Residential and non residential buildings directly and indirectly account for almost 50 percent of U.S. carbon dioxide emissions.
Source: Yudelson, J. (2010), Greening existing buildings, McGraw-Hill books, USA.

By far, the greatest proportion of energy is used during a building's operational phase. Though figures vary from building to building, studies suggest that over 80 percent of greenhouse gas emissions take place during this phase to meet various energy needs such as heating, ventilation, and air conditioning (HVAC), water heating, lighting, entertainment and telecommunications[2]. A smaller percentage, generally 10 to 20 percent, of energy is consumed in materials manufacturing and transport, construction, maintenance and demolition. Governments can therefore achieve the greatest reductions in greenhouse gas emissions by targeting the operational phase of buildings.

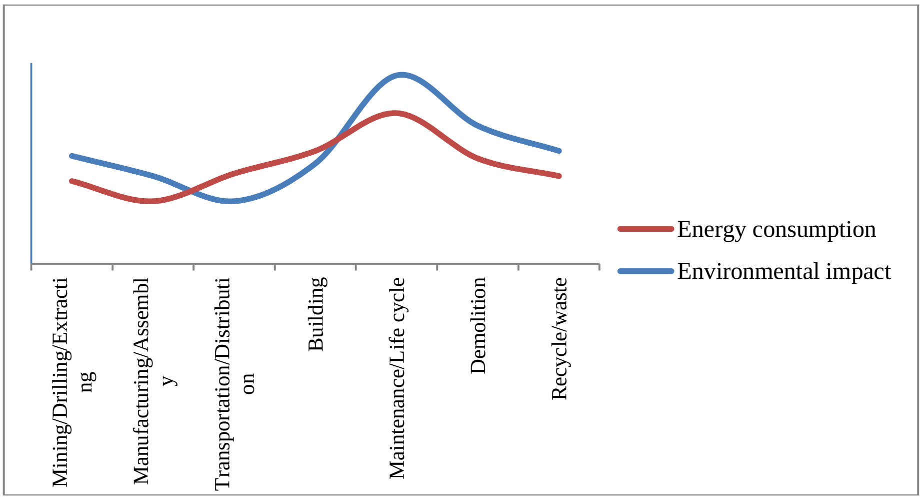


Figure 1.23 The majority of environmental impact and energy consumption takes place during life cycle phase (operational phase).
Source: Attmann, O., (2010), Green Architecture Advanced technologies and Materials, McGraw Hill books, United States of America.

[1] Yudelson, J. (2010), Greening existing buildings, McGraw-Hill books, USA.
[2] Huovila, P., Juusela, M., Melchert, L., Pouffary, S., Cheng, C., Urge-Vorsatz, D., Koeppel, S., Svenningsen, N., and Graham, P. (2009), Buildings and Climate Change Summary for Decision-Makers, United Nations Environment Programme UNEP, Paris. URL: http://www.unep.org/sbci/pdfs/SBCI-BCCSummary.pdf, accessed June 6, 2012.

(Figure 1.24) shows Life Cycle Approach linking emissions to the different stages of a building's life.

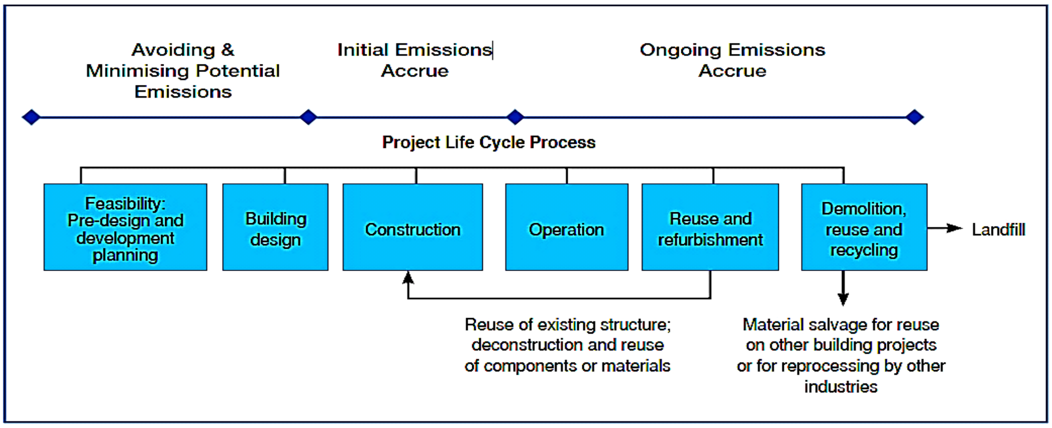


Figure 1.24 Life cycle phases of buildings and emissions.
Source: Graham, 2003.

As countries develop, and traditional fuels are complemented by and replaced by electricity and gas, the potential for greenhouse gas emissions increases profoundly for two main reasons; access to electricity can stimulate demand for electrical appliances, thereby increasing demand for energy over and beyond the level it had been before electricity was available. More significantly, the generation of electricity itself is a major source of GHG emissions, unless it comes from renewable sources such as hydroelectric power plants and solar energy, or from nuclear energy[1].

The energy consumption during the operational phase of a building depends on a wide range of interrelated factors, such as climate and location; level of demand, supply, and source of energy; function and use of building; building design and construction materials; and the level of income and behavior of its occupants. Climatic conditions, and the type of environment in which a building is found, affect every aspect of a building's energy use over its lifetime. Most countries, and even states within countries, have multiple climate zones[2].

1.1.4 Building Sector is a Major Part of the Mitigation of Green House Gas Emissions Strategies

The Building Sector has the largest potential for significantly reducing greenhouse gas emissions compared to other major emitting sectors. This potential is relatively independent of the cost per ton of CO_2 equ. achieved. (Figure 1.25), from the Intergovernmental panel on climate change (IPCC)'s Fourth Assessment Report, shows that the potential for greenhouse gas reductions from buildings is common to both developed and developing countries, as well as countries with economies in transition. What this means is that with proven and commercially available technologies, the energy consumption in both new and existing buildings can be cut by an estimated 30 to 80 percent[3] with potential net profit during the building life-

[1] Huovila, P., Juusela, M., Melchert, L., Pouffary, S., Cheng, C., Urge-Vorsatz, D., Koeppel, S., Svenningsen, N., and Graham, P. (2009), Buildings and Climate Change Summary for Decision-Makers, United Nations Environment Programme UNEP, Paris. URL: http://www.unep.org/sbci/pdfs/SBCI-BCCSummary.pdf, accessed June 6, 2012.
[2] Ibid.
[3] Ibid.

span, about 30 percent of the projected global greenhouse gas emissions in the building sector can be avoided by 2030 with net economic benefit t. According to the report, limiting CO2 emissions would also improve indoor and outdoor air quality, improve social welfare, and enhance energy security.

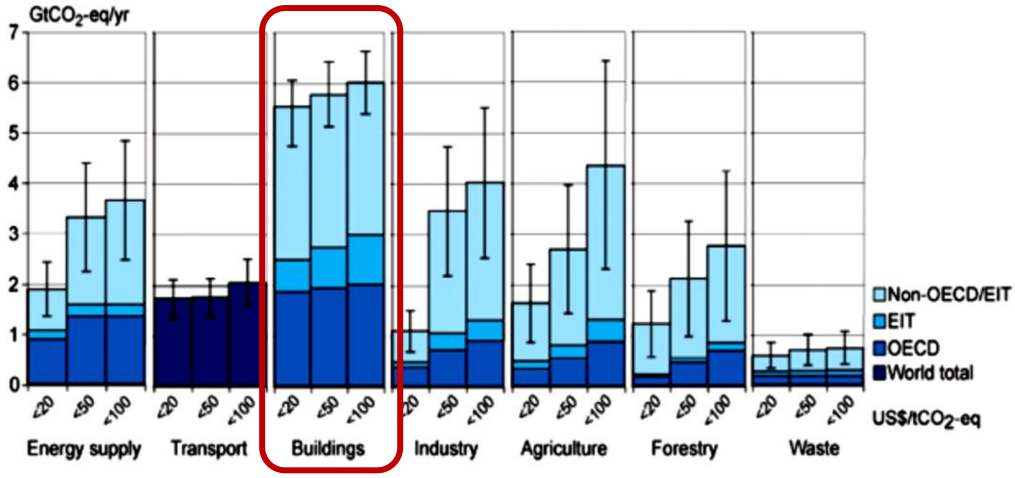


Figure 1.25 Estimated economic mitigation potential by sector and region using technologies and practices expected to be available in 2030. The potentials do not include non-technical options such as lifestyle changes. **Source:** IPCC, 2007: Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

In recent times, the lifespan of a typical building is estimated at between 40 to over 120 years[1] as illustrated in (Figure 1.26). It is apparent that buildings last much longer than appliances. The long lifespan of buildings is a key consideration to the achievement of significant energy efficiency efforts and reduction of greenhouse gas emissions in the building stock (both new and existing) by 2050.

The United Nations Environment Programme (UNEP) has stated that:

> "'No other sector has such a high potential for drastic emission reductions' and that the built environment offers some of the most cost effective and expedient ways to contribute to climate change mitigation."[2]

[1] Jennings, M., Hirst, N., Gambhir, A., (2011), REDUCTION OF CARBON DIOXIDE EMISSIONS IN THE GLOBAL BUILDING SECTOR TO 2050, Grantham Institute for Climate Change
Report GR3, Imperial College London.
[2] Comstock, M., Garrigan, C., Pouffary, S. (2012), Building Design and Construction: Forging Resource Efficiency and Sustainable Development, UNEP report. URL: https://www.usgbc.org/ShowFile.aspx?DocumentID=19073 , accessed October 30, 2012.

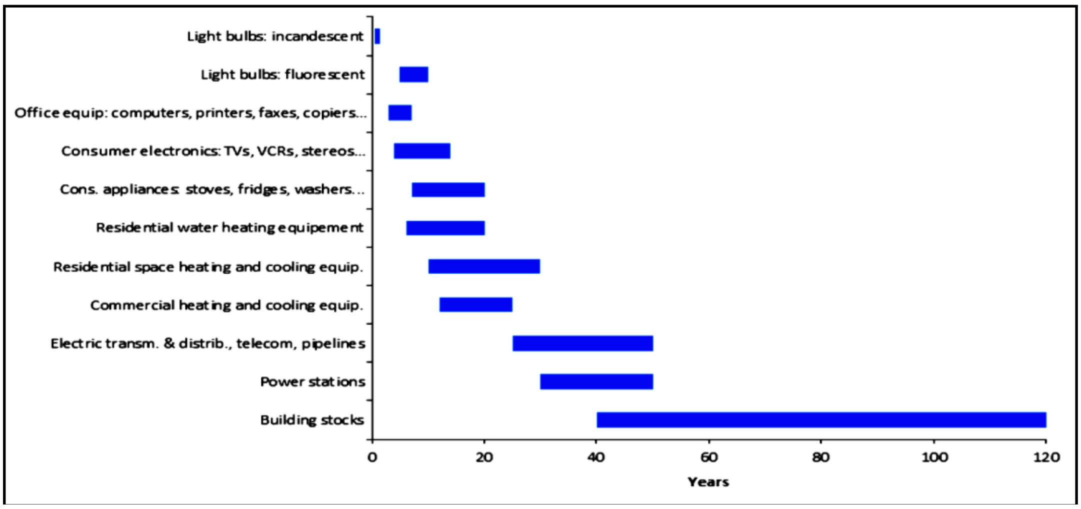
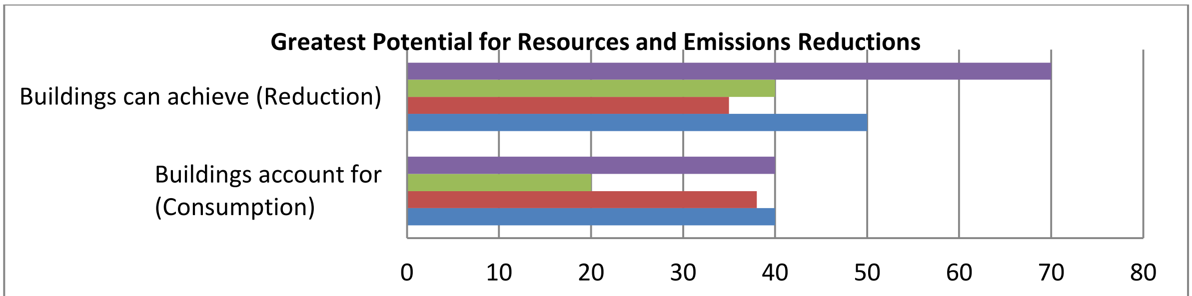


Figure 1.26 Typical lifespan of building appliances, services and stock.
Source: Jennings, M., Hirst, N., Gambhir, A., (2011), REDUCTION OF CARBON DIOXIDE EMISSIONS IN THE GLOBAL BUILDING SECTOR TO 2050, Grantham Institute for Climate Change, Report GR3, Imperial College London.

According to a global analysis of the buildings sector, McGraw-Hill Construction concludes that green buildings have the potential to reduce energy use by 30-50 per cent[1], CO2 emissions by 35 per cent, waste outputs by 70 per cent and water usage by 40 per cent.



	Buildings account for (Consumption)	Buildings can achieve (Reduction)
Solid Waste In Developed Countries	40	70
Water Use	20	40
Global GHG Emissions	38	35
Global Energy Use	40	50

Figure 1.27 Building sector potentials
Source: Comstock, M., Garrigan, C., Pouffary, S. (2012), Building Design and Construction: Forging Resource Efficiency and Sustainable Development, UNEP report. URL: https://www.usgbc.org/ShowFile.aspx?DocumentID=19073 , accessed October 30, 2012.

1.1.5 Buildings Sector 2050 Scenarios

A report by the International Energy Agency (IEA) offers two different scenarios and strategies to 2050. The scenarios are key element of the analysis. They serve with their more long-term vision up to 2050 as input to develop technology roadmaps which try to identify the short and medium-term technology policy needs to achieve the necessary long-term deployment levels of low-carbon technologies. Energy Technology perspective scenarios (ETP) are:

[1] Ibid.

- Baseline scenario:
    - Following the World Energy Outlook 2009 Reference Scenario
- BLUE scenario:
    - Target oriented: 50% reduction of energy related CO_2 emissions by 2050 compared to 2005[1]

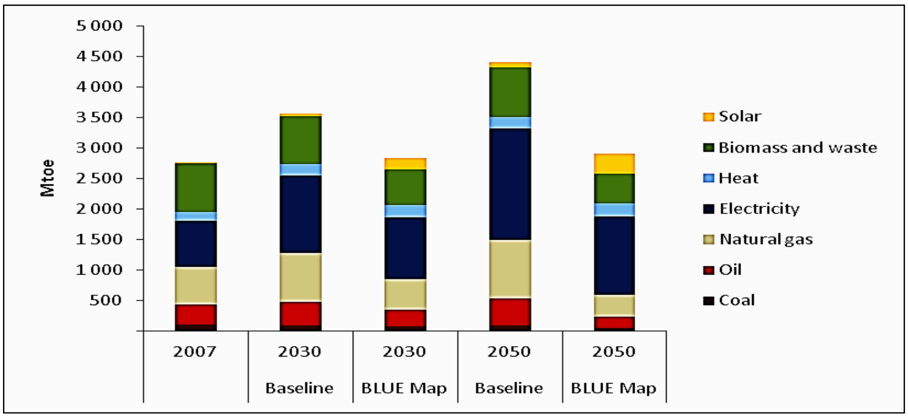


Figure 1.28 Energy consumption by fuel and by scenario. Energy consumption in the building sector is 5% higher in 2050 than in 2007 in the BLUE Map Scenario.
Source: International Energy Agency (IEA).

In the Baseline scenario, which assumes no new policies are put in place, Global final energy demand in buildings increases by 60% from 2007 and 2050. This increase is driven by a 67% rise in the number of households, a near tripling of the service sector building area, higher ownership rates for existing energy-consuming devices and increasing demand for new types of energy services.

The BLUE Map scenario charts an entirely different future for the building sector, in which aggressive policy action reduces energy consumption and CO2 and improves energy security. In this scenario, global building-sector energy consumption is reduced by around one-third of the Baseline scenario level in 2050. Energy consumption in 2050 is only 5% higher than in 2007 despite the same increases in the macro-economic variable than under a baseline scenario.

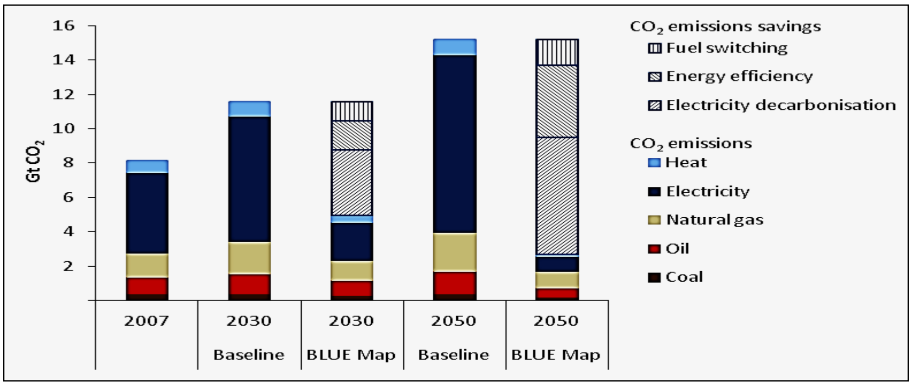


Figure 1.29 CO_2 emissions. In the BLUE Map scenario, buildings sector CO_2 emissions in 2050 are 83% lower than in the Baseline scenario.
Source: International Energy Agency (IEA).

[1] Trudeau, N., (2010), Energy Technology Perspectives 2010 Findings, International Energy Agency Workshop findings. URL: https://workspace.imperial.ac.uk/climatechange/Public/Events/Buildings%20Workshop/presentations%20from%20buildings%20workshop.zip , accessed October 30, 2012.

In the Baseline scenario, the buildings sector emits 15.2 GT CO2 in 2050, a 87% increase over 2007 levels. The BLUE Map scenario reduces CO2 emissions from the buildings sector by 12.6 GT CO2 from the Baseline scenario level in 2050, with 6.8Gt CO2 of this reduction being attributable to the decarbonisation of the electricity and heat sectors. As a result, buildings sector CO2 emissions are 83% lower than the Baseline level in 2050. This reduces the direct and indirect CO2 emissions attributable to the buildings sector to 2.6 Gt in 2050, one-third of the 2007 level.

Key Technologies for the Buildings Sector in BLUE Map:

The BLUE Map scenario is based on the large-scale deployment of a number of technology options for the buildings sector including:

- Tighter building standards and codes for new residential and commercial buildings
- Large-scale refurbishment of residential buildings in OECD
- Highly efficient heating, cooling and ventilation systems
- Improved lighting efficiency
- Improved appliance efficiency
- Widespread deployment of CO2-free technologies[1]

1.2 The 2030 Challenge

Buildings are the major source of global demand for energy and materials that produce by-product greenhouse gases (GHG). Slowing the growth rate of GHG emissions and then reversing it is the key to addressing climate change. To accomplish this, The 2030 Challenge asking the global architecture and building community to adopt the following targets:

- All new buildings, developments and major renovations shall be designed to meet a fossil fuel, GHG-emitting, energy consumption performance standard of 60% below the regional (or country) average/median for that building type[2].

- At a minimum, an equal amount of existing building area shall be renovated annually to meet a fossil fuel, GHG-emitting, energy consumption performance standard of 60% of the regional (or country) average for that building type.

- The fossil fuel reduction standard for all new buildings and major renovations shall be increased to:

  - 70% in 2015
  - 80% in 2020
  - 90% in 2025
  - Carbon-neutral in 2030 (using no fossil fuel GHG emitting energy to operate).

[1] Trudeau, N., (2010), Energy Technology Perspectives 2010 Findings, International Energy Agency Workshop findings. URL: https://workspace.imperial.ac.uk/climatechange/Public/Events/Buildings%20Workshop/presentations%20from%20buildings%20workshop.zip , accessed October 30, 2012.
[2] URL: http://architecture2030.org/2030_challenge/the_2030_challenge , accessed October 30,2012.

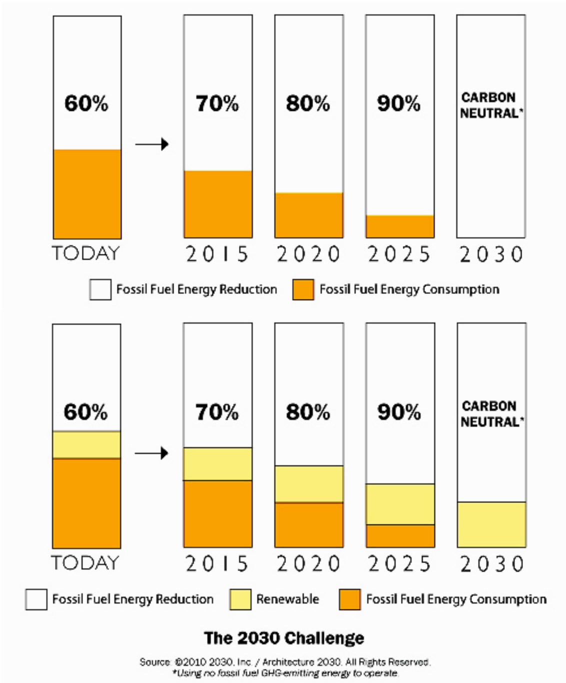


Figure 1.30 The 2030 Challenge sets achievable and affordable targets to dramatically reduce the energy consumption of the Building Sector by 2030 and beyond.
Source: URL: http://architecture2030.org/2030_challenge/the_2030_challenge , accessed October 30,2012.

These targets may be accomplished by implementing innovative sustainable design strategies, generating on-site renewable power and/or purchasing (20% maximum) renewable energy[1].

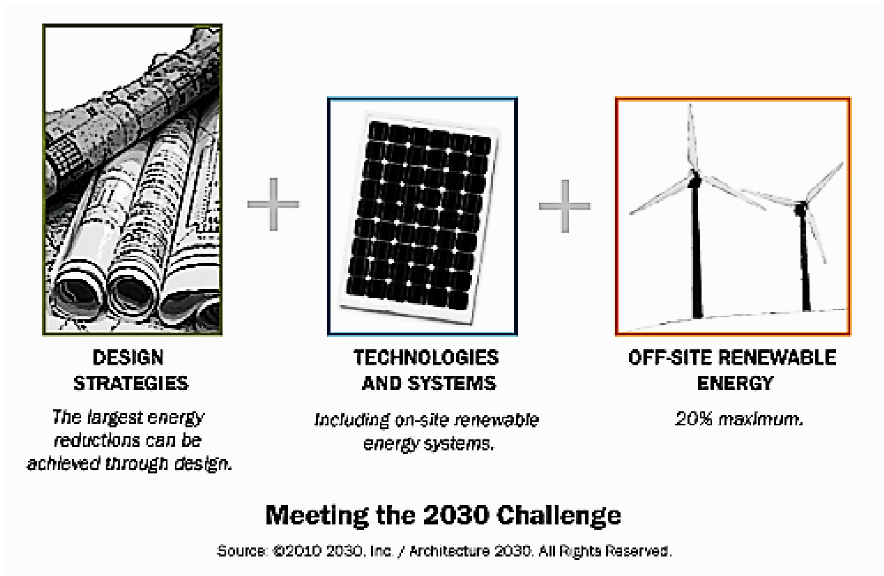


Figure 1.31 Through design strategies, technologies and system, and off-site renewable energy, buildings can be designed and constructed today that meet the 2030 Challenge targets.
Source: URL: http://architecture2030.org/2030_challenge/the_2030_challenge , accessed October 30, 2012.

[1] URL: http://architecture2030.org/2030_challenge/the_2030_challenge , accessed October 30,2012.

1.3 Responsibility of Architecture towards Environment and Climate Change

Due to its role, volume, and impact, it is evident that architecture has a direct responsibility to the immediate (city) ecosystem.

Architecture's main responsibility is not to pick and choose the "best" solution but to incorporate all options that might generate workable solutions. Clearly, there is an urgent need of a new way of thinking and designing. In order to fully address responsibilities, architecture should abandon old methods, technologies, and materials and push for a new paradigm shift. The design objectives should be based on sustainable, ecological, and performance criteria rather than trends and aesthetics; be environmentally conscious rather than market-driven; and be inherently resourceful rather than globally destructive.

1.4 Conclusion

The Global carbon problem and Climate change increased public focus on sustainability and Energy Efficiency.

A shift to green buildings and sustainable development should take place as soon as possible in developed and developing countries, for saving energy and mitigation of CO_2 emissions, The Building Sector has the largest potential for delivering long-term, significant and cost-effective greenhouse gas emissions. Governments can achieve the greatest reduction of GHG emissions by targeting the operational phase of the buildings ……. In other words "**Existing Buildings**".

The building sector is the problem and the solution at the same time for the climate change and global carbon problem. (Figure 1.32).

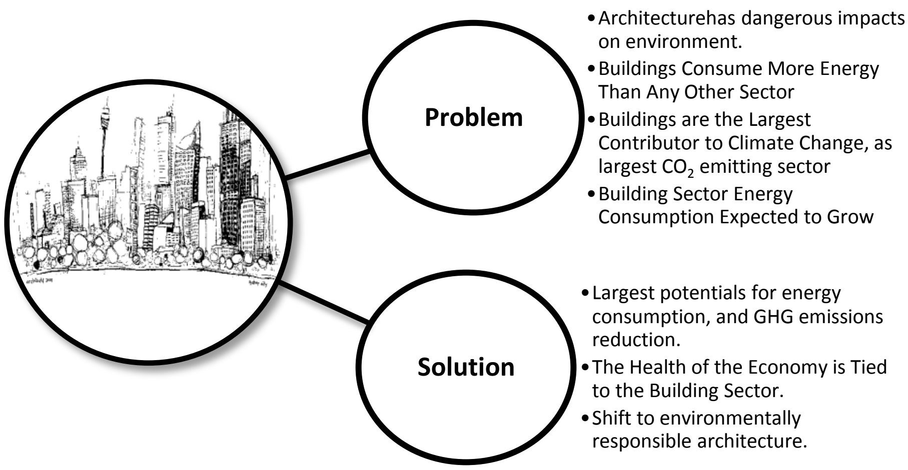


Figure 1.32 Building sector, The problem, and the solution.
Source: The Researcher.

Introduction

Green buildings are the ethical response to both global and local environmental and resource issues, the ‘right’ way to approach construction. A typical, code compliant building makes minimal efforts to address energy and water issues and totally ignores materials waste, impacts on the construction site and any other issue not specifically covered in the building codes. As has often been noted, if these buildings were built any cheaper, they would be against the law. Green buildings take a far different approach[1].

Environmental impacts and resource consumption are of primary importance in the design and construction process for a green building. The entire life cycle of the building and its constituent components are carefully considered. Emphasis is on renewable resources for energy systems; recycling and reuse of water and materials; integration of native and adapted species for landscaping; passive heating, cooling, and ventilation; and a wide range of other approaches that minimize environmental impacts and resource consumption[2].

Green buildings make economic sense, not always on a capital or first cost basis, but virtually always on a life cycle basis. However most of the key features of a green building will provide a payback on their original investment within a relatively short time. As energy and water prices rise due to increasing demand and diminishing supply, the payback period will become much shorter.

Green buildings address the spotty performance of conventional buildings with respect to human health. There is ample evidence that on the order of 40% of all illnesses can be traced to buildings and homes where people live, work, or attend school, church or sporting events[3]. Conventional construction, unless forced to by lawsuits, generally ignores issues of Sick Building Syndrome (SBS) or Building Related Illness (BRI). Green buildings meet the challenges of building health directly and provide several layers of consistent approaches that promote occupant health.

This chapter deals with Green Architecture, its definitions, principles, and rating systems (Assessment Tools) all over the world –focusing on the existing buildings and operational phase ratings-, mentioning the new Egyptian rating system named GREEN PYRAMID RATING SYSTEM (GPRS) compared to other rating systems.

2.1 Green Architecture

Green is an abstract concept, which requires the inclusion of terms: Sustainability, Ecology, and Performance. For instance, a building can be sustainable but not ecological or green, whereas a green building must be a combination of sustainable, ecological, and performative. The level of greenness is determined based on the level of interaction of these three categories (Figure 2.1).

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[1] Kibert, C., (2004), GREEN BUILDINGS: AN OVERVIEW OF PROGRESS, JOURNAL OF LAND USE, Vol: 19:2. URL: http://law-wss-01.law.fsu.edu/journals/landuse/vol19_2/kibert2.pdf, accessed November 9, 2012.
[2] Ibid, P 495.
[3] Ibid.

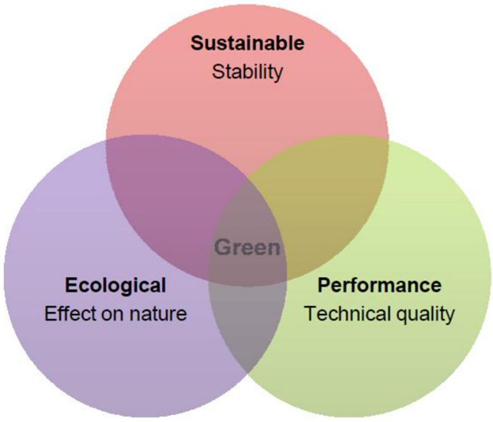

Figure 2.1 Relationship between the green categories.
Source: Attmann, O., (2010), Green Architecture Advanced technologies and Materials, McGraw Hill books, United States of America.

2.2 Green Building

According to the definition used by the U.S. Green Building Council, a green building is one that significantly reduces or eliminates negative impacts on the environment and on the building occupants[1].

Another definition by Donald L. House[2]: green building is a structure that is designed, built, renovated, operated, or reused in an ecological and resource-efficient manner. Green buildings are designed to meet certain objectives such as protecting occupant health; improving employee productivity; using energy, water, and other resources more efficiently; and reducing the overall impact to the environment[3].

According to the Governor's Green Government Council, a green building is one whose construction and lifetime of operation assure the healthiest possible environment while representing the most efficient and least disruptive use of land, water, energy and resources[4].

According to the Green Building Council in Australia a green building is one that incorporates design, construction and operational practices that significantly reduce or eliminate the negative impact of development on the environment and occupants[5].

2.3 Principles of Green Architecture

The principles of green building are simple: reduce energy consumption, draw on renewable resources where practical, conserve water, promote the best use of building

[1] Hunnicutt, S., (2007), A "GREEN BUILDING" IS NOT NECESSARILY GREEN, Chastain-Skillman, Inc., 2nd quarter 2007 issue of Consultant's Update, URL: http://www.chastainskillman.com/downloads/articles/GreenBuilding.pdf , accessed November 09,2012.
[2] Donald L. House has more than 15 years' experience in all aspects of environmental, emergency response and health industries. Donald currently works for MAPEI as its Manager of Regulatory
Affairs, providing regulatory oversight and support for all of MAPEI's locations in the Americas along with overseeing MAPEI's LEED Program since 2000.
[3] House, D., (2006), The Basics of Green Building and LEED, MAPEI Corporation. URL: http://www.guaranteedsupply.com/download-files/BasicsOfGreenBuildingAndLEED-MAPEI.PDF , accessed November 7, 2012.
[4] Governor's green government council, WHAT IS A GREEN BUILDING? Fundamental Principles of Green Building and Sustainable Site Design.
URL: http://www.epa.gov/statelocalclimate/documents/pdf/12_8_what_is_green_GGGC.pdf , accessed November 09, 2012.
[5] Jones, L., (2008), The Dollars and Sense of Green Buildings report Building the business case for green buildings in Australia, Green Building Council of Australia.

materials, encourage waste management, protect the building site, and focus on health and environmental quality, Maintenance, and holism (Figure 2.2).

All these principles can be achieved through special strategies and technologies, In a McGraw-Hill Construction survey; U.S. corporations revealed that green building strategies decrease operating costs by 8-9 per cent, increase building value 7.5 per cent, achieve a 6.6 per cent return on investment, increase occupancy ratio 3.5 per cent and increase rent ratios 3 per cent. Sixty-one per cent of corporate leaders surveyed also indicated that sustainability and a commitment to green building can lead to improved financial performance, competitive positioning and market differentiation[1].

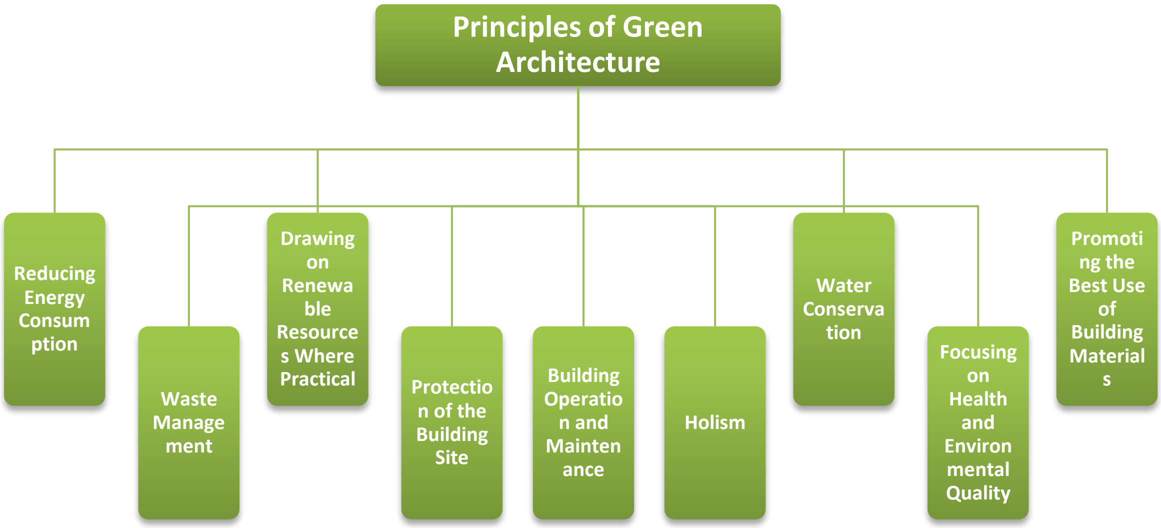

Figure 2.2 Principles of green architecture
Source: The Researcher

2.3.1 Reducing Energy Consumption "Energy Efficiency"

Green architecture focuses heavily on reducing energy consumption. In some cases, current technologies and practices exist that can easily and affordably reduce energy consumption in buildings by as much as 70%[2].This reduction in energy consumption clearly translates into real savings for homeowners as far as operating expenses are concerned. It also means that when homeowners attempt to sell their homes, they will likely obtain a higher resale value due to lower documented utility bills. A few of the techniques used in green buildings to help reduce energy consumption are passive solar design, light-colored roofing material, energy efficient appliances, low emissivity windows, improved insulation, efficient lighting, and energy efficient air conditioning and heating systems as will be mentioned in the next chapter.

2.3.2 Drawing on Renewable Resources Where Practical

It is important to understand that green architecture does not mean resource efficiency at any cost. In fact, it is just the opposite. Green architecture advocates often take a very common-sense approach to renewable resources, advocating their use only

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[1] Bernstein, H.M. and Bowerbank, A., (2008), *Global Green Building Trends: Market Growth and Perspectives from Around the World*. McGraw-Hill Construction. SmartMarket Report.
[2] Ankersen, T. et al, (2001), GREEN BUILDING: PRINCIPLES AND PRACTICE, CONSERVATION CLINIC UNIVERSITY OF FLORIDA LEVIN COLLEGE OF LAW. URL:http://www.law.ufl.edu/_pdf/academics/centers-clinics/clinics/conservation/resources/greenbldg_practices.pdf , accessed November 9, 2012.

when it is economically feasible to do so. Depending on factors such as tree coverage around the building, it may not be possible to utilize renewable resources, such as the sun, to help provide energy for a building. Where it is possible, the use of photovoltaic panels to provide energy to a home, solar thermal water heaters to heat a home's water, and passive solar design to utilize the sun's positive effects in the winter are all encouraged[1].

2.3.3 Water Conservation

Another major principle of green architecture is water conservation; by employing techniques such as the installation of low-flow fixtures and toilets. It also advocates the use of grey water systems and rainwater harvesting systems where possible. It addresses the problem of outdoor irrigation by encouraging the use of native plant species, xeriscaping, and "smart" irrigation systems[2].

2.3.4 Promoting the Best Use of Building Materials (Material Efficiency)

"*A building should be designed so as to minimize the use of new resources and, at the end of its useful life, to form the resources for other architecture"*[3]

Green architecture encourages builders to use the best materials available. This often involves the use of recycled content material such as recycled content carpet, insulation, and roofing material. Minimize the use of non-renewable construction materials and other resources such as energy and water through efficient engineering, design, planning and construction. It also involves the use of engineered lumber products, such as laminated wood, and the use of regionally produced products, such as lumber and concrete. Use dimensional planning and other material efficiency strategies. These strategies reduce the amount of building materials needed and cut construction costs[4].

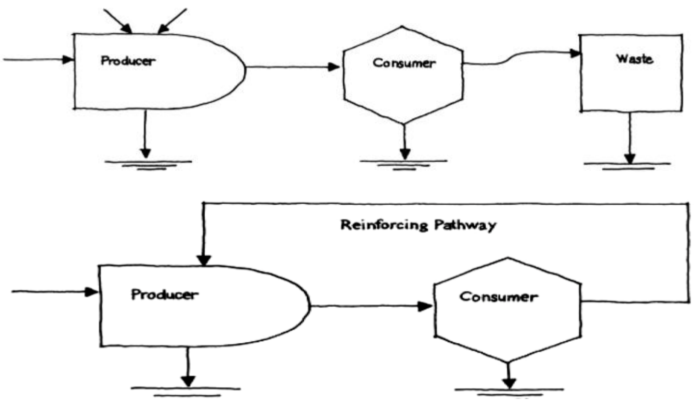

Figure 2.3 Top: inefficient Material Use. Bottom: Recyclable Material Use (Efficient)
Source: ElDemirdash, M., Mosallam, A., Bahnsawy, H., Fakhry, S., ElZahaby, K., (2009), Road to energy efficient and environmentally friendly affordable construction systems report, Kickoff meeting and round table on Egyptian green building council (EGBC) initiation, Housing and building national research center (HBRC), Cairo, Egypt.

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[1] Ankersen, T. et al, (2001), GREEN BUILDING: PRINCIPLES AND PRACTICE, CONSERVATION CLINIC UNIVERSITY OF FLORIDA LEVIN COLLEGE OF LAW. URL:http://www.law.ufl.edu/_pdf/academics/centers-clinics/clinics/conservation/resources/greenbldg_practices.pdf , accessed November 9, 2012.
[2] Yudelson, J., (2007), Green building A to Z understanding the language of green building, NEW SOCIETY PUBLISHERS, Canada.
[3] Vale, R. and Brenda (1991), Principles of green architecture, Routledge Press, New York. p189.
[4] House, D., (2006), The Basics of Green Building and LEED, MAPEI Corporation. URL: http://www.guaranteedsupply.com/download-files/BasicsOfGreenBuildingAndLEED-MAPEI.PDF , accessed November 7, 2012, p.2-3.

2.3.5 Waste Management

The amount of waste produced by the construction industry constitutes a major source of all landfill materials. A 1998 report on construction and demolition (C&D) waste produced for the Environmental Protection Agency reported that such waste totaled over 136 million tons per year[1]. Green architecture encourages waste management on the job site by encouraging job-site recycling plans and the reuse, donation, and selling of excess materials. Green architecture also emphasizes waste management by the eventual homeowner. Builders are encouraged to install outdoor composting stations and built-in kitchen recycling centers.

2.3.6 Protection of the Building Site

Part of resource efficiency is conserving the outdoor environment. Green architecture encourages the use of erosion control site plans and promotes the protection of existing trees. For any given site, green architecture also encourages the saving and reusing of topsoil, the maximization of the overall amount of pervious surface, and the replanting or donating of removed vegetation.

Make more efficient use of space in existing occupied buildings, renovate and re-use existing vacant buildings, sites, and associated infrastructure and consider re-development of brown field sites. Design buildings and renovations to maximize future flexibility and reuse thereby expanding useful life.

Locate projects on sites away from wetlands, above the 100-year flood level, away from prime agricultural land and away from endangered or threatened species habitat.

Provide opportunities and building infrastructure for people to commute to work using public transit and bicycles. Manage landscaping and parking lots to reduce excessive areas of open pavement that cause heating of the area around a building in summer, leading to more air-conditioning use[2].

Evaluate each site in terms of the location and orientation of buildings and improvements in order to optimize the use of passive solar energy, natural day lighting, and natural breezes and ventilation.

2.3.7 Focusing on Health and Environmental Quality

"*A green architecture recognizes the importance of all the people involved with it"*[3]

A healthy indoor environment is just as important as a healthy outdoor environment. Green architecture principles seek to not only increase the comfort level in the home, but also to help contribute to a healthy overall environment through the selection and use of environmentally sensible materials, such as low VOC (Volatile organic compound) paints and solvent free, low toxic finishes. Other techniques are also encouraged, including moisture control measures, radon mitigation, and the installation of exhaust fans in garages, and central vacuum systems that vent to the exterior.

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[1] Ankersen, T. et al, (2001), GREEN BUILDING: PRINCIPLES AND PRACTICE, CONSERVATION CLINIC UNIVERSITY OF FLORIDA LEVIN COLLEGE OF LAW.
URL: http://www.law.ufl.edu/_pdf/academics/centers-clinics/clinics/conservation/resources/greenbldg_practices.pdf , accessed November 9, 2012.

[2] Yudelson, J., (2007), Green building A to Z understanding the language of green building, NEW SOCIETY PUBLISHERS, Canada, P 15-16.

[3] Vale, R. and Brenda (1991), Principles of green architecture, Routledge Press, New York. P190.

2.3.8 Building Operation and Maintenance

Green-building measures cannot achieve their goals unless they work as intended. Building commissioning includes testing and adjusting the mechanical, electrical, and plumbing systems to ensure that all equipment meets design criteria. It also includes instructing the staff on the operation and maintenance of equipment. Over time, building performance can be assured through measurement, adjustment, and upgrading. Proper maintenance ensures that a building continues to perform as designed and commissioned.

2.3.9 Holism

"All the green principles need to be embodied in a holistic approach to the built environment"[1]

All green principles that have been previously demonstrated cannot be easily embodied in a single building; rather it can be involved into an interaction of systems-systems of playing, living, and working- among buildings- that represented into built forms. On the other hand, green architecture includes not only buildings and its designs but also sustainable form of urban environment.

2.4 Green Architecture Assessment Tools

The development of building rating systems was the result of growing concerns in the building industry and management, in topics such as sustainability, building performance, environmental impact, energy, cost efficiency, and maintenance. The rating systems were a partial response to these issues, proposing quantifiable tools to evaluate and measure the level of a building's environmental performance.

Several countries created their own standards of building performance, evaluation, and rating systems, addressing a wide range of environmental issues (i.e., energy, design, construction, site, technologies, and materials), see (Figure 2.4).

Nation	Label	Nation	Label
Australia	Nabers / Green Star	Mexico	LEED Mexico
Brazil	AQUA / LEED Brasil	Netherlands	BREEAM Netherlands
Canada	LEED Canada / Green Globes / Built Green Canada	New Zealand	Green Star NZ
Czech Rep	SBToolCZ	Philippines	BERDE / Philippine Green Building Council
China	GBAS	Portugal	Lider A
Finland	PromisE	Taiwan	China Green Building Network
France	HQE	Singapore	Green Mark
Germany	DGNB / CEPHEUS	South Africa	Green Star SA
Hong Kong	HKBEAM	South Korea	KGBC
India	Indian Green Building Council (IGBC) / (GRIHA)	Spain	VERDE
Indonesia	Green Building Council Indonesia (GBCI) / Greenship	Switzerland	Minergie
Italy	LEED / Italy / Protocollo Itaca / GBCouncil Italia	United States	LEED / Living Building Challenge / Green Globes
Japan	CASBEE	UAE	Estidama
Jordan	EDAMA	UK	BREEAM
Malaysia	GBI Malaysia		

Figure 2.4 Some of the almost 60 countries that either have or are developing green building assessment systems.
Source: URL: http://media.johnwiley.com.au/product_data/excerpt/53/04709044/0470904453-113.pdf , accessed November 2, 2012.

[1] Ibid.

In 1981, the R-2000 building evaluation program was created as a partnership between the Canadian Home Builder's Association and Natural Resources Canada, promoting sustainable technologies in residential buildings[1]. In 1990, the Building Research Establishment's Environmental Assessment Method (BREEAM) was one of the first acknowledged rating systems to evaluate the sustainability of new office buildings in the United Kingdom[2]. In 1992, the U.S. Department of Energy launched the Energy Star Program[3]. In 1993, the U.S. Green Building Council (USGBC) was founded, and in 1998 they launched their Leadership in Energy and Environmental Design (LEED) pilot program[4]. Currently, there are more than two dozen building rating systems worldwide, and they can be broadly categorized into one of three systems:

- Decision-making support systems
- Performance based evaluation systems
- Whole building evaluation systems[5]

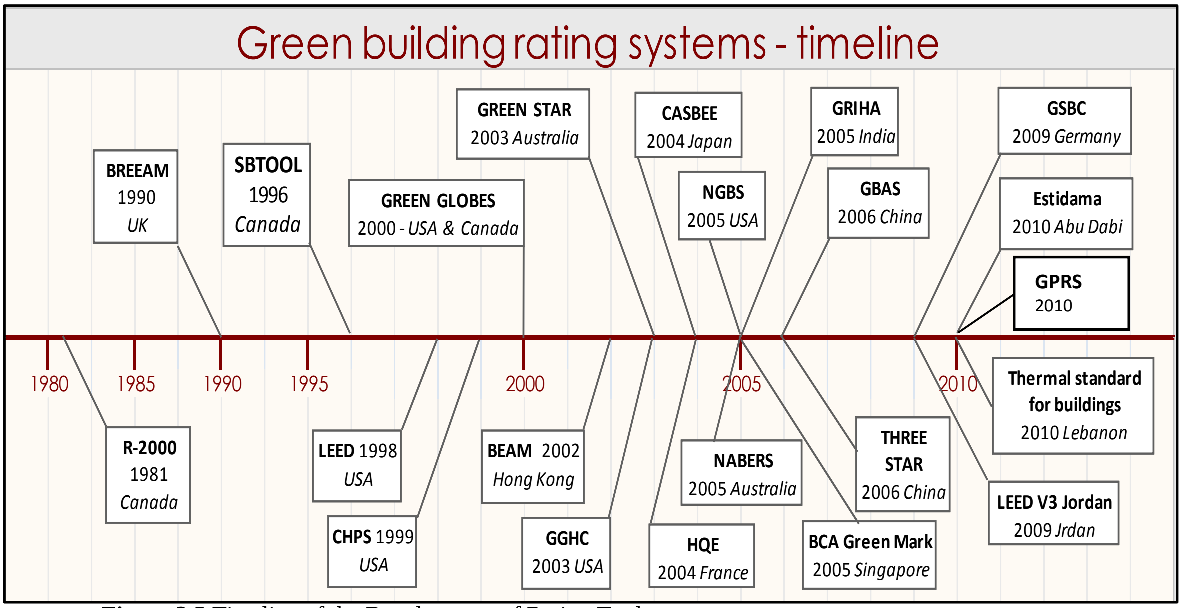

Figure 2.5 Timeline of the Development of Rating Tools.
Source: Younan, V., (2011), Developing a green building rating system for Egypt, A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Construction Engineering, The American University in Cairo, School of Sciences and Engineering.

Green building rating systems often use different evaluation criteria, methods, and procedures, ranging from scoring to categorization. As such, each system has its own advantages and disadvantages. Depending on the method used, individual points are either added up or initially weighted and then summed up to obtain the final result. The number of points is ranked in the rating scale, which is divided into different levels: The higher the number of points, the better the certification. Regardless of their differences, however, most of these systems utilize similar criteria to evaluate and rate green buildings, namely:

- Design
- Construction

[1] Attmann, O., (2010), Green Architecture Advanced technologies and Materials, McGraw Hill books, United States of America.
[2] Ibid.
[3] Ibid.
[4] Ibid.
[5] Ibid.

- Site
- Indoor air quality
- Environmental impact
- Technology
- Materials
- Energy and water consumption[1]

The certification process means quality assurance for building owners and users. Pike Research estimates that by 2020 green building certification programmes will certify 4.9 billion square meters[2]. Each rating system -as will be mentioned- encourages green building through a suite of sustainability strategies which promote energy efficiency, water conservation, indoor air quality, and more.

The (LEED- BREEAM- CASBEE- DGNB) systems are chosen to be reviewed because they are currently the most popular, influential and technically advanced rating tools available, on the other hand the (GPRS-ESTIDAMA) rating systems are chosen to be reviewed as an example from the Arab world rating systems.

2.4.1 LEED "Leadership in Energy and Environmental Design" (USA)

The (LEED) Green Building Rating System was developed by USGBC in 1998 and is currently the world's second most widely adopted method with 24,682 projects comprising 151,692,972 sq m certified in 120 counties at the time of writing[3]. The LEED is a voluntary, consensus-based standard to support and certify successful Green Building design, construction and operations. It guides architects, engineers, building owners, designers and real estate professionals to transform the construction environment into one of sustainability[4].

The rating system is organized into five different environmental categories: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Material and Resources, and two bonus credit categories:

- Innovation in design or innovation in operations credits address sustainable building expertise as well as design measures not covered under the five LEED credit categories. Six bonus points are available in this category.
- Regional priority credits address regional environmental priorities for buildings in different geographic regions. Four bonus points are available in this category[5], (Figure 2.6).

[1] Attmann, O., (2010), Green Architecture Advanced technologies and Materials, McGraw Hill books, United States of America.
[2] Comstock, M., Garrigan, C., Pouffary, S. (2012), Building Design and Construction: Forging Resource Efficiency and Sustainable Development, UNEP report. URL: https://www.usgbc.org/ShowFile.aspx?DocumentID=19073 , accessed October 30, 2012. P4.
[3] Sleeuw, M., (2011), A COMPARISON OF BREEAM AND LEED ENVIRONMENTAL ASSESSMENT METHODS A REPORT TO THE UNIVERSITY OF EAST ANGLIAESTATES AND BUILDINGS DIVISION, Low carbon innovation center LCIC, University of East Anglia, P4.
[4] Bauer, M., Mösle, P., Schwarz, P., (2007), Green Building – Guidebook for Sustainable Architecture, Springer Heidelberg Dordrecht, London New York.
[5] URL: https://new.usgbc.org/leed/rating-systems/credit-categories , accessed November 12,2012.

Figure 2.6 LEED Structure
Source: Comstock, M., Garrigan, C., Pouffary, S. (2012), Building Design and Construction: Forging Resource Efficiency and Sustainable Development, UNEP report. URL: https://www.usgbc.org/ShowFile.aspx?DocumentID=19073 , accessed October 30, 2012.

Each Category consists of points to earn –differs according to LEED rating system-; the points from each credit category are totaled to create a final score. The higher the score, the higher the certification level earned, points possible = 100 points (+10 bonus) from bonus categories.

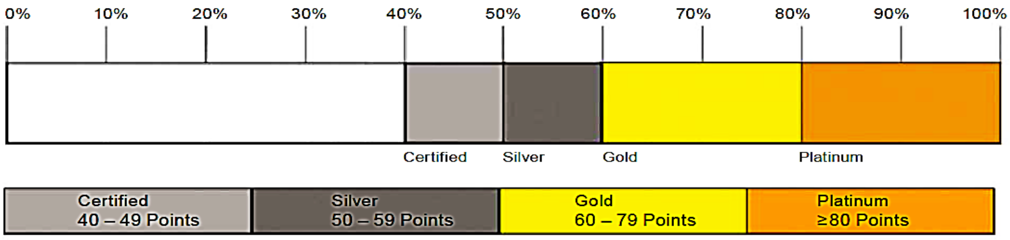

Figure 2.7 LEED Certification
Source: Bauer, M., Mösle, P., Schwarz, P., (2007), Green Building – Guidebook for Sustainable Architecture, Springer Heidelberg Dordrecht, London New York.

▪ The LEED Rating Systems

The LEED rating systems are grouped into five main categories: Building Design & Construction, Interior Design and Construction, Operations & Maintenance, Homes, and Neighborhood Development[1] (Figure 2.8).

[1] URL: http://www.everblue.edu/leed-rating-systems-explained , accessed November 12, 2012.

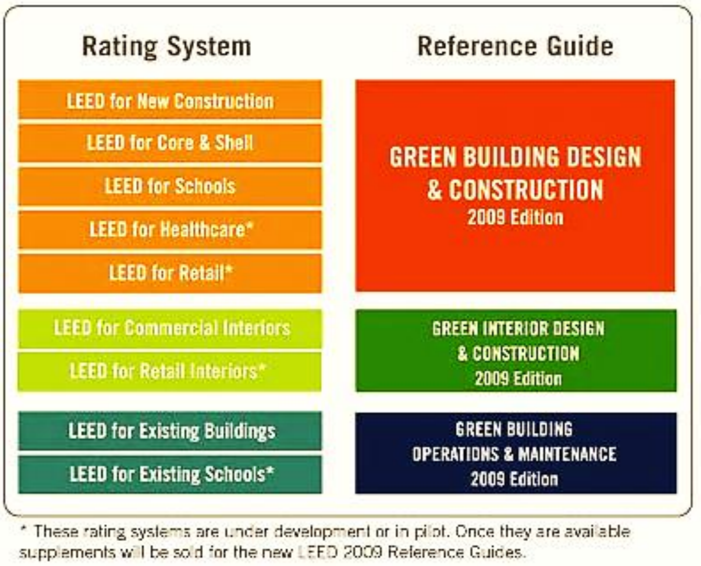

Figure 2.8 LEED Rating Systems
Source: URL: https://new.usgbc.org/leed/rating-systems/credit-categories , accessed November 12,2012.

2.4.1.1 Building Design and Construction (BD+C)

The first category, Building Design and Construction, contains five LEED rating systems. These rating systems are guidelines for new buildings and old buildings undergoing major renovations. Schools, Hospitals, Office Buildings, and Apartment Buildings are all examples of buildings that would fall into this category.

2.4.1.2 Green Interior Design and Construction

The second category is Green Interior Design and Construction, which includes LEED Commercial Interiors and LEED Retail Interiors. These rating systems were designed specifically for tenants leasing a portion of a larger building. For example, they could be used for a company leasing commercial office space or for a Starbucks in a strip center.

2.4.1.3 Green Building Operations and Maintenance

The third category is Green Building Operations and Maintenance, which includes LEED for Existing Buildings and LEED for Existing Schools. The rating systems for existing buildings can be used by building owners and operators to measure operations and maintenance as well as make minor improvements.

2.4.1.4 LEED for Homes

The fourth category is LEED for Homes, which was specifically designed for single and multi-family residential structures that are three stories or less. LEED for Homes is modeled after the Environmental Protection Agency's successful Energy Star for Homes program and became available to the public in 2008. It applies to single and multi-family residential units up to three stories tall.

2.4.1.5 LEED for Neighborhood Development

The fifth and final category is LEED for Neighborhood Development, which integrates the principles of smart growth, urbanism and green building into the first national program for neighborhood design[1].

LEED-certified buildings are designed to:

- Lower operating costs and increase asset value
- Reduce waste sent to landfills
- Conserve energy and water
- Be healthier and safer for occupants
- Reduce harmful greenhouse gas emissions
- Qualify for tax rebates, zoning allowances and other incentives in hundreds of cities[2]

- **<u>LEED for Existing Buildings: Operations and Maintenance (EBOM)</u>**

LEED for Existing Buildings: Operations & Maintenance is the tool for the ongoing operations and maintenance of existing commercial and institutional buildings. The certification system identifies and rewards current best practices and provides an outline for building's to use less energy, water and natural resources; improve the indoor environment; and uncover operating inefficiencies[3]. LEED helps building owners and managers solve building problems, improve building performance, and maintain and improve this performance over time. LEED reduces cost streams associated with building operations, reduces environmental impacts, creates healthier and more productive employee workspaces. The majority of requirements for LEED for Existing Building certification are operations and maintenance best practices. LEED V4 (EBOM) has 12 prerequisites, 40 credits, and 106 points to earn[4].

LEED V4 (EBOM)	
Total possible points 106	
Location and Transportation	**15**
Sustainable sites	**10**
Water Efficiency	**12**
Energy and Atmosphere	**38**
Materials and Resources	**4**
Indoor Environmental Quality	**17**
Innovation	**6**
Regional Priority	**4**

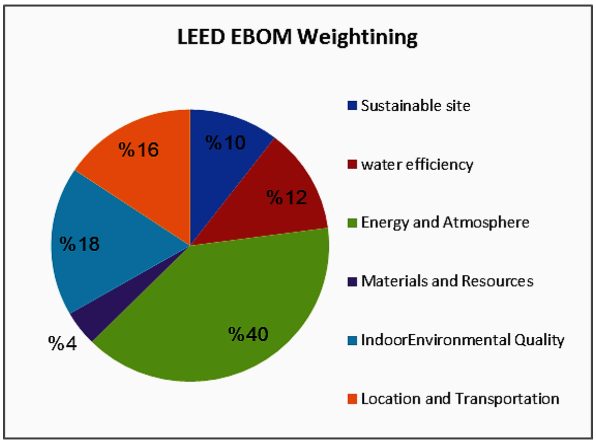

Figure 2.9 Left: LEED V4 (EBOM) credit categories and distribution, Right: LEED EBOM weighting, energy efficiency receives the greatest weighting, followed by Indoor Environmental Quality.
Source: U.S.Green Building Council, URL: http://www.usgbc.org/resources/leed-v4-building-operations-and-maintenance-checklist , accessed September 23, 2013.

[1] URL: https://new.usgbc.org/leed/rating-systems/credit-categories , accessed November 12,2012.
[2] URL: https://new.usgbc.org/leed , accessed November 12, 2012.
[3] U.S.Green Building Council, URL: http://www.usgbc.org/ShowFile.aspx?DocumentID=3353 , accessed November 15, 2012.
[4] U.S.Green Building Council, URL: http://www.usgbc.org/resources/leed-v4-building-operations-and-maintenance-checklist , accessed September 23, 2013.

One thing that tends to confound people new to LEED rating and certification system is the presence of prerequisites, things you have to do in every project to achieve recognition.

2.4.2 BREEAM "Building Research Establishment's Environmental Assessment Method" (Great Britain)

(BREEAM) was launched in 1990[1] and is currently the world's most widely adopted environmental assessment method with over 200,000 projects certified. Over 300 buildings outside of the UK have been registered for assessment.

As BREEAM is predominately a design-stage assessment, it is important to incorporate details into the design as early as possible. By doing this, it will be easier to obtain a higher rating and a more cost-effective result. The methods and tools cover different scales of construction activity. BREEAM Development is useful at the master planning stage for large development sites like new settlements and communities.

In addition, BREEAM has four assessment tools that can be used at different stages of a building's life cycle. BREEAM Design and Procurement (D&P) can be used during the design stage of a building renovation or for a new build or extension project. The Post Construction Review (PCR) is carried out once the construction is complete to verify the D&P assessment. The Fit Out assessment is employed during major renovations of existing buildings and a Management and Operation (M&O) assessment evaluates the performance of a building during its operation[2]

Different building versions have been created since its launch, to assess the various building types. Currently, the evaluation program is available for offices, industry, schools, courts, prisons, multiple purpose dwellings, hospitals, private homes and neighborhoods. The versions of assessment essentially look at the same broad range of environmental impacts: Management, Health and Well-being, Energy, Transport, Water, Material and Waste, Land Use and Ecology and Pollution. Credits are awarded in each of the above, based on performance. A set of environmental weightings then enables the credits to be added together to produce a single overall score. The building is then rated on a scale of certified, good, very good, excellent or outstanding and a certificate awarded to the design or construction[3].

[1]Sleeuw, M., (2011), A COMPARISON OF BREEAM AND LEED ENVIRONMENTAL ASSESSMENT METHODS A REPORT TO THE UNIVERSITY OF EAST ANGLIAESTATES AND BUILDINGS DIVISION, Low carbon innovation center LCIC, University of East Anglia, P4.

[2] Air Quality Sciences, Inc. report, (2009), BUILDING RATING SYSTEMS (CERTIFICATION PROGRAMS): A COMPARISON OF KEY PROGRAMS. URL: http://www.aerias.org/uploads/2009.12.09_Green_Building_Programs_Comparison_PUBLISHED.pdf , accessed November 15, 2012, P3.

[3] Bauer, M., Mösle, P., Schwarz, P., (2007), Green Building – Guidebook for Sustainable Architecture, Springer Heidelberg Dordrecht, London New York.

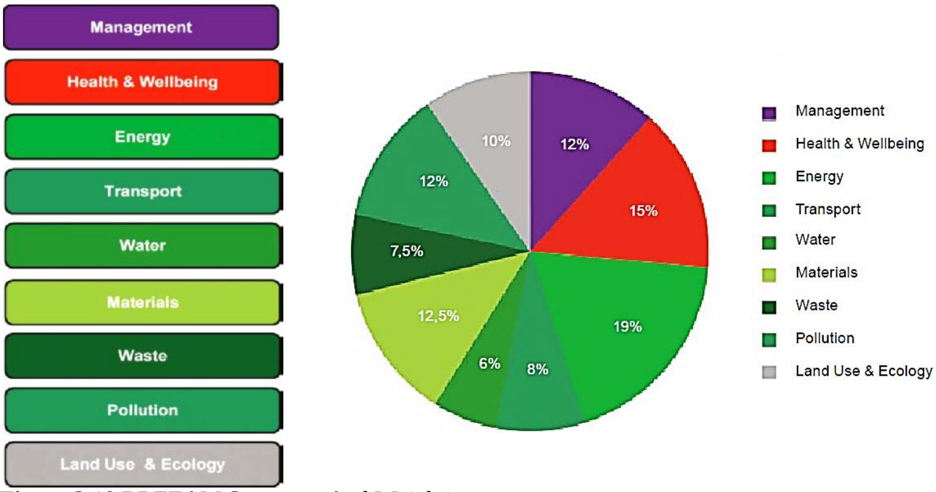

Figure 2.10 BREEAM Structure. And Weighting.
Source: Bauer, M., Mösle, P., Schwarz, P., (2007), Green Building – Guidebook for Sustainable Architecture, Springer Heidelberg Dordrecht, London New York.

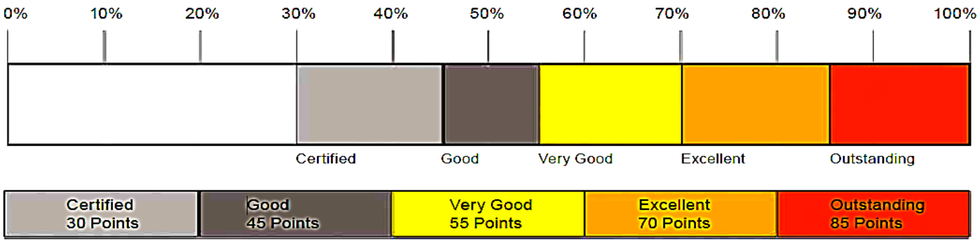

Figure 2.11 BREEAM Certification.
Source: Bauer, M., Mösle, P., Schwarz, P., (2007), Green Building – Guidebook for Sustainable Architecture, Springer Heidelberg Dordrecht, London New York.

- **<u>BREEAM In-Use</u>**

BREEAM In-Use is a scheme to help building managers reduce the running costs and improve the environmental performance of existing buildings. It consists of a standard, an easy-to-use assessment methodology and a 3rd party certification process that provides a clear and credible route map to improving sustainability. BREEAM In-Use can assist users to:

- Reduce operational costs
- Enhance the value and marketability of property assets
- Give a transparent platform for negotiating building improvements with landlords and owners
- Provide a route to compliance with environmental legislation and standards,
- Give greater engagement with staff in implementing sustainable business practices
- Provide opportunities to improve staff satisfaction with the working environment with the potential for significant improvements in productivity[1].

2.4.3 DGNB "German Sustainable Building Certificate" (Germany)

The German Sustainable Building Certificate was developed by the German Sustainable Building Council (DGNB) together with the Federal Ministry of Transport,

[1] BREEAM Brochure, URL: http://www.breeam.org/filelibrary/BREEAM_Brochure.pdf , accessed November 12, 2012.

Building, and Urban Affairs (BMVBS) to be used as a tool for the planning and evaluation of buildings in this comprehensive perspective on quality. As a clearly arranged and easy to understand rating system, the German Sustainable Building Certificate covers all relevant topics of sustainable construction, and awards outstanding buildings in the categories bronze, silver, and gold[1].

The certification is based on 49 criteria in six categories[2], 43 of which evaluate the building's quality and 6 evaluate the quality of the building's location, as follows:

- Ecological Quality: Outdoor environmental issues.
- Economical Quality: Life cycle costs and value stability.
- Socio-Cultural and Functional Quality: Thermal, visual and acoustical comfort, indoor hygiene and influences by users.
- Technical Quality: Fire and noise protection, quality of the building shell, cleaning and maintenance, and deconstruction, dismantling and recycling.
- Quality of the Process: Process of designing, constructing and commissioning the building.
- Quality of the Location: How well the building will respond to risks such as terrorists, man-made hazards, and weather and natural events; the building's impact on the local environment; the building's contribution to the local neighborhood; and how close it is to mass transportation and other important services. This category is evaluated separately and is not included in the overall assessment of the building's quality, so that each building can be evaluated independent of its location.

Each criterion is assigned a maximum of 10 points, depending on the documented or calculated quality. All criteria are weighted with a factor from 0 to 3, depending on its relevance for that particular building. Using a special software program, the degree of compliance with the program's requirements is calculated in accordance with an evaluation matrix.

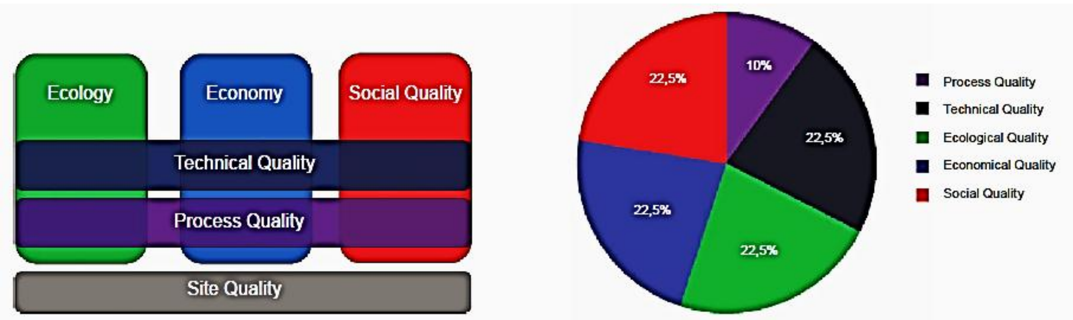

Figure 2.12 Left: DGNB structure. Right: DGNB weighting.
Source: Bauer, M., Mösle, P., Schwarz, P., (2007), Green Building – Guidebook for Sustainable Architecture, Springer Heidelberg Dordrecht, London New York.

From (Figure 2.12) we notice that the four quality sections (Social-Economy-Ecology-Technical) have equal weight in the assessment. This means that the DGNB

[1] Sobek, W., et al, (2009), GERMAN SUSTAINABLE BUILDING CERTIFICATE Structure – Application – Criteria, German Sustainable Building Council DGNB, Second English edition. URL: http://ecorussia.s3.amazonaws.com/assets/paragraph_attaches/7457/paragraph_media_7457_original.pdf?AWSAccessKeyId=AKIAJFNJQDNBKKWFW3UQ&Expires=1353057303&Signature=K7S2QKb9wmHIYuSGaZ8eiXdqlGU%3D , accessed November 10, 2012.

[2] Air Quality Sciences, Inc. report, (2009), BUILDING RATING SYSTEMS (CERTIFICATION PROGRAMS): A COMPARISON OF KEY PROGRAMS. URL: http://www.aerias.org/uploads/2009.12.09_Green_Building_Programs_Comparison_PUBLISHED.pdf , accessed November 15, 2012, P15.

System is the only one that gives as much importance to the economic aspect of sustainable building as it does to the ecological criteria. The assessments are always based on the entire life cycle of a building. Of course the focus is always also on the wellbeing of the user.

If all requirements are fulfilled, the owner receives a Gold, Silver or Bronze certificate as mentioned. A total degree of compliance of 50 percent earns a Bronze certificate, 65 percent for Silver and 89 percent for Gold[1].

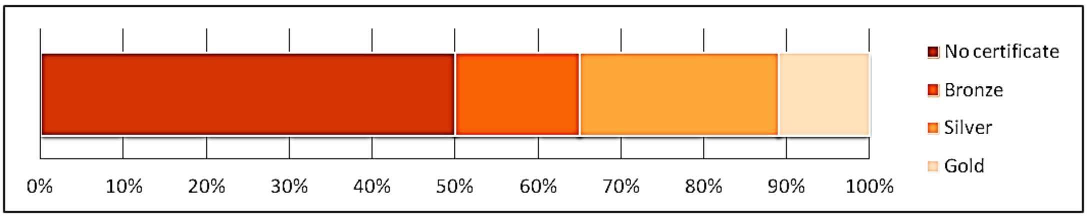

Figure 2.13 DGNB Certification.
Source: Researcher.

- **DGNB System for Existing Buildings**

DGNB (German Sustainable Building Council) presents an analytical instrument and certificate for existing buildings and offering new solutions. The assessment of an existing building is based on the same principles of the comprehensive DGNB system. Existing buildings scheme includes: office and administrative buildings, retail buildings, industrial buildings, and residential buildings[2].

2.4.4 CASBEE "Comprehensive Assessment System for Built Environment Efficiency" (Japan)

CASBEE is a tool for assessing and rating the environmental performance of buildings and built environment developed by Japan Green Build Council (JaGBC)/Japan Sustainable Building Consortium (JSBC)[3]. It is a comprehensive assessment of the quality of a building, evaluating features such as interior comfort and scenic aesthetics, in consideration of environmental practices which include using materials and equipment that save energy or achieve smaller environmental load.

CASBEE is comprised of assessment tools of different scales; Construction (houses and buildings), and Urban (town and city development) Known as CASBEE Family.

- **CASBEE Assessment**

The Building Environmental Efficiency (BEE) value is at the core of CASBEE‟s assessment method and represents the buildings total environmental performance value. The BEE value distinguishes between a building's environmental load (L), defined as "the negative impact on the environment outside the virtual enclosed space", and the building's quality performance (Q), defined as "the improvement of

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[1] Air Quality Sciences, Inc. report, (2009), BUILDING RATING SYSTEMS (CERTIFICATION PROGRAMS): A COMPARISON OF KEY PROGRAMS. URL: http://www.aerias.org/uploads/2009.12.09_Green_Building_Programs_Comparison_PUBLISHED.pdf , accessed November 15, 2012, P18.
[2] URL: http://www.dgnb.de/dgnb-system/en/schemes/scheme-overview/ , accessed on November 27, 2012.
[3] URL: http://www.ibec.or.jp/CASBEE/english/index.htm , accessed on November 15, 2012.

environmental quality within the enclosed virtual space.” The indoor and outdoor environments are divided by a hypothetical boundary, which is defined by the site boundary and other elements (Figure 2.14). Within the Q and L values, buildings are evaluated for the following:

- Q1: Indoor Environment, Q2: Quality of Service and Q3: Outdoor Environment on Site
- L1: Energy, L2: Resources and Materials and L3: Offsite Environment[1]

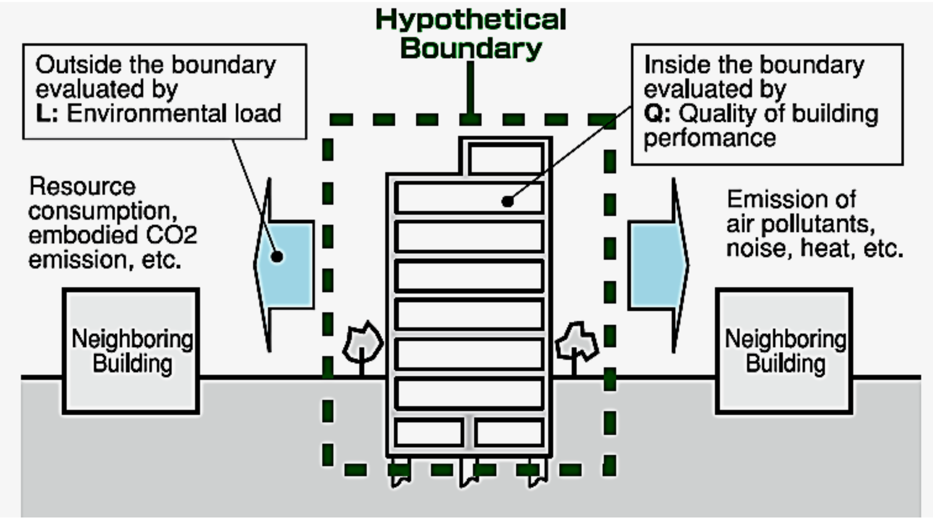

Figure 2.14 Definition of Q and L through the hypothetical boundary.
Source: CASBEE brochure, (2011), Japan Green Build Council (JaGBC)/Japan Sustainable Building Consortium (JSBC), P2.

The indoor environmental quality assessment under Q1 looks at source control of chemical pollutants, mineral fibers, biological contaminants and legionella; ventilation; and an operation plan that monitors carbon dioxide and controls smoking. Within the L2, there is a provision that focuses on materials with low health risks, which primarily relates to release into the outdoor environment. The CASBEE assessment process rewards applicants that effectively employ an integrated strategy for indoor air quality: source control, ventilation, and an operation and management plan. The more aggressive or “strenuous” the strategy, the higher the performance level awarded (on a scale of 1 to 5, with 5 being the highest level)[2].

The BEE value is defined as Q/L to indicate the overall result of the environmental assessment of the building. The Q and L values are then plotted on a graph: L on the x axis and Q on the y axis. The BEE value is expressed as the gradient of the straight line passing through the origin (0,0). Buildings on the diagonal line (BEE = 1.0) are classified as ordinary buildings. The higher the Q value and the lower the L value yields a steeper the gradient, which equates to a more sustainable building.

Depending on the BEE value, buildings are labeled as C: BEE of 0 – 0.49; B-: BEE of 0.5 – 0.99; B+: BEE of 1 – 1.49; A: BEE of 1.5 – 2.99; or S: BEE of 3.0 or more. A star rating from 1 to 5 also is provided[3] (Figure 2.15).

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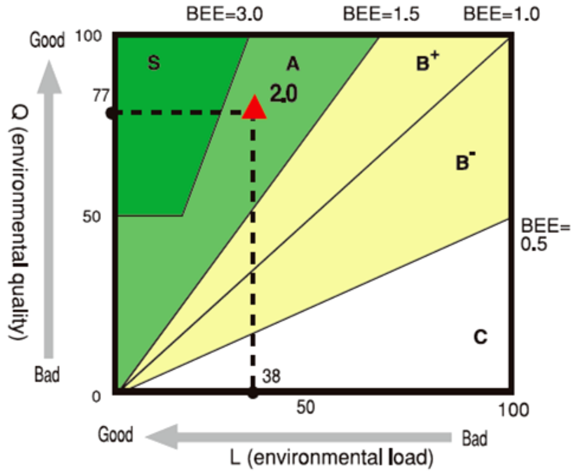
[1] CASBEE brochure, (2011), Japan Green Build Council (JaGBC)/Japan Sustainable Building Consortium (JSBC), P2.
[2] Air Quality Sciences, Inc. report, (2009), BUILDING RATING SYSTEMS (CERTIFICATION PROGRAMS): A COMPARISON OF KEY PROGRAMS. URL: http://www.aerias.org/uploads/2009.12.09_Green_Building_Programs_Comparison_PUBLISHED.pdf , accessed November 15, 2012, P12.
[3] Ibid, P14.



Ranks	Assess ment	BEE value, etc.	Expression
S	Excelle nt	BEE >= 3.0, Q >= 50	★★★★★
A	Very Good	3.0 > BEE >= 1.5	★★★★
B+	Good	1.5 > BEE >= 1.0	★★★
B-	Slightly Poor	1.0 > BEE >= 0.5	★★★
C	Poor	BEE < 0.5	★

Figure 2.15 Sustainability ranking of buildings, using the BEE value.
Source: CASBEE brochure, (2011), Japan Green Build Council (JaGBC)/Japan Sustainable Building Consortium (JSBC), P2.

Although CASBEE is designed to be a self-assessment tool, the Japan Sustainable Building Consortium advises that only CASBEE Accredited Professionals with expertise and knowledge of the environmental performance of buildings should conduct the assessments. To be accredited, candidates must attend a CASBEE Accredited Professional Registration System training course and pass an examination.

- **CASBEE for Existing Buildings (CASBEE-EB)**

CASBEE-EB targets existing buildings stock, based on operation records for at least one year after completion. The tool was also developed to be applicable to assest value assessment. This assessment tool evaluates achieved performance when the assessment is made. The result is valid for 5 years, and requires assessment using the latest version of the assessment tool, because the conditions of the buildings may change over time. It can be used as a labeling tool to declare the environmental performance of buildings. CASBEE-EB is also used to support building maintenance[1].

2.4.5 GPRS "Green Pyramid Rating System" (Egypt)

The government of the Arab Republic of Egypt, represented in the Ministry of Housing, Utilities and Urban Development has an interest in promoting green building as part of the Ministry's overall sustainable development policies.

As a result the Egyptian Green Building Council (GBC-Egypt) was established at the beginning of 2009[2].

In response to the need for an Egyptian green building assessment system, and with the benefit of the experiences of early-adopters in other countries, the Housing and Building National Research Center has produced The Green Pyramid Rating System (GPRS) in 2010[3].

[1] CASBEE brochure, (2011), Japan Green Build Council (JaGBC)/Japan Sustainable Building Consortium (JSBC), P5.
[2] El-Demirdash, M., et al, (2011), The Green Pyramid Rating System, The Housing and Building National Research Center In conjunction with The Egyptian Green Building Council, First edition. On line version for public review. URL: http://www.hbrc.edu.eg/files/GPRS-%20for%20Public%20Review_June%202011.pdf ,accessed November 17,2012, P5.
[3] Ibid.

The (GPRS) is developed from the USA LEED despite the great difference between the two countries in economic and technology and the difference in social problems and quality between the two countries[1].

The Green Pyramid Rating System is a national environmental rating system for buildings. Additionally, the System should assist building designers, constructors and developers to make reasoned choices based upon the environmental impact of their decisions[2].

The Green Pyramid Rating System is designed for use in new building works. The Rating can be used to assess individual new buildings at either or both of the following stages:

- at Design Stage
- at Post-Construction Stage

It will be mandatory for applicants wishing for a Green Pyramid assessment at Post-Construction stage to have first undergone a Green Pyramid assessment at Design Stage. For assessment of Refurbishment-only projects (i.e. where building work will take place on an existing building) certain of the credits that apply to new buildings will not be applicable.

This will require modification of the current system and The *Green Pyramid Rating System for Refurbishment-only Projects* will be produced at a later date[3]. The system for assessment of New Buildings at Post-Occupancy Stage1 and for Existing Buildings (i.e. where no intended building work will take place) will also require further modification of the current system. Two further documents – *The Green Pyramid Rating System for New Buildings at Post-Occupancy Stage* and *The Green Pyramid Rating System for Existing Buildings* will be produced at a later date. To be eligible for assessment, a building should meet all of the minimum national statutory provisions and Egyptian National Codes for the design and construction of buildings.

2.4.5.1 COMPONENTS OF THE GREEN PYRAMID RATING SYSTEM

The system comprises seven rating Categories (1-7) which in turn contain sub-categories[4] as follows

1. Sustainable Site, Accessibility, Ecology 15%: To encourage development in desert areas, redevelopment in informal areas and avoid projects which negatively affect archaeological, historical and protected areas.
2. Energy Efficiency 25%: To reduce energy consumption and carbon emissions by incorporating passive design strategies.
3. Water Efficiency 30%: Helping professionals across the country to improve the quality of our buildings and their impact on the environment Develop and implement a comprehensive water strategy Minimize indoor and outdoor water demands Reduce potable water use.

[1] Ammar, M., (2012), Evaluation of the Green Egyptian Pyramid, Alexandria Engineering Journal, Available online 11 October 2012 via Science Direct. URL: http://dx.doi.org/10.1016/j.aej.2012.09.002 , accessed November 17,2012.
[2] El-Demirdash, M., et al, (2011), The Green Pyramid Rating System, The Housing and Building National Research Center In conjunction with The Egyptian Green Building Council, First edition. On line version for public review. URL: http://www.hbrc.edu.eg/files/GPRS-%20for%20Public%20Review_June%202011.pdf ,accessed November 17,2012, P7.
[3] Ibid, P8.
[4] El-Demirdash, M., et al, (2011), The Green Pyramid Rating System, The Housing and Building National Research Center In conjunction with The Egyptian Green Building Council, First edition. On line version for public review. URL: http://www.hbrc.edu.eg/files/GPRS-%20for%20Public%20Review_June%202011.pdf ,accessed November 17,2012, P9.

4. Materials and Resources 10%: To encourage selection of materials with a low environmental impact and cost over the full life cycle of the building.
5. Indoor Environmental Quality 10%: To provide a building and its systems that supports the wellbeing and comfort of occupants by providing sufficient outside air ventilation and indoor air quality. to encourage use of low emission adhesives, sealants, paints, coatings, flooring and ceiling systems and to mitigate the health risks associated with formaldehyde in building products. To promote thermal, visual and acoustic comfort of occupants.
6. Management 10%: To encourage development in desert areas, redevelopment in informal areas and avoid projects which negatively affect archaeological, historical and protected areas.
7. Innovation and Added Value Bonus[1]

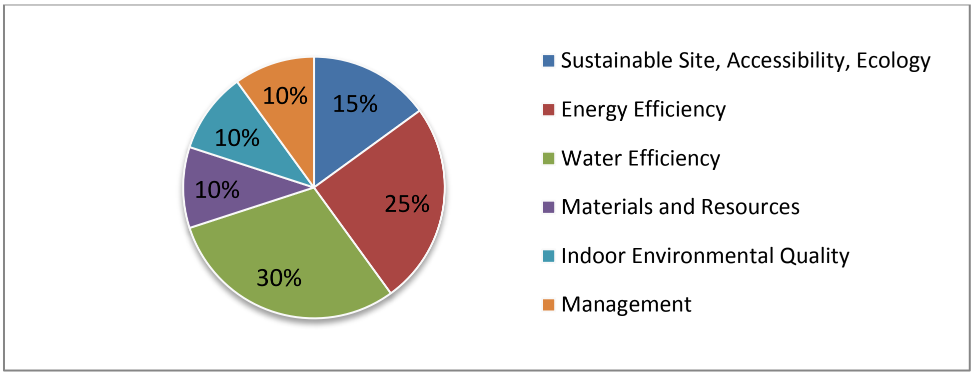


Figure 2.16 GPRS weighting.
Source: Researcher.

2.4.5.2 CERTIFICATION AND LEVELS OF RATING

To earn Green Pyramid certification a project must satisfy all the stated Mandatory Minimum Requirements and may obtain Credit Points by meeting certain criteria. Projects will be rated, based on Credit Points accumulated, according to the following rating system:

- GPRS Certified: 40–49 credits
- Silver Pyramid: 50–59 credits
- Gold Pyramid: 60–79 credits
- Green Pyramid: 80 credits and above
- Projects with less than 40 credits will be classified as 'Uncertified'[2] (Figure 2.17).

[1] Ibid, P9.
[2] Farouh, H., (2012), A Greener Cairo - Visions & Realities Presentation, Housing & Building National Research Center (HBRC), Cairo Climate Talks Panel Discussion, DAAD. URL: http://cairoclimatetalks.net/sites/default/files/Vision%20for%20Greener%20%20Cairo_CCT_Dr.%20Hend%20Farouh.pdf , accessed November 17, 2012.

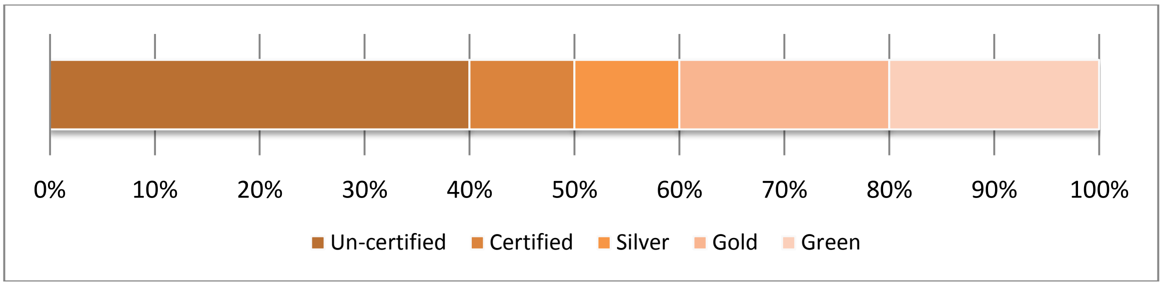


Figure 2.17 GPRS Certification.
Source: The Researcher.

2.4.5.3 Integration between the Unified Building Law and the GPRS

By comparing the building codes included in the Unified Building Law No.119 for year 2008, and its executive appendix released in April 2009 by the Minister of Housing, law No. 114 for the year 2009 on one hand, and the GPRS document released by the EGBC/HBRC, Ministry of Housing committee that was formed the same year, astonishing results reveal. There are serious contradictions between both documents, as the Unified Building Law and its appendix allow building designs and procedures that do not comply with to the GPRS[1].

Moreover, there is no reference in the Unified Building Law for the GPRS or green building in general, nor there is any reference for the Unified Building Law in the GPRS documentation released by the Ministry of Housing, Utilities and Urban Development. Thus, it is clear that the GPRS is an isolated document that does not fit into the current legislations, nor represent a binding legislation on its own.

This gap between a fully-enforced non-green building law and an unendorsed green building law must be filled. This is basically doable by greening some of the regulations of the Unified Building Law and also by putting a timeline for the enforcement of the GPRS that starts by giving incentives to projects that apply it, then imposing fines on those which do not, and ends by requiring the achievement of at least a ‘GPRS-certified’ standard for gaining a license[2].

2.4.6 Estidama or PRS “Pearl Rating System” (Emirate of Abu-Dhabi)

The Abu Dhabi urban planning council has been established on 2007[3], and the PRS was the outcome of their vision for sustainability. The system was launched in September 2008[4]. The rating method includes both prerequisites and voluntary credits. The prerequisites will be encoded in one of three regulatory processes:

- The Urban Planning Council (UPC) Planning Approval Process
- The UPC Framework Development Regulations (released in the latter half of 2009)
- The ongoing update of the Abu Dhabi Building code

The ultimate goal of Estidama is to preserve and enrich Abu Dhabi's physical and cultural identity, while creating an always improving quality of life for its residents on

[1] Ayyad, K., and Gabr, M., (2012), Greening Building Codes in Egypt, Sustainable Futures: Architecture and Urbanism in the Global South, Kampala, Uganda report, P63. URL: http://www.sfc2012.org/ayyad_gabr_1.pdf , accessed November 17, 2012.
[2] Ayyad, K., and Gabr, M., (2012), Greening Building Codes in Egypt, Sustainable Futures: Architecture and Urbanism in the Global South, Kampala, Uganda report, P63. URL: http://www.sfc2012.org/ayyad_gabr_1.pdf , accessed November 17, 2012.
[3] Ammar, M., (2012), Evaluation of the Green Egyptian Pyramid, Alexandria Engineering Journal, Available online 11 October 2012 via Science Direct. URL: http://dx.doi.org/10.1016/j.aej.2012.09.002 , accessed November 17,2012, P4.
[4] URL: http://estidama.org/?lang=en-US , accessed November 17, 2012.

four equal pillars of sustainability: environmental, economic, social, and cultural (Figure 2.18).

Figure 2.18 The Four Pillars of Sustainability.
Source: Abu Dhabi urban planning council

The PRS is a program encompassing a Pearl Building Rating System (PBRS), a Pearl Community Rating System (PCRS) and a Pearl Villa Rating System (PVRS)[1], introducing rating practices across the design and construction phases of development projects. The system provides a set of measurable guidelines for rating sustainability performance of communities, buildings, and large-scale developments of villas, across Estidama's four pillars.

The system addresses seven categories;

- Integrated Development Process: Encouraging cross-disciplinary teamwork to deliver environmental and quality management throughout the life of the project.
- Natural Systems: Conserving, preserving and restoring the region's critical natural environments and habitats.
- Livable Communities and buildings: Improving the quality and connectivity of outdoor and indoor spaces.
- Precious Water: Reducing water demand and encouraging efficient distribution and alternative water sources.
- Resourceful Energy: Targeting energy conservation through passive design measures, reduced demand, energy efficiency and renewable sources
- Stewarding Materials: Ensuring consideration of the 'whole-of-life' cycle when selecting and specifying materials.
- Innovating Practice: Encouraging innovation in building design and construction to facilitate market and industry transformation [2](Figure 2.19).

To achieve a 1 Pearl rating, all the mandatory credit requirements must be met. To achieve a higher Pearl rating (2-5 Pearls), all the mandatory credit requirements must be met along with a minimum number of credit points. Upon completion of rating method process, and by submitting an Estidama summary report, a percentage score is awarded to the project. The score is then translated into an official Pearl Rating as shown in (Table 2.1).

---

[1] URL: http://estidama.org/media-center/estidama-press-releases/estidama-advances-the-arab-world's-first-sustainability-rating-system.aspx?lang= , accessed November 17, 2012.
[2] URL: http://www.estidama.org/estidama-and-pearl-rating-system/pearl-rating-system.aspx , accessed November 11, 2012.

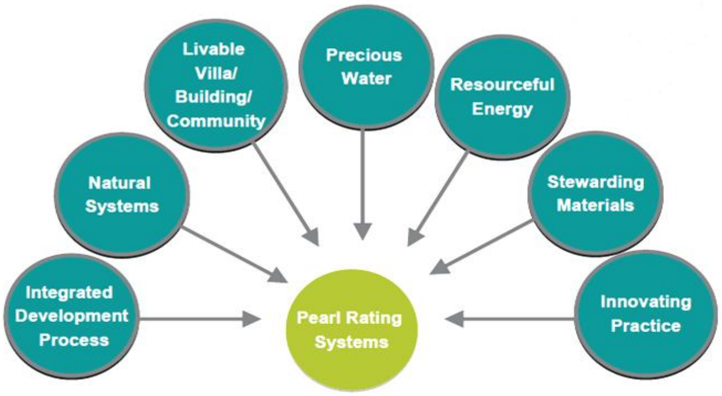


Figure 2.19 Pearl Rating System – Categories.
Source: Abu Dhabi urban planning council, URL: http://www.energimyndigheten.se/Global/Internationellt/Exportfrämjande%20o%20Bilateralt/Brothers_Estidama_Pearl_Rating_System.pdf ,accessed November 17, 2012.

An Executive Council Order of May 2010 states all new buildings must meet the 1 Pearl requirements starting in September 2010, whilst all government funded buildings must achieve minimum 2 Pearls[1].

Table 2.1 Pearl Rating levels.
Source: http://www.estidama.org/estidama-and-pearl-rating-system/pearl-rating-system.aspx , accessed November 17, 2012.

Pearl Rating	**Optional credit points required**		
	Pearl Community Rating System	**Pearl Building Rating System**	**Pearl Villa Rating System**
1	All Mandatory Credits	All Mandatory Credits	All Mandatory Credits
2	55+	60+	30+
3	75+	85+	44+
4	100+	115+	57+
5	125+	140+	70+

(Figure 2.20) shows the weighing of each category in different Pearl Rating Systems.

- **The pearl Rating System Stages**

- Design Rating is awarded upon completion of design and provides recognition of the sustainable measures incorporated during the design phase. The Design Rating is only valid until construction is complete, at which time projects will proceed to the Construction Rating.
- Construction Rating is awarded upon completion and verification that the construction activities on the project have achieved the design intent and have incorporated the measures awarded in the Design Rating. The Pearl Construction Rating is valid for two years, at which time projects will proceed to the Operational Rating.
- Operational Rating is unique to the Pearl Rating System. The Pearl Operational Rating verifies the operational performance of a development to ensure the design's intent has achieved its stated objectives[2].

[1] URL: http://estidama.org/pearl-rating-system-v10/pearl-building-rating-system.aspx ,accessed November 17, 2012.
[2]URL: http://www.estidama.org/estidama-and-pearl-rating-system/pearl-rating-process.aspx?lang=en-US , accessed November 17, 2012.

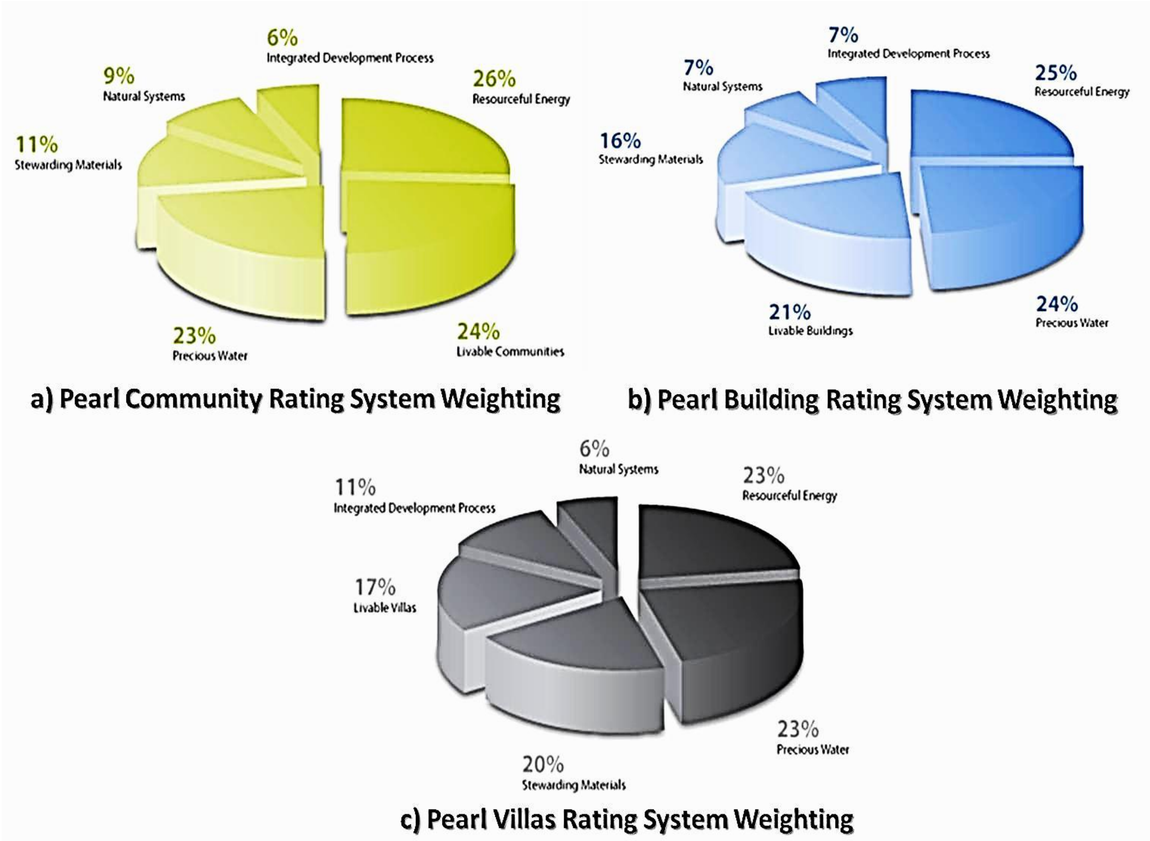


Figure 2.20 PRS for Community. Buildings, and Villas Weighting.
Source: Abu Dhabi urban planning council.

2.4.7 Analytical Comparison of Different Green Building Rating Systems

The following table summarizes the most common feature of the assessment tools mentioned earlier. Each tool depends on a certain methodology of rating and assessment according to the region and the area it is originated in.

Table 2.2 Analytical Comparison Between Green Building Rating Systems.
Source: The Researcher.

	LEED	BREEAM	GSBC	CASBEE	GPRS	PRS
Place	United States of America	United Kingdom	Germany	Japan	Egypt	Emirate of Abu Dhabi
Date	1998	1990	2009	2004	2010	2008
Developed From (Source)	Original	Original	Original	Original	LEED	LEED
Categories	- Location & Transportation 16 % - Sustainable Sites 10% - Water Efficiency 11% - Energy and Atmosphere 33% - Material and Resources 13% - Indoor Environmental quality 16% - Integrative process 1% - Regional priority (bonus) - Innovation in operation **(Based on LEED 'V.4.0')**	- Management 12% - Health and Well-being 15% - Energy 19% - Transport 8% - Water 6% - Materials 12.5 % - Waste 7.5% - Land Use and Ecology 10% - Pollution 12% (Based on BREEM 2008)	- Ecological Quality - Economical Quality - Social Quality - Technical Quality - Process Quality - Site Quality	Certification on the basis of "building environment efficiency factor"(BEE). BEE=Q/L Q … Quality (Ecological Quality of buildings) Q1 - Interior space Q2 - Operation Q3 - Environment L … Loadings (Ecological effects on buildings) L1 - Energy L2 - Resources L3 – Material Main Criteria: (1) Energy Efficiency (2) Resource Consumption Efficiency (3) Building Environment (4) Building Interior	- Sustainable Site, Accessibility, Ecology 15% - Energy Efficiency 25% - Water Efficiency 30% - Materials and Resources 10% - Indoor Environmental Quality 10% - Management 10% - Innovation and Added Value (Bonus)	- Integrated Development Process 6% - Natural Systems 9% - Livable Buildings or Community 24% - Precious Water 23% - Resourceful Energy 26% - Stewarding Materials 11% - Innovating Practice 2% (Based on Pearl community Rating System)

	LEED	BREEAM	GSBC	CASBEE	GPRS	PRS
Schemes and Versions	LEED for: ✚ New Construction ✚ Existing Buildings ✚ Commercial Interiors ✚ Core and Shell ✚ Healthcare ✚ Homes ✚ Neighborhood Development ✚ Schools ✚ Retail	BREEAM for: ✚ Courts ✚ EcoHomes ✚ Education ✚ Industrial ✚ Healthcare ✚ Multi- Residential ✚ Offices ✚ Prisons ✚ Retail Schemes : New Construction · Refurbishment · Code for Sustainable Homes · Communities · In-Use	GSBC for: ✚ Offices ✚ Existing Buildings ✚ Retail ✚ Industrial ✚ Portfolios ✚ Schools	CASBEE applies for residential and non-residential buildings) CASBEE for Pre-Design CASBEE for New Construction CASBEE for Existing Buildings CASBEE for Renovation CASBEE for Heat Island CASBEE for Urban Development CASBEE for an Urban Area + Buildings CASBEE for Cities CASBEE for Home (Detached House) CASBEE for Market Promotion CASBEE Property Appraisal	GPRS for ✚ New Buildings ✚ Sustainable Community ✚ Hotels ✚ Refurbishment-only Projects (later date) ✚ New Buildings at Post-Occupancy Stage (later date) ✚ Existing Buildings (later date)	✚ Pearl Building Rating System ✚ Pearl Community Rating System ✚ Pearl Villa Rating System
Rating For Existing Buildings and Operational Phase	✓	✓	✓	✓	Will be produced at a later date	✓
Level of Certification	✚ LEED Certified ✚ LEED Silver ✚ LEED Gold ✚ LEED Platinum	✚ Certified ✚ Good ✚ Very good ✚ Excellent ✚ Outstanding	✚ Bronze ✚ Silver ✚ Gold	✚ C (poor) ✚ B- ✚ B+ ✚ A ✚ S (excellent)	✚ GPRS Certified ✚ Silver Pyramid ✚ Gold Pyramid ✚ Green Pyramid	✚ 1 Pearl ✚ 2 Pearl ✚ 3 Pearl ✚ 4 Pearl ✚ 5 Pearl
Web Site	https://new.usgbc.org/leed	http://www.breeam.org	http://www. dgnb.de	http://www.ibec.or.jp/CASBEE/english	http://www.egypt-gbc.gov.eg/ratings/index.html	http://www.estidama.org/
Availability of the system	PDF Rating Checklists, Excel Checklists, and guidelines	Checklists and Excel Pre Assessment Estimators	Only a brochure for DGNB certification with Evaluation matrices, DGNB auditor guides you if registered.	Assessment Tool and Manuals (Partly Japanese)	PDF Rating Checklists for public review	PDF Summary of credit points for the system and guidelines.
Updating process	As required	Annual	As required	As required	-	As required

	LEED	BREEAM	GSBC	CASBEE	GPRS	PRS
Global Relevance	LEED can sit alongside as part of a global corporate policy.	BREEAM is generally relevant in the UK as it uses UK policies	The DGNB has been committed to international cooperation, it can be applied internationally.	Relevant to Japan and Asia	Relevant to Egypt	Relevant to Emirates
Methodology Summary	Score-based system. Building's performance is rated based on overall score.	Score-based system. Building's performance is rated based on overall score. BREEAM has licensed assessors who assess the evidence against the credit criteria and report it to the BRE, who QA the assessment and issue the certificate.	Score based on the degree of compliance with the requirements of the certification is calculated in accordance with the evaluation matrix with a special software.	Building is rated based on the 'BEE Factor'	Score-based system. Building's performance is rated based on overall score.	Score-based system. Building's performance is rated based on overall performance and then translated into an official pearl rating.
Data Gatherer	Management team or Accredited Professional	Management team or assessor	DGNB Auditor and his team.	Design/management team	Design/ management team	Design/ management team
Rating Development	USGBC member committees developed the LEED Rating System over more than a decade of leadership experience. LEED V. 1.0 LEED V. 2.0 LEED V. 2.1 LEED V. 2.2 LEED 2009 (V. 3.0) launched in 27 April 2009. The next version of LEED, LEED 2012 (V. 4.0).	BREEAM rewards performance above regulation which delivers environmental, comfort or health benefits. Latest version BREEAM 2011.	DGNB system is developing new schemes, and can be used locally and for international application since the system can easily be adapted to the climatic, constructional, legal and cultural peculiarities of other countries.	CASBEE was developed according to the following policies: 1) The system should be structured to award high assessments to superior buildings, thereby enhancing incentives to designers and others. 2) The assessment system should be as simple as possible. 3) The system should be applicable to buildings in a wide range of building types. 4) The system should take into consideration issues and problems peculiar to Japan and Asia.	It has been developed from the global system (LEED), although the difference in economic and technological and social and cultural aspects between the two countries, as there is no benefit from the experience ancient Egyptian architecture, and was not addressing local problems such as mismanagement and lack of Awareness and Training	(Estidama) expresses the concept of sustainability, which is more comprehensive than concept of green architecture, so it is more sustainability than (UAE – LEED), and more expression of the cultural and social aspects

	LEED	BREEAM	GSBC	CASBEE	GPRS	PRS
Governance	It has been created by a governmental body: the U.S. Green Building Council (USGBC). USGBC is a national nonprofit membership body; members are organizations including corporations, governmental agencies, nonprofits and others from throughout the industry. LEED is consensus-driven with committee-based development.	It has been created by a governmental body in the UK by the Building Research Establishment (BRE). British Government is offering tax incentives for certifying BREEAM. The BRE was a government funded research body when BREEAM was conceived	It has been created by a governmental body: the German Sustainable Building Council (DGNB) together with the Federal Ministry of Transport, Building, and Urban Affairs (BMVBS).	It has been created by a governmental body: Japan Green Build Council (JaGBC)/Japan Sustainable Building Consortium (JSBC)	It has Been created by governmental Body: the Housing and Building National Research Center(HBRC)and Egyptian Green Building Council (GBC-Egypt), with the absence of any support from other segments of society	It has Been created by Governmental body. A decision has been taken to make the pearl requirements as a condition for all projects in the new urban complexes. It has Been integrated with the code of Abu Dhabi international building

2.5 Conclusion

- Green building practices can substantially reduce or eliminate negative environmental impact through high performance, market-leading design, construction, and operations practices. As an added benefit, green operations and management reduce operating costs, enhance building marketability, increase worker's productivity, and reduce potential liability resulting from indoor air quality problems.
- Building green has become a growing trend as architects and property owners became more and more conscious of preserving the environment and promoting healthier products and construction practices.
- The rating systems are based on the principals of designing of green building, those are efficient use of water, energy, rationalizing material and sources, existing internal environment and disproportionately stander of sustainable site among evaluating system, with difference of relative weight of standard according to each vision of system and place of application which serves local problems, Most systems are characterized by adding degrees of innovation, creativity to present treatments to achieve the green architecture.

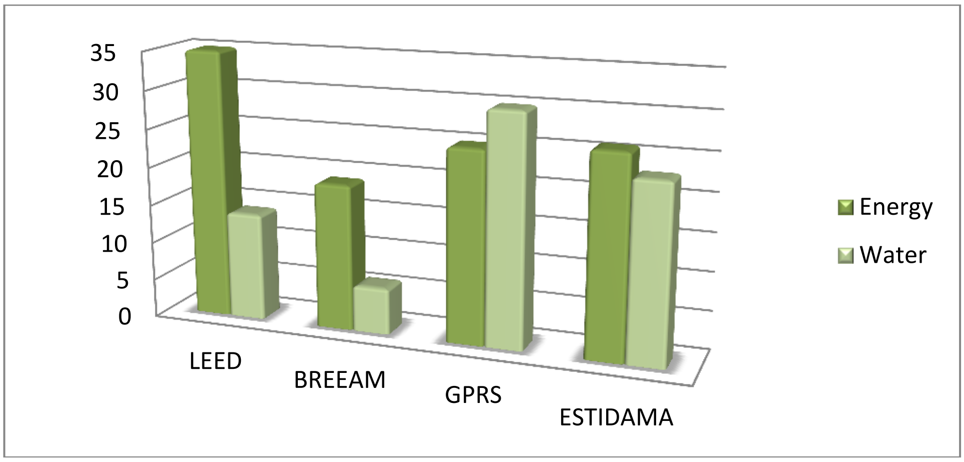


Figure 2.21 Different weights of the same categories in different assessment tools
Source: The Researcher

- BREEAM and LEED are the two most widely recognized environmental assessment methodologies used globally in the construction industry today[1].
- Egyptian Green pyramid system is considered as the first step to achieve the green architecture concepts in Egypt.

[1] Starrs, M., (2010), BREEAM versus LEED, Inbuilt Ltd white paper, www.inbuilt.co.uk .

Introduction

Conventional buildings rarely enable change, unless undergoing complex renovations, and rarely consider environmental features beyond mandatory legislation.

The building sector already plays an important role in climate change mitigation efforts as mentioned in chapter one. For example, voluntary programs such as the LEED Rating System, the Architecture 2030 Challenge, the American College and University Presidents' Climate Commitment, and the Clinton Climate Initiative focus almost exclusively on reducing energy consumption and increasing renewable energy generation. Mandatory regulations such as the International Energy Conservation Code, the International Green Building Code, and CalGreen (California Green Buildings Standard Code) also emphasize GHG emission reduction targets[1]; these are considered approaches to greening existing buildings.

Though a green building or green measures can cost more to construct, advocates argue that long-term cost savings cover the upfront expenses and more. Green building measures and features on average trim energy costs by 30 percent and carbon emissions by 35 percent, cut water usage by 30 percent to 50 percent, and generate a 50 percent to 90 percent reduction in waste costs[2].

The real challenge of greening the existing buildings is to demonstrate achievement while still respecting budgets, addressing tenant/occupant resistance to change, and meeting corporate constraints on activities.

This chapter discusses the challenge of greening existing buildings, Drivers and Barriers to growth of its market, mentioning its business case and benefits to government agencies owners, building owners, tenants, and to future financial performance. It also discusses the incentive programs and policies that encourage greening the existing buildings.

3.1 The Reason behind the Focus on Existing –Office- Buildings

Existing buildings are the overwhelming percentage of the building stock, and therefore, are the key to improving overall sustainability and efficiency; buildings account for a major share of the climate change crisis, Current rate of new construction is quite low and unlikely to change significantly; (over 70 Billion Sq. Ft. of Existing Commercial Space in the U.S., Maybe more than 90% of Commercial Buildings[3], roughly two percent of commercial floor space is newly constructed each year[4], and a comparable amount renovated, while the replacement rate of existing buildings by the new-build is only around 1.0–3.0% per annum[5]. Improved efficiency

[1] Adele Houghton, (2011) Health Impact Assessments A Tool for Designing Climate Change Resilience Into Green Building and Planning Projects. Journal of Green Building: Spring 2011, Vol. 6, No. 2, pp. 66-87. URL: http://www.journalofgreenbuilding.com/doi/abs/10.3992/jgb.6.2.66, accessed December 12, 2012.

[2] Birk, C., (2007), Building a reputation, St. Louis Business Journal. URL: http://www.usgbc.org/News/USGBCInTheNewsDetails.aspx?ID=3288 , accessed January 16, 2013.

[3] LaRoe, J., Building for the 21st century Rebuilding the 20th century Energy efficient retrofits, ROI, and self-funding improvements to reduce energy consumption, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. URL: http://www.nationalbuildingmuseum.net/Jim%20LaRoe%27s%20powerpoint.pdf , accessed January 31, 2013.

[4] URL: http://www.institutebe.com/Existing-Building-Retrofits/Why-Focus-On-Existing-Buildings.aspx , accessed January 30, 2013.

[5] Annex 50, prefabricated systems for low energy renovation of residential buildings, URL: http://www.ecbcs.org/annexes/annex50.htm, accessed February 15, 2013.

of existing buildings—through building retrofitting and other measures—represents a high-volume, low-cost approach to reducing energy use and greenhouse gas emissions.

Even for new buildings—constructed in compliance with modern codes requiring higher levels of efficiency—there exist countless savings opportunities in the form of improved maintenance and more efficient operation practices. Buildings are often occupied without a commissioning process to ensure performance in line with original design. Sustainable new construction, no matter how environmentally sensitive and energy efficient can't by itself significantly changes the environmental impact of the built environment[1].

In developed economies, at least half of the buildings that will be in use in 2050 *have already been built*[2]. (Figure 3.1)

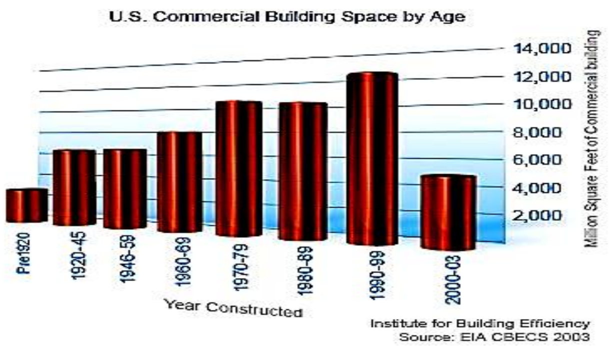


Figure 3.1 U.S. commercial building space by age.
Source: URL: http://www.institutebe.com/Existing-Building-Retrofits/Why-Focus-On-Existing-Buildings.aspx , accessed January 31, 2013.

3.2 Drivers to Greening Existing Office Buildings

Over the years from 2006 to 2009, there has been remarkable consistency in the motivations behind the adoption of green building or greening our buildings. In 2006, 40% of executives from corporate America reported government incentive as a major driver of green buildings, only 29 believe the same in 2009-a decrease over 72%; less emphasis on government regulation indicate the maturity of industry, as outside incentives become less important than the inherent business benefits these initiatives can yield, see (Figure 3.2).

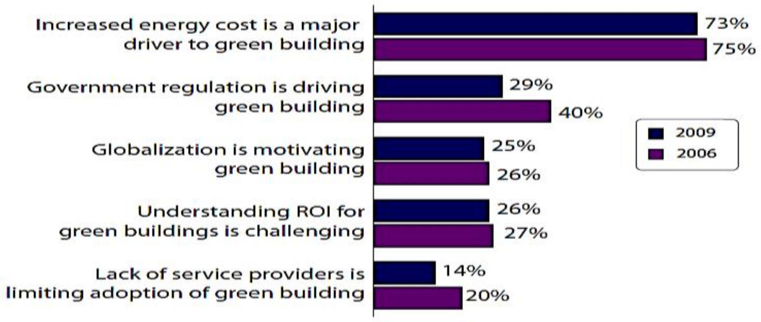


Figure 3.2 Motivations behind green building over time 2006-2009
Source: Haeberle, B. et al, Siemens Industry,(2009), Greening of corporate America the pathway to sustainability from strategy to action report, MC Graw Hill Construction.

[1]Tobias, L. et al, (2009), Retrofitting Office Buildings to Be Green and Energy-Efficient: Optimizing Building Performance, Tenant Satisfaction, and Financial Return, Urban Land Institute, Washington D.C.
[2] URL: http://www.institutebe.com/Existing-Building-Retrofits/Why-Focus-On-Existing-Buildings.aspx , accessed January 30, 2013.

The Building and Construction Industry (BCI) Australia survey for the Green Building Market Report in 2008 found that the main triggers for committing to green buildings included[1]:

· Rising energy costs: 77% (up from 74% in 2006)
· Client demand: 65% (up from 56% in 2006)
· Government regulations: 62% (up from 60% in 2006)
· Availability of green building technology: 60% (up from 5% in 2006)
· Worsening of environmental conditions: 57% (up from 27% in 2006)
· Lower lifecycle costs: 53% (down from 58% in 2006)
· Superior performance of a green building: 51% (up from 35% in 2006)
· Industry rating system: 48% (down from 53% in 2006)
· Increased education: 46% (up from 2% in 2006)
· Competitive advantage of green projects: 45% (up from 37% in 2006)
· Government rating system: 41% (down from 43% in 2006)

(Table 3.1) summarizes the driving forces for greening existing office buildings from the economic, environmental, cultural/social, and political/governmental aspects, these forces will be discussed in details in this chapter.

Table 3.1 Driving Forces for Greening Existing Office Buildings
Source: The Researcher.

Driving force		Commentary
Economic	Attractive Return on Investment (ROI)	Many energy retrofits and LEED-EB certifications are showing high rates of return on investment for owners
	Responsible Property Investing	Investors and owners committed to corporate social responsibility (CSR) are asking for certified green buildings, or applying green strategies and measures
	Future Competitiveness	Owners with a longer term perspective are concerned that their properties' attractiveness might diminish
	Concern about Energy Prices and Future Volatility	Energy is the largest cost of building operations and the least controllable
Environmental	Tackling Climate Change	Reducing greenhouse gas emissions from buildings, and resource conservation.
	Providing a cleaner and healthier work environment	Through applying green techniques
Cultural/Social	Tenant Demand, and Stakeholder Pressure	Employees, investors, tenants, and communities want green buildings
	Corporate Sustainability	Building owners see investing in sustainable measures as an important way to occupy a leadership position
	Increase of awareness	Towards the environment and the climate change problem; thus seeking solution through green buildings
Political/ Governmental	Mandatory programs and regulations, and introduction of new green codes and standards	Politicians worldwide seek strategies to encourage greater energy efficiency and more efficient resource utilization through political measures such as subsidies and tax cuts for renewable energies. (Increased energy independence will lead to increased national security)

3.2.1 Economic Driving Forces

For many firms there is no greater motivator than the financial bottom line. Utility charges are typically among the top operating expenses for buildings, and studies document energy savings for green buildings average 30% over conventional

[1] Building and Construction Industry BCI Australia, (2008), "Green Building Market Report", P 25.

buildings[1], this is confirmed by a report from McGrawHill, which finds overall operating costs to be lower by 8-9%[2].

Attractive return on investment (ROI) is certainly very important; a number of case studies of LEED-EB projects indicate that the "payback" on incremental investment can be as low as two years[3]. An analysis by the American Council for an Energy Efficient Economy shows that the average return on investment for energy efficiency projects is over 20%[4].

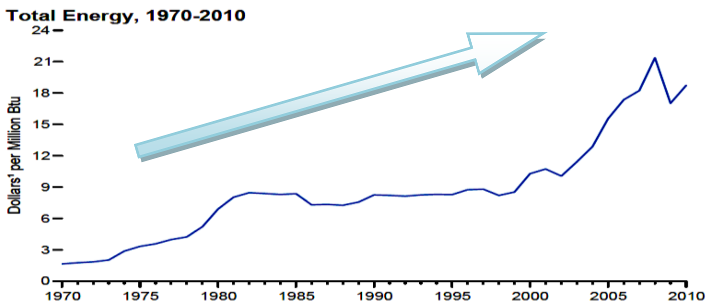


Figure 3.3 Total energy price estimates for consumer 1970-2010
Source: U.S. Energy Information Administration

أسعار بيع الطاقه الكهربائيه طبقاً للتقرير السنوى للشركه القابضه لكهرباء مصر 2006-2005

البيـــــان	السعر الحالى (قرش/ك.و.س)
١. استخدامات الطاقة على الجهد الفائق (قرش/ك.و.س)	
كيما	٤,٧
مترو الإنفاق رمسيس	٦,٨
فوسفات أبو طرطور	٦,٨
الشركة العربية لأنابيب البترول (سوميد)	٢٢,٠
باقى المشتركين ٢ – استخدامات الطاقة على الجهد العالى (قرش/ك.و.س)	١٠,٣
جميع المشتركين	١٢,٥
٣ – شركات الإسكان (قرش/ك.و.س)	١٢,٠
٤ – استخدامات الطاقة على الجهد المتوسط والمنخفض ١/٤ بقدرة أكبر من ٥٠٠ك.و (لجميع المشتركين)	
قسط شهرى ثابت عن الحمل الأقصى المسجل الفعلى (جنيه/ك.و.)	٨,٠
سعر موحد للطاقة (قرش/ك.و.س)	١٧,٠
٢/٤ بقدرة حتى ٥٠٠ ك.و (أ) الزراعة واستصلاح الأراضى	
سعر موحدة للطاقة (قرش/ك.و.س)	٩,٠
مقابل استهلاك الكهرباء للفدان للمنتفعين بمحطات الرى الجماعى (جنيه)	١٠٩,٠
(ب) باقى المشتركين سعر موحد للطاقة (قرش/ك.و.س)	٢٠,٠

٥ – الاستخدامات المنزلية

الهيكل	السعر (قرش/ ك.و.س)
١ – ٥٠ ك.و.س الأولى شهريا	٥,٠
٢ – ٥١ إلى ٢٠٠ك.و.س التالية	٩,٢
٣ – ٢٠١ إلى ٣٥٠ك.و.س التالية	١٢,٥
٤ – ٣٥١ إلى ٦٥٠ك.و.س التالية	١٨,٠
٥ – ٦٥١ إلى ١٠٠٠ك.و.س التالية	٢٥,٥
٦ – أكثر من ١٠٠٠ ك.و.س	٣١,٠

٦ – المحلات التجارية

الهيكل	السعر (قرش/ ك.و.س)
١ – ١٠٠ ك.و.س الأولى شهريا	١٩,٨
٢ – ١٠١ إلى ٢٥٠ك.و.س التالية	٢٨,٧
٣ – ٢٥١ إلى ٦٠٠ك.و.س التالية	٣٦,٦
٤ – ٦٠١ إلى ١٠٠٠ك.و.س التالية	٤٥,٣
٥ – أكثر من ١٠٠٠ ك.و.س	٤٧,٥

٧ – الإنارة العامة وإشارات المرور (قرش/ك.و.س)	٣٣,١

* الأسعار موضوعة على أساس معامل قدرة ٠,٩

أسعار بيع الطاقه الكهربائيه طبقاً للتقرير السنوى للشركه القابضه لكهرباء مصر 2012-2011 - أسعار بيع الطاقة اعتباراً من 2008/10/1

البيـــــان	السعر الحالى (قرش/ك.و.س)
١ - استخدامات الطاقة على الجهد الفائق (قرش/ك.و.س)	
كيما	٤,٧
مترو الانفاق رمسيس	٦,٨
الشركة العربية لانابيب البترول (سوميد)	٢٧,٣
باقى المشركين	١٢,٩
٢ - استخدامات الطاقة على الجهد العالى (قرش/ك.و.س)	
مترو الانفاق طره	١١,٣٤
باقى المشتركين	١٥,٧
٣ - استخدامات الطاقة على الجهد المتوسط والمنخفض	
٣/١ بقدرة اكبر من ٥٠٠ ك.و	
قسط شهرى ثابت عن الحمل الاقصى المسجل الفعلى (جنية /ك.و.)	٩,٥
سعر موحد للطاقة (قرش/ك.و.س)	٢١,٤
٣/٢ بقدرة حتى ٥٠٠ ك.و	
(أ) الزراعة واستصلاح الاراضى	١١,٢
مقابل استهلاك الكهرباء للفدان للمنتفعين بمحطات الرى الجماعى (جنية/فدان)	١٣٥,٢
(ب) باقى الاغراض	٢٥,٠

٤ - الاستخدامات المنزلية

الهيكل	السعر (قرش/ك.و.س)
١) من ٥٠ ك.و.س الاولى شهريًا	٥,٠
٢) من ٥١ الى ٢٠٠ ك.و.س التالية شهريًا	١١,٠
٣) من ٢٠١ الى ٣٥٠ ك.و.س التالية شهريًا	١٦,٠
٤) من ٣٥١ الى ٦٥٠ ك.و.س التالية شهريًا	٢٤,٠
٥) من ٦٥١ الى ١٠٠٠ ك.و.س التالية شهريًا	٣٩,٠
٦) من اكثر من ١٠٠٠ ك.و.س شهريًا	٤٨,٠

٥ - المحلات التجارية

الهيكل	السعر (قرش/ك.و.س)
١) من ١٠٠ ك.و.س الاولى شهريًا	٢٤,٠
٢) من ١٠١ الى ٢٥٠ ك.و.س التالية شهريًا	٣٦,٠
٣) من ٢٥١ الى ٦٠٠ ك.و.س التالية شهريًا	٤٦,٠
٤) من ٦٠١ الى ١٠٠٠ ك.و.س التالية شهريًا	٥٨,٠
٥) من اكثر من ١٠٠٠ ك.و.س شهريًا	٦٠,٠

٦ - الانارة العامة واشارات المرور (قرش / ك.و.س)	٤١,٢

● الاسعار موضوعة على اساس معامل قدرة ٠,٩

Figure 3.4 Energy Prices Rise(Tarrifs) in Egypt according to 2005-2006 and 2011-2012 annual reports
Source: Ministry of Electricity and Energy in Egypt

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1 Kats, Greg et al., (2003), The Costs and Financial Benefits of Green Buildings. A Report to California's Sustainable Building Task Force. USA.
2 McGraw Hill Construction (2006), Green Building Smart Market Report.
3 Yudelson, J. (2010), Greening existing buildings, McGraw-Hill books, USA.
4 URL: http://www.institutebe.com/Existing-Building-Retrofits/Why-Focus-On-Existing-Buildings.aspx , accessed January 31, 2013.

As for the future competitiveness, many building owners believe that they will be less competitive in future years without a certified building.

Energy prices and concern over their volatility, is of medium concern in the short and medium term. For most commercial office buildings, energy costs represent about one third of all operating costs[1] and are least controllable; thus rising in energy prices is a main economic driver to examine energy efficient buildings more closely; economists suggest that current increase in energy prices is not an anomaly and that the "era of cheap energy is over"[2]. See (Figure 3.3) and (Figure 3.4).

3.2.2 Environmental Driving Forces

The experts are calling for immediate and far-reaching action to fight global warming. One of the most important tasks is to reduce greenhouse gas emissions. The Intergovernmental Panel on Climate Change (IPCC) projects that without more immediate action to limit greenhouse gas emissions, global warming could cause irreversible and possibly catastrophic consequences[3]. Recent studies by the (IPCC), McKinsey & Company (an international consulting firm), and Vattenfall (a Swedish utility company), indicate that improved building practices are some of the quickest and cheapest ways to reduce significantly greenhouse gas emissions, often with net economic benefit[4].

Buildings over their life cycle account for a large share of global greenhouse gas emissions; consequently, green buildings and energy refurbishments hold enormous saving potential[5] which was explained in details in chapter one. A study by International Energy Agency (IEA) shows that if implemented globally, energy efficiency measures could deliver two-thirds of the energy-related CO2 emissions reductions needed to achieve climate protection[6]. See (Figure 3.5).

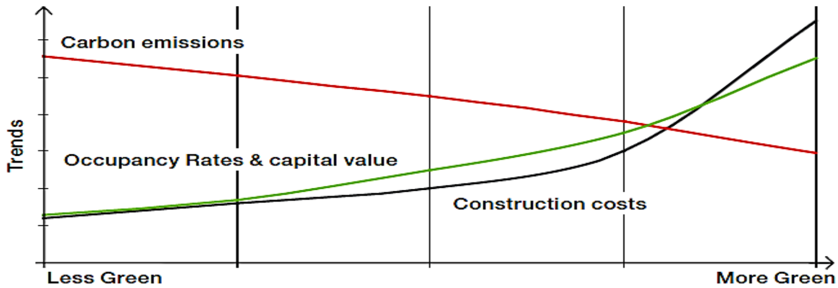

Figure 3.5 Effect of going green on CO2 emissions, occupancy rates, and construction costs.
Source: Langdon, D., (2007), The cost & benefit of achieving Green buildings data report, Innovative thinking in property and construction, series of Davis Langdon's insights into Sustainability, 2nd edition, P 3. URL: http://www.davislangdon.com/upload/StaticFiles/AUSNZ%20Publications/Info%20Data/InfoData_Green_Buildings.pdf , accessed January 10, 2013.

1Yudelson, J. (2010), Greening existing buildings, McGraw-Hill books, USA, P24.
[2] Lave, Lester B., (2008), The era of cheap energy is over, Pittsburgh-Post Gazette, URL: http://www.post-gazette.com/stories/opinion/perspectives/sunday-forum-the-era-of-cheap-energy-is-over-392436/ , accessed January 17, 2013.
[3] The Secretariat of the Commission for Environmental Cooperation (CEC), (2008), Green Buildings in North America Opportunities and Challenges, Article 13 report of the North American agreement on environmental cooperation, Communications Department of the CEC Secretariat, Canada., P5.
[4]Ibid, P5.
[5] Andrew, J. Nelson, Rakau, O., Dörrenberg, P., (2010), **Green buildings** A niche becomes mainstream, Deutsche Bank Research, Germany. URL: http://www.dbresearch.com/PROD/DBR_INTERNET_EN-PROD/PROD0000000000256216.pdf accessed January 5, 2013.
[6]Institute for Building Efficiency, Driving Transformation to Energy Efficient Buildings: Policies and Actions, URL: http://www.institutebe.com/energy-policy/Driving-Transformation-Energy-Efficient-Buildings2.aspx , accessed January 10, 2013.

3.2.3 Cultural/Social Driving Forces

Reflecting the rapid growth in public awareness of climate change and the need to reduce GHG emissions, the property industry is quickly coming to understand the fundamental importance of buildings in tackling climate change.

Perhaps the best indicator of the rapidly changing level of acceptance and adoption of green building practices is the increase in the numbers of buildings registered green building rating systems such as LEED; the total amount of LEED-certified buildings grew by one billion square feet in 2010, up to eight billion, or a growth rate of 14 percent[1], especially for the LEED certified existing buildings that are outpacing their newly built counterparts, according to the U.S. Green Building Council (USGBC), square footage of LEED-certified existing buildings surpassed LEED-certified new construction by 15 million square feet on a cumulative basis[2]. (Figure 3.6), and (Figure 3.7).

Tenants demand, this driver has come largely from corporate and governmental lessees, who want to locate in office space that their employees and other stakeholders will find attractive from a green standpoint and another reputational issue for companies is the rising need to report on their social achievements, including on the environment. The ability to attract and retain workers is also a factor. Younger workers in particular and especially highly-valued creative and knowledge workers, frequently consider a firm's record on social issues in making their employment choices[3].

Stakeholder Pressure can come from a variety of sources, including political sources and internal, in the form of employee pressure. Some cities are beginning to mandate LEED-EB certification for major retrofits; other pressure might come from the need to acquire a building energy label[4].

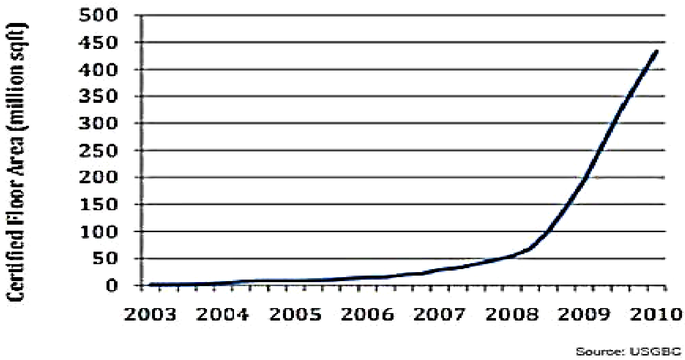

Figure 3.6 Growth in LEED Certified Space for Existing Buildings: Operations & Maintenance Certified Space
Source: U.S. Green Building Council, URL: http://www.institutebe.com/Green-Building/green-buildings-second-look.aspx , accessed January 20, 2013.

[1] Green building staff, (2010), LEED Buildings Grow by 14% Despite Market Crash, URL: http://www.greenbiz.com/news/2010/11/17/leed-buildings-grow-14-percent-despite-market-crash , accessed January 26, 2013.
2 Katz, A., (2011), Square Footage of LEED-Certified Existing Buildings Surpasses New Construction Uptake signals green building market sea change Report, USGBC. URL: http://www.usgbc.org/ShowFile.aspx?DocumentID=10712 , accessed January 26, 2013.
[3] Andrew, J. Nelson, Rakau, O., Dörrenberg, P., (2010), Green buildings A niche becomes mainstream, Deutsche Bank Research, Germany, P6. URL: http://www.dbresearch.com/PROD/DBR_INTERNET_EN-PROD/PROD0000000000256216.pdf accessed January 5, 2013.
[4] Yudelson, J. (2010), Greening existing buildings, McGraw-Hill books, USA.

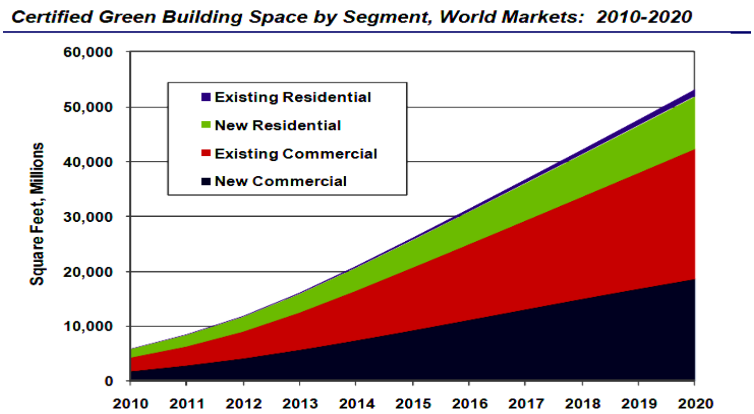

Figure 3.7 Certified Green Building Space by Segment, World Markets: 2010-2020 (Pike Research forecasts that cumulative green building certified space will grow from about 6 billion sf in 2010 to about 53 billion sf worldwide in 2020. Taking market conditions and regulatory changes into account, commercial buildings will likely represent about 80% of space certified under green building programs in 2020. While LEED and BREEAM will continue to dominate the North American and European green building markets, respectively, newly developed programs in China and India are likely to represent about 30% of all certified green new construction by 2020.)
Source: Pike Research

3.2.4 Political Driving Forces

Government regulations and programs help to drive the market. These programs are generally driven in large part by a desire to save energy and water costs and to improve living and working conditions through government supported research, development, educational programs, and tax shifting.

Many state, provincial, and local governments have also adopted or moved to adopt legislation to address environmental impacts of buildings. Municipal programs have helped accelerate the dissemination and use of green technologies through the use of local codes and programs. Most of these have required that public buildings meet minimum levels of green building design or performance; increasingly a number of jurisdictions have begun to impose green building requirements for private construction[1].

A survey of the largest corporations in America by SIEMENS INDUSTRY (in total, the firms interviewed represent over 75% of the $36 Trillion U.S. equities market), mentions attitudes toward emission reduction policies and demonstrates the strong agreement over the importance of prioritizing renewable energy, over three quarters of respondents agree that:

- Increased energy independence will lead to increased national security
- Investing in clean energy will help limit the use of fossil fuels
- Increasing the percentage of electricity from renewable sources is an important national priority

Furthermore 74% believe that investing in green energy jobs will support the economy as well as the environment. However, despite the strong agreement on the importance of these proposals, there is lack of consensus over how to finance and achieve these goals.

[1]The Secretariat of the Commission for Environmental Cooperation (CEC), (2008), Green Buildings in North America Opportunities and Challenges, Article 13 report of the North American agreement on environmental cooperation, Communications Department of the CEC Secretariat, Canada, P51.

- Only 40% agree to pay more for clean technology
- Only 31% agree that cap and trade program[1] will help reduce GHG emissions. See (Figure 3.8).

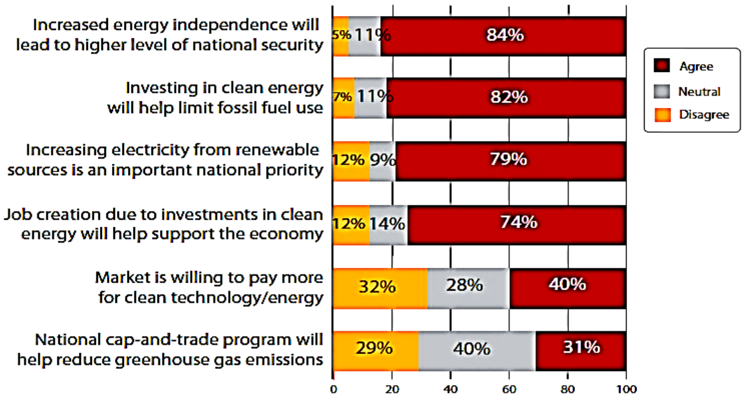

Figure 3.8 Attitude towards Renewable energy impact and green policies
Source: Haeberle, B. et al, Siemens Industry,(2009), Greening of corporate America the pathway to sustainability from strategy to action report, MC Graw Hill Constuction.

3.3 The Business Case Benefits of Greening Existing Office Buildings

Undertaking a green retrofit of a building brings about both tangible and intangible benefits to the owner, tenants, investors, and property managers. It can reduce the energy consumption, utilities and water consumption. It also improves the building's indoor environment quality and reduces the negative impacts of buildings on occupants, especially work-environment related illnesses or 'sick building' syndrome[2].

SIEMENS INDUSTRY survey, demonstrates a substantial growth in green activity over the last three years with a shift in focus from internal operations and public relations to a core part of business performance, one of the key findings of the survey is strong business benefits to be expected, over three quarters of corporate executives expect green efforts to retain and attract customers and to drop costs of doing business. (Figure 3.9).

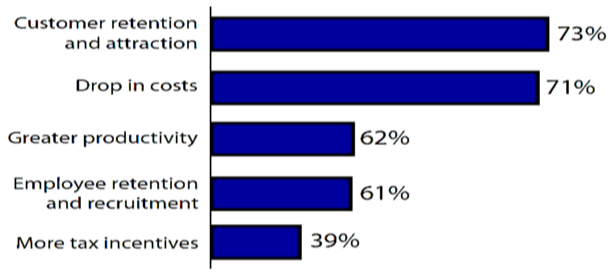

Figure 3.9 Expected business benefits from green measures adoption
Source: Haeberle, B. et al, Siemens Industry,(2009), Greening of corporate America the pathway to sustainability from strategy to action report, MC Graw Hill Constuction.

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[1] Cap and trade is an environmental policy tool that delivers results with a mandatory cap on emissions while providing sources flexibility in how they comply. Successful cap and trade programs reward innovation, efficiency, and early action and provide strict environmental accountability without inhibiting economic growth. URL: http://www.epa.gov/captrade/ , accessed January 11, 2013.

[2] The Centre for Sustainable Buildings and Construction, (2010), existing building Retrofit guide, Building and Construction Authority, Arup Singapore, BCA, Singapore. URL: http://www.bca.gov.sg/GreenMark/others/existingbldgretrofit.pdf , accessed January 7, 2013.

The business case for greening existing office buildings is based on a framework of benefits: economic, financial, productivity, public relations and marketing, and project funding. See (Table 3.2).

Table 3.2 Benefits of Green Building.
Source: BetterBricks Bottom Line Thinking on Energy, (2007), THE HIGH PERFORMANCE PORTFOLIO: GREEN BUILDING RATING SYSTEMS. URL: www.betterbricks.com/office/briefs, accessed December 1, 2012.

Business Case Benefits of Green Buildings	
Tenants	✚ Potential for reduced utility costs ✚ More appealing work environment, ✚ leading to an enhanced ability to recruit and attract talent ✚ Greater productivity due to health and environmental benefits ✚ Reflection of tenant's sustainability goals and corporate image
Owners	✚ Potentially expedited permitting for new construction and major renovation ✚ Maximized results on investments through reduced operating costs ✚ Through commissioning, greater certainty that a building will perform as expected ✚ Extended equipment life due to "right-sizing" and improved operations (less need for refurbishment in the future) ✚ Higher rents ✚ Greater occupancy ✚ lower tenant turnover ✚ enhanced marketability ✚ reduced liability and risk
Investors	✚ Improved long-term value through reduced performance risk ✚ Higher resale value
Property managers	✚ Management advantages gained through a high-performance building, yielding improved comfort, increased tenant retention, and reduced operating costs ✚ Fewer tenant and owner complaints ✚ Potential for greater building marketability

3.3.1 Benefits Directly to the Building Owner

According to a new survey published by FMLink, the Building Owners and Managers Association (BOMA) International, the U.S. Green Building Council (USGBC) and the Association for Facility Engineers (AFE), more and more facility owners and managers are implementing re-commissioning and energy audits to measure and improve their building's energy performance[1], (Figure 3.10) summarizes the benefits to green buildings owners.

[1] Survey by FMLink, others, finds aggressive approach to energy savings, (2008), URL: http://www.fmlink.com/article.cgi?type=News&archive=true&title=Survey%20by%20FMLink%2C%20others%2C%20finds%20aggressive%20approach%20to%20energy%20savings&mode=source&catid=1000&display=article&id=25121 , accessed January 7, 2013.

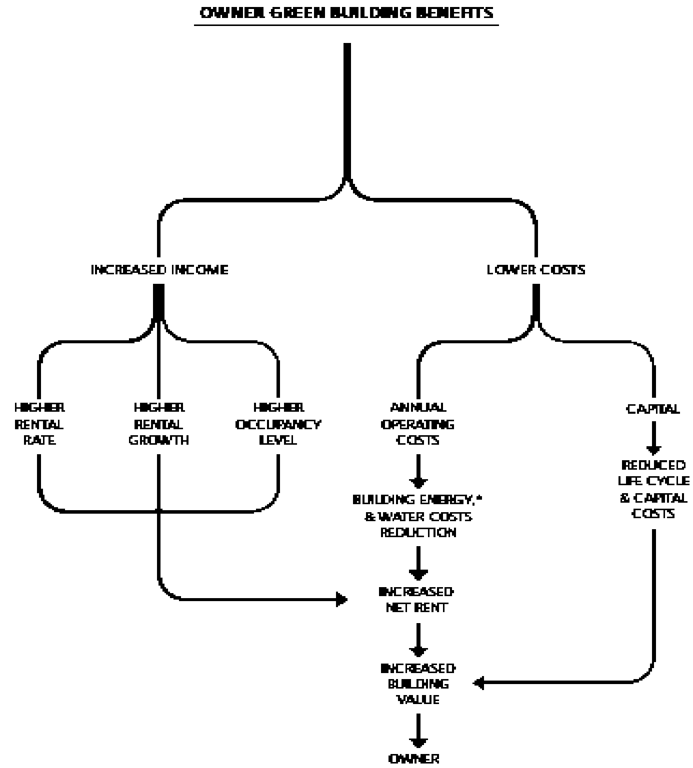

Figure 3.10 Owner Green Building Benefits
Source: Jones, L., (2008), The Dollars and Sense of Green Buildings report Building the business case for green buildings in Australia, Green Building Council of Australia, P 37.

3.3.1.1 Economic and Financial Benefits

Increased economic benefits are the prime drivers of change for most innovations; for energy efficient and green buildings, these benefits take a variety of forms, and their full consideration is vital for promoting any sustainability initiatives.

Reduced Operating Costs: Direct operating costs include all expenditures incurred to operate and maintain a building over its full life. Obvious costs are energy and water consumption, security, cleaning, minor repairs and routine maintenance activities. However, this cost category also includes less obvious costs such as property taxes, insurance, and the costs of reconfiguring and upgrading space and services to accommodate occupant moves. Excluded are the costs of major renovations that are considered to be direct capital investments[1].

Owners of green projects reported Operating costs decreased by 13.6% for new construction and 8.5% for existing building projects[2].

Reduced Maintenance Costs: (Figure 3.11) By looking at the buildings that have had re-commissioning at least twice a year there are clear indications that they are likely to have considerable energy savings (the height of each column trends downward from left to right). There were no such trends for re-commissioning when done once a year or less. When there was no re-commissioning the trend goes upwards to the right,

[1] Jones, L., (2008), The Dollars and Sense of Green Buildings report Building the business case for green buildings in Australia, Green Building Council of Australia, P 37.
[2] McGraw Hill Construction (2010). Green Outlook 2011: Green Trends Driving Growth.

indicating that one is less likely to experience energy savings. Note: The percentages of energy savings represent savings over the most recent two-year period[1].

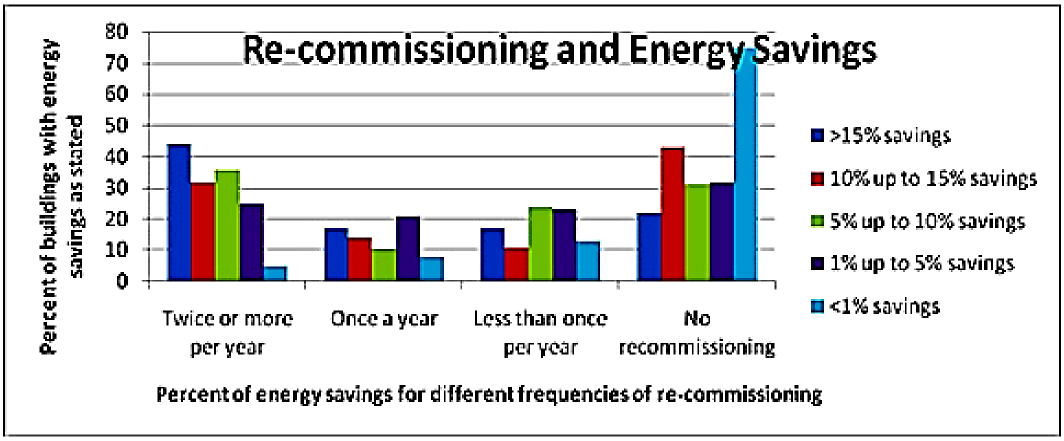

Figure 3.11 Recommissioning and Energy Savings through applying green measures
Source: FMLink URL:
http://www.fmlink.com/article.cgi?type=News&archive=true&title=Survey%20by%20FMLink%2C%20others%2C%20finds%20aggressive%20approach%20to%20energy%20savings&mode=source&catid=1000&display=article&id=25121 , accessed January 7, 2013.

More competitive product: Green buildings with lower operating costs and better indoor environmental quality are more attractive to a growing group of corporate, public, and individual tenants[2].

Companies are finding that they can achieve revenue or job growth while maintaining a high environmental and social impact[3].

Increase rental rates: A 2008 CoStar Group study found that green buildings outperform their non-green peer assets in key areas, such as occupancy, sale price, and rental rates, sometimes by wide margins. According to the study, LEED buildings command rent premiums of $11.33 per square foot over their non-LEED peers and have 4.1 percent higher occupancy. Rental rates in Energy Star buildings (green certified building) represent a $2.40 per square foot premium over comparable non-Energy Star buildings and have 3.6 percent higher occupancy[4].

Green building owners reported an increase in occupancy by 6.4% for new construction and 2.5% for existing building projects[5]

3.3.1.2 Productivity Gains

In the service economy, productivity gains for healthier indoor spaces are worth anywhere from one to five employee costs, for example eleven case studies strongly suggest that innovative day lighting systems can pay for themselves in less than one

[1] Survey by FMLink, others, finds aggressive approach to energy savings, (2008), URL: http://www.fmlink.com/article.cgi?type=News&archive=true&title=Survey%20by%20FMLink%2C%20others%2C%20finds%20aggressive%20approach%20to%20energy%20savings&mode=source&catid=1000&display=article&id=25121 , accessed January 7, 2013.
[2] Spencer, M., (2011), The Business Case for Green Building Article , Heating/Piping/AirConditioning HPAC engineering site, URL: http://hpac.com/news/business-case-for-green-building-0118 , accessed January 17,2013.
[3] Conlon, E. and Glavas, A. (2012). The Relationship Between Corporate Sustainability and Firm Financial Performance. URL: business.nd.edu/uploadedFiles/Conlon%20and%20Glavas%202012.pdf, accessed December 6, 2012.
[4]USGBC, The Business Case for LEED , URL: http://www.usgbc.org/DisplayPage.aspx?CMSPageID=2331 , accessed January 17, 2013.
[5] McGraw Hill Construction (2010). Green Outlook 2011: Green Trends Driving Growth.

year due to energy and productivity benefits[1], in (Figure 3.12)the median productivity gains equals 3.2 percent from high performance lighting, this is in addition to a reported average savings of 18 percent on total energy bills from proper lighting[2].

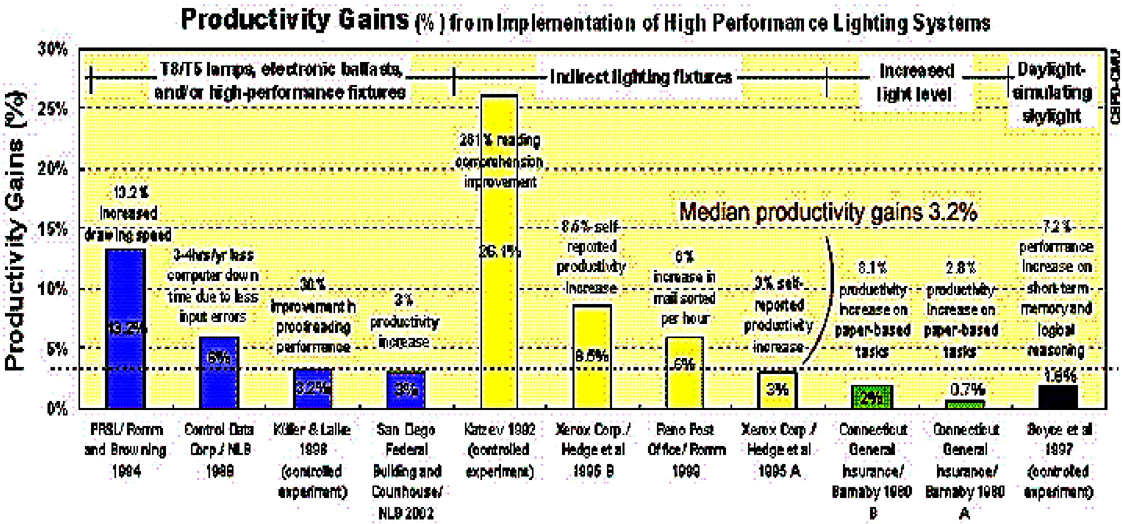

Figure 3.12 Many international studies strongly suggest gains in employee health and productivity from improving the quality of interior lighting and integrating natural daylighting with artificial lighting.
Source: http://cbpd.arc.cmu.edu/ebids/images/strategy/lighting_benefit_03.gif, accessed January 7, 2013.

According to researchers, green building has the potential to generate an additional $200 billion annually in worker performance in the United States by creating offices with better indoor air[3].

Health Improvements: A key element to productivity is healthy workers. By focusing on measures to improve indoor environmental quality such as increased ventilation, day lighting, view to outdoors, and low toxicity finishes and furniture, people in green buildings show an average reduction in symptoms of 41.5 percent on an annual basis, according to 17 academic studies reviewed by researchers at Carnegie Mellon University[4].

3.3.1.3 Reduced Liability and Risk Management

According to an Organization for Economic Cooperation and Development (OECD) report health problems from indoor air pollution have become one of the most acute problems related to building activities. Pollutants from building materials, ranging from paints to backing materials, lead to occupational health issues. Considering 25% of an office worker's life, or 40% of their waking hours are spent inside commercial buildings, there is now a realization that conventional building practices expose people to raised levels of toxins[5].

'Sick Building Syndrome', whilst unheard of in Egypt, are very common in the United States, owners and managers are increasingly facing legal action from tenants

[1] URL: http://cbpd.arc.cmu.edu/ebids/pages/home.aspx , accessed January 7, 2013.
[2] URL: http://cbpd.arc.cmu.edu/ebids/pages/strategy.aspx?group=3&strategy=1 , accessed January 7, 2013.
[3] The American Institute for Architects, URL: http://www.aia.org/aiarchitect/thisweek05/tw1021/tw1021plantsatwork.cfm , accessed December 27, 2012.
[4] Center for Building Performance and Diagnostics, Carnegie Mellon University. BIDS: Energy Building Investment Decision Support Tool. URL: http://cbpd.arc.cmu.edu/ebids/ , accessed January 7, 2013.
[5] Organization for Economic Cooperation and Development (OECD) "Environmentally Sustainable Buildings Challenges and Policies" 2003, Paris.

blaming the building for their health problems[1]. Good indoor environment can reduce the risk of lawsuits and insurance claims, in Bloomquist v. Wapello county, Lowa 1993, workers successfully sued their employers for providing inadequate ventilation and failing to provide a safe work place[2].

As more data is compiled on the risks of poor ventilation and air supply, and cross contamination of illnesses, tighter controls on the Indoor Environment Quality (IEQ) of commercial buildings should be taken into action. Since property owners are responsible for IEQ, it is prudent for owners to reduce their liability.

Another risk management benefit of green buildings in the private sector is the faster sales and leasing of such buildings, compared with similar projects in the same town. Green buildings can be easier to rent and sell because tenants increasingly understand their benefits[3]. (Figure 3.13).

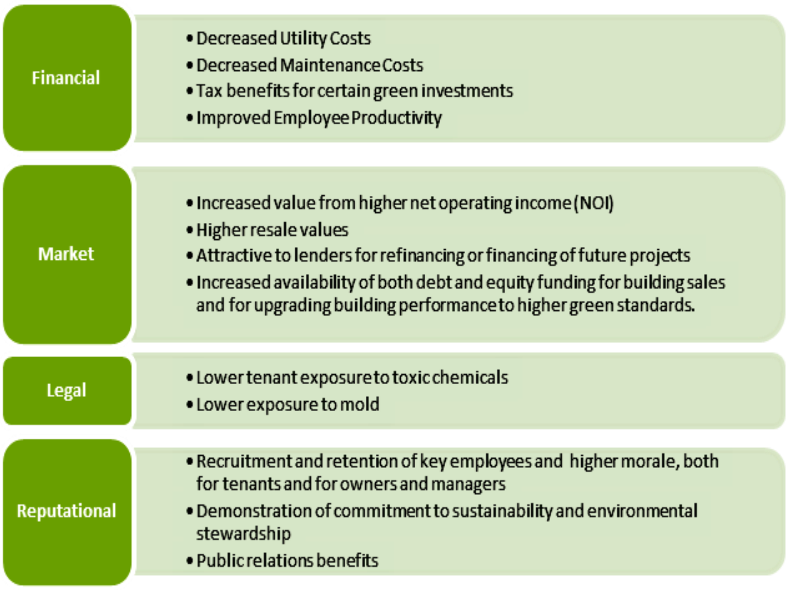

Figure 3.13 Risk Mitigation from Green Building
Source: Yudelson, J. (2010), Greening existing buildings, McGraw-Hill books, USA.

3.3.2 Benefits Directly to the Tenants

The pursuit of Green ratings is becoming increasingly relevant to both building owners and tenants. Tenants are placing a higher value on the intangible benefits, which include productivity, staff attraction and retention, reduced sick leave and absenteeism and improved organization culture, morale and wellbeing.

According to the Bond University online staff survey having a green building is likely to have a positive effect on attracting and retaining employees as 93% of employees said it is important to work in a green office[4]. This is reinforced by 66.6% of business managers stating they believed that renting /owning a green building has

[1] Lucuik, M., (2005), A Business Case for Green Buildings in Canada, Morrison Hershfield, Ontario.
[2] Withkin, James B., (2004), Environmental Aspects of Real Estate and Commercial Transactions, Section of environment, energy, and resources real property, Probate and trust section, American Bar Association, Chicago, P656-657.
[3] Spencer, M., (2011), The Business Case for Green Building Article , Heating/Piping/AirConditioning HPAC engineering site, URL: http://hpac.com/news/business-case-for-green-building-0118 , accessed January 17,2013.
[4]Bond University Mirvac School of Sustainability, (2008), Enhancing Performance of Green Star Rated Buildings report. URL: http://www.bond.edu.au/prod_ext/groups/public/@pub-burcs-gen/documents/genericwebcontent/bd3_015058.pdf , accessed January 10, 2013.

helped to attract and/ or retain their employees[1]. The survey revealed that the marketability and branding ability were the most recognized strengths of a green office by occupants. When asked about what they think of their employers who provide such workplace environment, the majority agreed that they are proud of their employers. The majority of respondents noted the high importance and positive psychological attributes that the green office had on them.

The major benefits for tenants in occupying a green building are explained in (Figure 3.14).

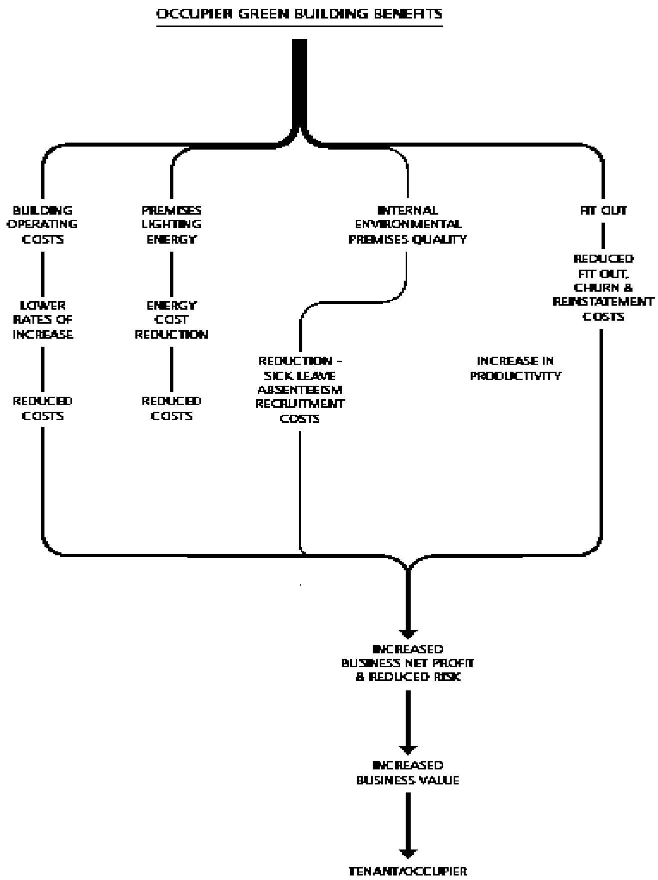

Figure 3.14 Benefits of green building to tenants[2]
Source: Jones, L., (2008), The Dollars and Sense of Green Buildings report Building the business case for green buildings in Australia, Green Building Council of Australia, P 51.

3.3.3 Benefits Directly to the Investors

There is now growing, but not universal, acceptance that 'green' is being reflected in values[3]. By creating more desirable working and living conditions, green buildings can offer a handsome return on investment. The following opportunities have been identified for investors:

[1] Ibid.
[2] *Churn:* defined as the frequency with which a building's occupants are moved, either internally or externally, including those who move but stay within an organization, and those who leave a company and are replaced. Churn is caused by business restructuring, staff increases, staff reductions, bad space planning and management whims. Jones, L., (2008), The Dollars and Sense of Green Buildings report Building the business case for green buildings in Australia, Green Building Council of Australia, P 53.
[3] Jones, L., (2008), The Dollars and Sense of Green Buildings report Building the business case for green buildings in Australia, Green Building Council of Australia, P 39.

Capital Cost Savings: Optimizing building environmental systems to interact synergistically can lead to substantial savings in capital cost. For example, downsizing HVAC systems through energy efficient design not only produces savings in ductwork but, by reducing the requirement for bulky mechanical equipment, more floor space can be made available for leasing.

Enhanced Value: Green buildings have an enhanced ability to rent or sell space based on their superior indoor environment, lower operating costs and enhanced marketability[1]. Building value increases 10.9% new construction and 6.8% existing building projects[2].

Improved Marketability: Building green creates a distinct product in the marketplace, which can be integrated with corporate image and used to market the property to attract and retain tenants.

Publicity: Green buildings can generate media interest and publicity. The increased marketing potential of a superior building can recapture some of the costs associated with green building through faster leasing and reduced costs for promotional advertising.

Future Proofing: Green buildings use less water and energy than conventional buildings, thereby providing a buffer against future increases in water and energy services costs and protecting against services shortages, another benefit that can be marketed to customers[3].

Higher Building Valuations: Reducing operating costs, capturing lease premiums and building more competitive, future proofed projects provide a basis for higher valuations. Return On Investment (ROI) improvements: 19.2% on average for retrofit/renovation green projects as compared to 9.9% on average for new projects[4]

3.4 Barriers to Greening Existing Office Buildings

"Green" building projects worldwide are proving the viability of resource-efficient, health-conscious design as discussed earlier. Increasingly, governments and the public perceive the need for more sustainable building products and practices. But it isn't the mainstream due to the following barriers. These barriers reduce the growth rate of green building renovations and make them more costly.

According to the Turner Company survey (2008), Executives were asked to rate the significance of eight issues in potentially discouraging the construction of Green buildings measures (Figure 3.15), At the top of the list was the amount of documentation and additional cost to have a building become LEED-certified, which was rated as an extremely or very significant obstacle to Green construction by 54% of executives. In spite of these perceived difficulties, LEED certification has achieved widespread recognition, and most executives find that it provides value as mentioned earlier. Two issues relating to the cost of Green construction came next—higher construction costs and the length of the payback period—which were each rated as extremely or very significant obstacles by half of the executives. This is an indication

1 Ibid, P 45.
2 McGraw Hill Construction (2010). Green Outlook 2011: Green Trends Driving Growth.
3 Jones, L., (2008), The Dollars and Sense of Green Buildings report Building the business case for green buildings in Australia, Green Building Council of Australia, P 46.
4 McGraw Hill Construction (2010). Green Outlook 2011: Green Trends Driving Growth.

of the fact that many executives incorrectly believe that Green construction is significantly more expensive than traditional building methods, when in fact it can often be achieved with little or no cost premium[1].

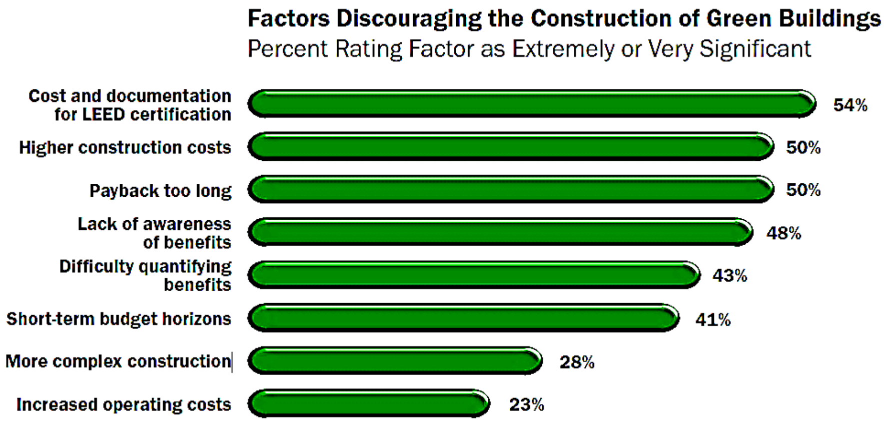

Figure 3.15 Barriers to the construction of green buildings
Source: Turner Construction, (2008), Green Building Market Barometer. URL: http://www.turnerconstruction.com/content/files/Green%20Market%20Barometer%202008.pdf , accessed January 26, 2013.

3.4.1 Split Incentives

Often the one paying the bill and the one capturing the benefits differ. A developer may not be interested in paying for green features when the benefits will be passed on to the new owners or tenants—unless, of course, he is able recoup the additional cost of green features in the sale price or project income realized. The split incentive problem is particularly evident for new homes and condominiums and for nonowner- occupied existing commercial buildings where, because of high turnover rates, owners may want short payback periods on energy-saving investments[2].

3.4.2 Higher Perceived or Actual First Costs

Higher perceived or actual first costs of many green building strategies and technologies are a significant disincentive.

3.4.3 Risk and Uncertainty

- Uncertainty over reliability of green building technologies;
- Uncertainty over costs of developing a green building;
- Uncertainty about the economic benefits of greening existing buildings; and
- Uncertainty about building performance over time[3].
- Uncertainty and worry about the payback period.

According to another survey by Turner Construction (2012), Concerns Persist about Construction Costs and the Length of the Payback Period, 44% of executives said they would accept five years and almost 80% of executives said they would accept a payback period of five years or longer. Despite the acceptance by most

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[1]Turner Construction, (2008), Green Building Market Barometer. URL: http://www.turnerconstruction.com/content/files/Green%20Market%20Barometer%202008.pdf , accessed January 26, 2013.
[2] The Secretariat of the Commission for Environmental Cooperation (CEC), (2008), Green Buildings in North America Opportunities and Challenges, Article 13 report of the North American agreement on environmental cooperation, Communications Department of the CEC Secretariat, Canada., P55.
[3]Ibid, P56.

executives of an extended payback period, 61% of executives still felt that the length of the payback period was an extremely or very significant obstacle to the construction of Green buildings while 62% cited higher construction costs[1], see (Figure 3.16).

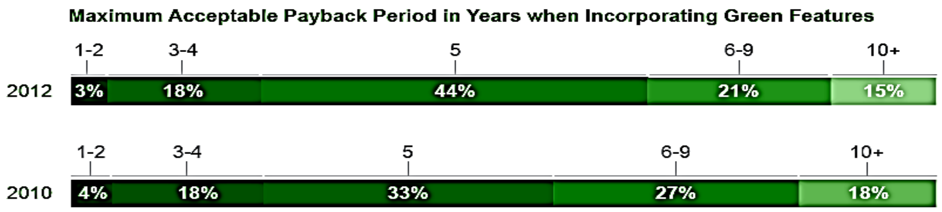

Figure 3.16 Maximum Acceptable Payback Period in Years when Incorporating Green Features.
Source: Turner Construction, (2012), Green Building Market Barometer. URL: http://www.turnerconstruction.com/download-document/turner2012greenmarketbarometer.pdf , accessed January 26, 2013.

3.4.4 Lack of Experienced Workforce

There is lack of experienced workers and thus increasing the risk of inexperienced or untrained service providers entering the green building market in search of a premium on their services.

3.4.5 Scarce Product Information and Sourcing

Scarce and poorly accessible information available on green products and high-performance building systems. The lack of information about performance and cost attributes of building elements can force projects to depend on specialized consultants. Alternatively, designers and builders risk costly call-backs to remedy green products that don't perform well[2].

3.4.6 Lack of Coordination and Consistency in Government Policies Affecting Buildings

For example, building codes can hinder the use of alternative building materials and innovative design strategies, unintentionally require environmentally harmful practices, and fail to require environmentally preferable practices.

3.4.7 Lack of Research Investments

In the United States a recent report found that funding for research related to green building practices averaged $193 million per year from 2002 to 2005. This represents only 0.02 percent of the estimated annual value of US building construction and 0.2 percent of all federal research[3].

3.4.8 Organizational Dynamics

In a multitenant building, it take participation from nearly all the tenants to achieve a green certification (for example LEED-EBOM), and that can be very

[1]Turner Construction, (2012), Green Building Market Barometer. URL: http://www.turnerconstruction.com/download-document/turner2012greenmarketbarometer.pdf , accessed January 26, 2013.
[2]URL: http://www.greenbiz.com/blog/2001/11/01/barriers-building-green , accessed January 26, 2013.
[3]US Green Building Council, (2007), Green Building Research Funding: An Assessment of Current Activity in the United States, URL:http://www.usgbc.org/ShowFile.aspx?DocumentID=2465, accessed January 17, 2013.

difficult to achieve. Even in a single tenant building; getting everyone to adopt policies, provide data, and cooperate during the performance period for the project can often be quite difficult[1].

3.4.9 Lack of Awareness

Lack of awareness of the benefits that Green buildings provide was an important obstacle that potentially discourages Green construction. This underscores the need for continued education about both the financial and non-financial benefits of Green construction. And the client knowledge barrier pertains to codes and regulations. As the regulation of building design and construction becomes increasingly complex, developers and clients have difficulty assessing the costs and requirements of complying with regulations. When regulations require modification of a building design or site plan, clients sometimes conclude that the green specifications have caused these costly delays[2].

(Figure 3.17) shows the challenge of greening the Existing buildings, Barriers, Drivers, and Benefits. Benefits are considered drivers to greening existing buildings; barriers can be overcome by means of some of the drivers either environmental, cultural, economic, or governmental.

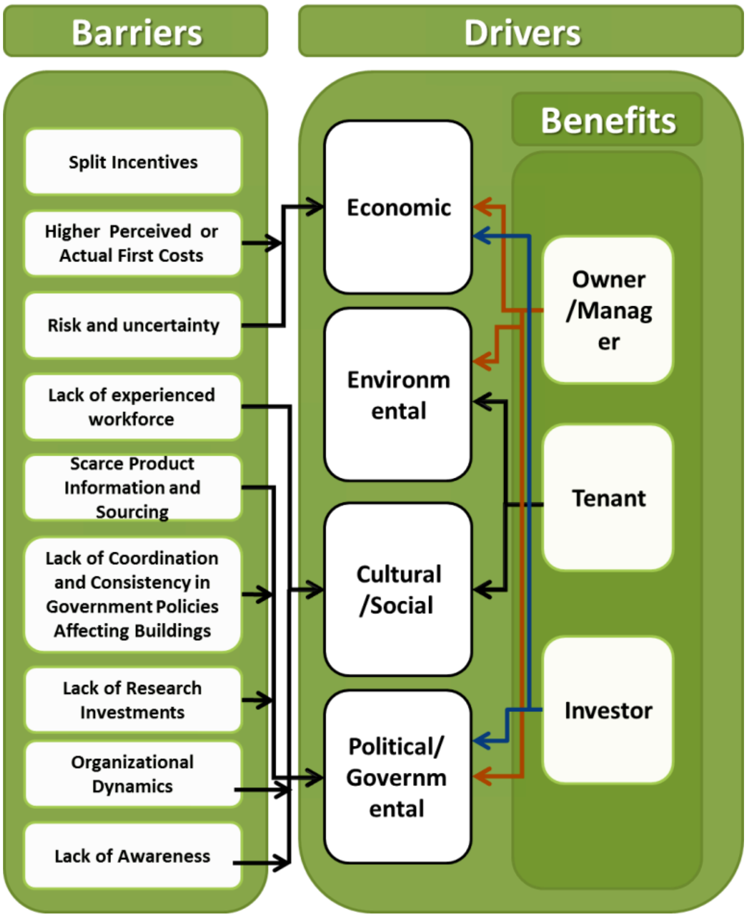

Figure 3.17 The Challenge of Greening Existing Buildings
Source: The Researcher

[1]Yudelson, J. (2010), Greening existing buildings, McGraw-Hill books, USA.
[2]URL: http://www.greenbiz.com/blog/2001/11/01/barriers-building-green , accessed January 26, 2013.

3.5 Initiatives to Greening Existing –Office- Buildings

A building doesn't have to be new to be green. Today's building owners are retrofitting buildings, converting existing buildings into models of sustainability. They are using new financing tools such as performance contracting to minimize financial risk and maximize energy savings[1]. With an emphasis on "whole building" rather than piecemeal approaches, existing buildings can significantly lower energy consumption and greenhouse gas emissions while producing financial rewards for owners.

3.5.1 Global Environmental Management Initiative (GEMI)

Founded in 1990, GEMI is an organization of leading companies dedicated to foster global environmental, health and safety (EHS) and sustainability excellence through the sharing of tools and information to help business achieve environmental sustainability excellence. GEMI currently has 26 member companies representing more than 12 business sectors[2]. It provides a way for companies in a wide range of industrial sectors to work together in a cost effective manner. Members address strategic and tactical issues impacting progressive corporate environmental, health and safety activities in their companies around the world.

3.5.2 U.S. Department of Energy's Commercial Building Alliance

The U.S. Department of Energy supports research, development, and deployment projects that increase energy efficiency nationwide. Funds to help commercial builders, businesses, and homeowners reduce energy use through energy efficiency and renewable energy technologies through DOE programs for buildings, how to use efficient and renewable energy in buildings, and access information resources and financial incentives[3]. One of the programs is The Building Technologies Program (BTP) that works with the commercial building industry to accelerate the uptake of energy efficiency technologies and techniques in both existing and new commercial buildings. By developing, demonstrating, and deploying cost-effective solutions, BTP strives to reduce energy consumption across the commercial building sector by at least 1,600 TBtu[4].

3.5.3 Coalition for Environmentally Responsible Economies (Ceres)

This helps companies develop sustainability and green plans, manage annual reporting, and institute continuous performance improvements. Founded in Boston in 1989, Ceres now works with 82 firms[5].

3.5.4 Environmental Protection Agency (EPA) Green Power Partnership

Launched in 2001, this program that includes 1135 partner companies emphasizes the increased use of alternative energy through estimating annual electricity use, reviewing purchase requirements and locating and purchasing green power[6].

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[1] Institute for Building Efficiency, URL: http://www.institutebe.com/Existing-Building-Retrofits.aspx , accessed January 28, 2013.
[2] URL: http://www.gemi.org/AboutGEMI.aspx , accessed January 30, 2013.
[3] U.S. Department of Energy, URL: http://www.eere.energy.gov/topics/buildings.html , accessed January 30, 2013.
[4] U.S. Department of Energy , URL: http://www1.eere.energy.gov/buildings/commercial/index.html , accessed January 30, 2013.
[5] URL: http://www.ceres.org/ , accessed January 30, 2013.
[6] Environmental Protection Agency , URL: http://www.epa.gov/greenpower/ accessed January 30, 2013.

Organizations that become Green Power Partners can benefit from earned media recognition, EPA communications support, and resources such as the Green Power Equivalency Calculator and Green Power Partner mark.

3.5.5 California's Comprehensive Energy Efficiency Program for Existing Buildings (Under Development)

AB758 (Chapter 470, Statutes of 2009) requires the Energy Commission to develop and implement a comprehensive program to achieve greater energy savings in the state of California's existing residential and nonresidential building stock. The Energy Commission will conduct regulatory proceedings to establish the program, titled the "Comprehensive Energy Efficiency Program for Existing Residential and Nonresidential Buildings." The program is to be comprised of a complimentary portfolio of techniques, applications, and practices, to achieve greater energy efficiency in existing residential and nonresidential structures, especially those structures that fall significantly below the efficiency required by the current California Building Energy Efficiency Standards[1]. Proposed program strategies include:

- Energy assessments
- Building benchmarking
- Building energy use ratings and labels
- Cost-effective energy efficiency improvements
- Public and private sector energy efficiency financing
- Public outreach and education
- Green workforce training

3.5.6 Commercial Building Disclosure (CBD) Australia

A national program designed to improve the energy efficiency of Australia's large office buildings. Most sellers or lessors of office space of 2,000 square meters or more are required to obtain and disclose a current Building Energy Efficiency Certificate (BEEC). A BEEC is comprised of:

- a NABERS Energy star rating for the building
- an assessment of tenancy lighting in the area of the building that is being sold or leased and
- general energy efficiency guidance[2]

3.5.7 GreenBuild International Conference and Expo (USA)

Greenbuild is an annual conference and exhibition organized by the USGBC. It attracted 13,329 registrants in 2010, with 477 exhibitors and 43 countries represented[3]. The exhibition promotes green building industry, including environmentally responsible materials, sustainable architecture techniques and public policy. This year (2013) it will be held in Philadelphia on November 20-22[4].

[1] URL: http://www.energy.ca.gov/ab758/ , accessed February 1, 2013.
[2] Australian Government, URL: http://www.cbd.gov.au/ , accessed February 15, 2013.
[3] URL: http://www.greenbuildexpo.org/Home.aspx , accessed February 23, 2013.
[4] Ibid.

3.5.8 Greenbuild Expo and Conference (United Kingdom)

The UK's newest sustainable building and refurbishment event, essential and informative event for the construction industry covering everything from training opportunities and renewable technologies to sustainable materials and legislation updates[1]. This event is sponsored by UK Green Building Council.

3.5.9 Carbon/energy tax policy

Energy tax is used, a consumer will have to pay an amount of tax proportional to the amount of energy consumed, quantified and based on common units, such as the oil equivalent or British Thermal Unit (BTU)[2]. The energy tax is, therefore, only indirectly related to GHG emissions. The use of carbon tax links the taxation policy directly to the abatement objective. Since in addition to the consumed amount, the tax is based on the carbon content of the fuel burnt. Carbon tax was first introduced as a regulatory instrument in Norway in 1991 [3]as a national policy for reducing CO2 emissions, and similar policies have been adopted in many other countries.

Many economists and international organizations regard carbon or energy tax a more cost-effective policy than other regulatory instruments for reducing CO2 emissions[4]. Carbon or energy taxes are revenue to the government, which will allow the government to reduce other taxes, such as sales, income, profit and property taxes, without affecting the government's budgetary position and the overall tax burden on society.

3.5.10 Egyptian Group for Energy in Buildings and Environmental Design Research (Egypt)

The Egyptian Group for Energy in Buildings and Environmental Design Research has been established by Dr. Mohammad Fahmy and Dr. Shady Attia upon gathering the ideas of Prof. Dr. Abdel-Monteleb Mohamed Aly, Prof. Dr Morad Abdel-Kader, and others to campaign architects, planners, urban planners and all the qualified specialists in the Built Environment Sustainable Design and Control issues[5].

3.5.11 IBPSA - Egypt Conference Building Simulation

International Building Performance Simulation Association (IBPSA) is founded to advance and promote the science of building performance simulation in order to improve the design, construction, operation, and maintenance of new and existing buildings worldwide[6].

IBPSA-Egypt 1st conference about Building Simulation Contributions to Built Environment in Egypt.

The conference will be hosted by the Arabian Group for Development within InterBuild2013 proceedings on 23rd & 24th of June. The scientific committee of this

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[1] URL: http://www.greenbuildexpo.co.uk/ , accessed February 23, 2013.
[2] W.L. Lee, F.W.H. Yik , (2004), Regulatory and voluntary approaches for enhancing building energy efficiency, Progress in Energy and Combustion Science 30 (2004) , P 477–499. Online version via www.elsevier.com/locate/pecs .
[3] Baranzini A, Goldemberg J, Speck S. A future for carbon taxes. Ecol Econ 2000;32(3):395–412.
[4] Baranzini A, Goldemberg J, Speck S. A future for carbon taxes. Ecol Econ 2000;32(3):395–412.
[5] EEER, URL: http://eeer-society.wikispaces.com/Introduction , accessed February 23,2013.
[6] URL: http://www.ibpsa.org/m_about.asp , accessed February 23, 2013.

conference are internationally recognized people from Egypt and the UK such as Prof. Morad Abdel-Kader, Prof. Ahmad Abdin, Prof. Essam Khalil, Prof. Adel Yaseen, Prof. Ayman Hassan, Prof. George Basili[1].

Scientific Topics

1	Energy in buildings.	5	Renewable energy and water in buildings.
2	Indoor environmental quality.	6	Green architecture.
3	Climate change and architecture.	7	Environmental design education.
4	Sustainable development.		

The conference introduced papers that enhanced the role of the building sector in tackling climate change, and one of the most significant recommendations that Digital simulation as an evaluation strategy is very important method to recreate a comfort spaces and enhance indoor environmental quality with passive way.

3.5.12 Egypt Go Green Expo

First Energy Saving Solutions & Recycling Exhibition was held on 25-26 May 2013, second will be on 27- 29 Nov 2013[2]. It exhibits Electricity Saving Solutions, Water Conservation & Saving Solutions, and recycling Solutions.

3.6 Incentive Programs and policies that Encourage Greening the Existing -Office- Buildings

The main driving force to achieve the ambitious goals that have been set for the reduction of greenhouse gases will come from energy efficiency regulations, building codes, standards, labels, certifications, obligations and incentives. International institutions are rolling out energy efficiency directives and standards that set minimum requirements for buildings. Today, most energy efficiency regulations concern building design. They hardly touch on Energy Management aspects that can generate major operational gains with relatively low investments and quick payback. Beyond regulations that focus on minimum requirements, environmental performance labels use building rating criteria that can take energy efficiency much further. They offer a practical way of assigning value to energy efficiency and in this way represent powerful market drivers. Indeed, through effective building measurement, monitoring and control systems, Energy Management is one of the keys to rapidly reducing carbon emissions and achieving climate change targets.

3.6.1 Federal Legislation (USA)

Some of the recent drives towards increased green and corporate sustainability are due to the changing of regulatory environment

3.6.1.1 Energy-Efficient Commercial Buildings Tax Deduction

The federal Energy Policy Act of 2005 established a tax deduction for energy-efficient commercial buildings applicable to qualifying systems and buildings placed in service from January 1, 2006, through December 31, 2007[3]. This deduction was

[1] URL: http://eeer-society.wikispaces.com/IBPSA-Egypt+Conference , accessed February 23, 2013.
[2] URL: http://gogreenexpo.webs.com/ , accessed May 29, 2013.
[3] Data base of state incentives for renewables and efficiency, URL: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US40F&re=1&ee=1 , accessed January 30, 2012.

subsequently extended through 2008, and then again through 2013 by Section 303 of the federal Energy Improvement and Extension Act of 2008, enacted in October 2008.

A tax deduction of $1.80 per square foot is available to owners of new or existing buildings who install (1) interior lighting; (2) building envelope, or (3) heating, cooling, ventilation, or hot water systems that reduce the building's total energy and power cost by 50% or more in comparison to a building meeting minimum requirements set by ASHRAE Standard 90.1-2001[1]. Energy savings must be calculated using qualified computer software approved by the Internal Revenue Service (IRS), such as Autodesk Green Building Studio, and Design Builder[2].

Deductions of $0.60 per square foot are available to owners of buildings in which individual lighting, building envelope, or heating and cooling systems meet target levels that would reasonably contribute to an overall building savings of 50% if additional systems were installed. The deductions are available primarily to building owners, although tenants may be eligible if they make construction expenditures. In the case of energy efficient systems installed on or in government property, tax deductions will be awarded to the person primarily responsible for the system's design. Deductions are taken in the year when construction is completed. The following table summarizes the program overview, see (Table 3.3)

Table 3.3 Energy-Efficient Commercial Buildings Tax Deduction Program Overview
Source: Data base of state incentives for renewables and efficiency, URL: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US40F&re=1&ee=1 , accessed January 30, 2012.

Incentive Type	Corporate Deduction
Eligible Efficiency Technologies	Equipment Insulation, Water Heaters, Lighting, Lighting Controls/Sensors, Chillers , Furnaces , Boilers, Heat pumps, Central Air conditioners, Caulking/Weather-stripping, Duct/Air sealing, Building Insulation, Windows, Siding, Roofs, Comprehensive Measures/Whole Building, Tankless Water Heaters, Heat Pump Water Heaters
Applicable Sectors	Commercial, Construction, State Government, Fed. Government, (Deductions associated with government buildings are transferred to the designer)
Amount	$0.30-$1.80 per square foot, depending on technology and amount of energy reduction
Maximum Incentive	$1.80 per square foot
Equipment Requirements	Not specified, but building must be certified as meeting specific energy reduction targets as a result of improvements in interior lighting; building envelope; or heating, cooling, ventilation, or hot water systems.

3.6.1.2 Business Energy Investment Tax Credit (ITC)

The federal business energy investment tax credit was expanded significantly by the Energy Improvement and Extension Act of 2008, enacted in October 2008[3]. This law extended the duration - by eight years - of the existing credits for solar energy, fuel cells and micro turbines; increased the credit amount for fuel cells; established new credits for small wind-energy systems, geothermal heat pumps, and combined heat and power (CHP) systems; allowed utilities to use the credits; and allowed taxpayers to take the credit against the alternative minimum tax (AMT), subject to certain limitations. The credit was further expanded by the American Recovery and Reinvestment Act of 2009, enacted in February 2009[4].

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[1] Ibid.
[2] U.S. Department of Energy URL: http://www1.eere.energy.gov/buildings/commercial/qualified_software.html , accessed January 30, 2013.
[3] Data base of state incentives for renewables and efficiency, URL: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US02F&re=1&ee=1, accessed January 30, 2013.
[4] Ibid.

The following table summarizes the program overview, see (Table 3.4)

Table 3.4 (ITC) Program Overview
Source: Data base of state incentives for renewables and efficiency, URL: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US02F&re=1&ee=1, accessed January 30, 2013.

Incentive Type	Corporate Tax Credit
Eligible Renewable/ Other Technologies	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Municipal Solid Waste, CHP/Cogeneration, Solar Hybrid Lighting, Hydrokinetic Power (i.e., Flowing Water), Anaerobic Digestion, Small Hydroelectric, Tidal Energy, Wave Energy, Ocean Thermal, Fuel Cells using Renewable Fuels, Microturbines, Geothermal Direct-Use
Applicable Sectors	Commercial, Industrial, Utility, Agricultural
Amount	30% for solar, fuel cells, small wind and PTC-eligible technologies;* 10% for geothermal, microturbines and CHP*
Maximum Incentive	Fuel cells: $1,500 per 0.5 kW Microturbines: $200 per kW Small wind turbines placed in service 10/4/08 - 12/31/08: $4,000 Small wind turbines placed in service after 12/31/08: no limit All other eligible technologies: no limit
Eligible System Size	Small wind turbines: 100 kW or less (except unlimited for PTC-eligible wind)* Fuel cells: 0.5 kW or greater Microturbines: 2 MW or less CHP: 50 MW or less* Marine and Hydrokinetic: 150 kW or greater (as defined by PTC eligibility)
Equipment Requirements	Fuel cells, microturbines and CHP systems must meet specific energy-efficiency criteria

The following credits are available for eligible systems placed in service:

- Solar: The credit is equal to 30% of expenditures, with no maximum credit. Eligible solar energy property includes equipment that uses solar energy to generate electricity, to heat or cool (or provide hot water for use in) a structure, or to provide solar process heat. Hybrid solar lighting systems, which use solar energy to illuminate the inside of a structure using fiber-optic distributed sunlight, are eligible. Passive solar systems and solar pool-heating systems are not eligible.
- Fuel Cells: The credit is equal to 30% of expenditures, with no maximum credit. However, the credit for fuel cells is capped at $1,500 per 0.5 kilowatt (kW) of capacity. Eligible property includes fuel cells with a minimum capacity of 0.5 kW that have an electricity-only generation efficiency of 30% or higher. (Note that the credit for property placed in service before October 4, 2008, is capped at $500 per 0.5 kW.)
- Small Wind Turbines: The credit is equal to 30% of expenditures. Eligible small wind property includes wind turbines up to 100 kW in capacity. (In general, the maximum credit is $4,000 for eligible property placed in service.)
- Geothermal Systems: The credit is equal to 10% of expenditures, with no maximum credit limit stated. Eligible geothermal energy property includes geothermal heat pumps and equipment used to produce, distribute or use energy derived from a geothermal deposit. For electricity produced by geothermal power, equipment qualifies only up to, but not including, the electric transmission stage. For geothermal heat pumps, this credit applies to eligible property placed in service after October 3, 2008. Note that the credit for geothermal property, with the exception of geothermal heat pumps, has no stated expiration date.
- Microturbines:The credit is equal to 10% of expenditures, with no maximum credit limit stated (explicitly). The credit for microturbines is capped at $200 per kW of

capacity. Eligible property includes microturbines up to two megawatts (MW) in capacity that have an electricity-only generation efficiency of 26% or higher.

- Combined Heat and Power (CHP): The credit is equal to 10% of expenditures, with no maximum limit stated. Eligible CHP property generally includes systems up to 50 MW in capacity that exceeds 60% energy efficiency, subject to certain limitations and reductions for large systems. The efficiency requirement does not apply to CHP systems that use biomass for at least 90% of the system's energy source, but the credit may be reduced for less-efficient systems.

3.6.1.3 U.S. Department of Energy - Loan Guarantee Program

Section 1703 of Title XVII of the federal *Energy Policy Act of 2005* (EPAct 2005) authorized the U.S. Department of Energy (DOE) to issue loan guarantees for projects that "avoid, reduce or sequester air pollutants or anthropogenic emissions of greenhouse gases; and employ new or significantly improved technologies as compared to commercial technologies in service in the United States at the time the guarantee is issued." The loan guarantee program has been authorized to offer more than $10 billion in loan guarantees for energy efficiency, renewable energy and advanced transmission and distribution projects[1].

The DOE actively promotes projects in three categories: (1) manufacturing projects, (2) stand-alone projects, and (3) large-scale integration projects that may combine multiple eligible renewable energy, energy efficiency and transmission technologies in accordance with a staged development scheme. See (Table 3.5).

Table 3.5 Loan Guarantee Program Overview.
Source: Data base of state incentives for renewables and efficiency , URL: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US48F&re=0&ee=1 , accessed January 31, 2013.

Incentive Type	Federal Loan Program
Eligible Efficiency Technologies	Unspecified Technologies
Eligible Renewable/Other Technologies	Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Hydroelectric, Geothermal Electric, Fuel Cells, Daylighting, Tidal Energy, Wave Energy, Ocean Thermal, Biodiesel, Fuel Cells using Renewable Fuels
Applicable Sectors	Commercial, Industrial, Nonprofit, Schools, Local Government, State Government, Agricultural, Institutional, Any non-federal entity, Manufacturing Facilities
Amount	Varies (program focuses on projects with total project costs over $25 million)
Maximum Incentive	Not specified
Terms	Full repayment is required over a period not to exceed the lesser of 30 years or 90% of the projected useful life of the physical asset to be financed
Web Site	http://www.lgprogram.energy.gov

3.6.1.4 American Recovery and Reinvestment Act (ARRA) of 2009[2]

President Obama's federal stimulus plan included a range of features aimed at improving energy efficiency:

- $4.5 billion to the U.S general services administration, earmarked for their green buildings and energy efficient upgrade[1].

[1] Data base of state incentives for renewables and efficiency , URL: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US48F&re=0&ee=1 , accessed January 31, 2013.
[2] Kubba, S., (2012), Handbook of Green building design and construction LEEDs, BREEAM, and GREENGOLBES, Elsevier Inc. USA.

- The department of defense and veterans affairs also received funds, $4.2 billion, and $1 billion respectively, earmarked for energy efficient improvements and green renovation projects.
- $30.6 billion set aside for smart grid technology, energy efficiency programs, and renewable energy loans.

3.6.1.5 Energy Independence and Security Act (EISA) of 2007

EISA has three main provisions to increase energy efficiency and the availability of renewable energy, the most important provision is the appliance and lighting efficiency standards in which a required target is set for lighting efficiency and energy efficiency labeling for consumer electronic products. It aims to cut energy use in federal buildings in the United States by 30 percent by 2015 and requires new and renovated federal buildings to significantly reduce their reliance on energy from fossil fuels. Compared with existing federal buildings, federal buildings built or renovated in 2010 must cut their fossil-fuel dependency by 55 percent and by 2030, new or renovated federal buildings must eliminate their use of fossil fuel energy[2].

3.6.1.6 Energy Policy Act of 2005 (EPA)

This federal law signed by President George W. Bush in August 2005[3], contains substantial incentives for the use of renewable energy efficiency for all sectors of energy demand and supply: Section 1331 of this law enacted Section 179D of the Internal Revenue Code and established incentives for energy efficiency measures in commercial buildings. The intent of Section 1331 is to encourage energy efficiency in commercial buildings through tax incentives. To qualify for the full tax deductions, the energy-efficient property must produce at least 50% energy and power cost savings. The significance of this law is that higher green design and development costs for new commercial building construction can be offset by such incentives.

3.6.2 Incentive Schemes for Existing Buildings in Singapore

In recognizing the importance of upgrading existing buildings, several incentive schemes have been developed to aid property owners as follows.

3.6.2.1 National Environmental Agency NEA – ENERGY EFFICIENCY (Singapore)

The Energy Efficiency Improvement Assistance Scheme (EASe) is a co-funding scheme administered by the National Environment Agency (NEA) to encourage companies in the manufacturing and building sectors to carry out detailed studies on their energy consumption, also known as energy audits, and identify potential areas for energy efficiency improvement. Eligible companies can receive funding for:

- Up to 50% of the qualifying cost of engaging an expert consultant or Energy Services Company (ESCO) to conduct an energy audit and recommend

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[1] Haeberle, B. et al, Siemens Industry,(2009), Greening of corporate America the pathway to sustainability from strategy to action report, MC Graw Hill Construction, P 13.
[2] U.S Department of Energy, URL: http://www1.eere.energy.gov/femp/sustainable/news_detail.html?news_id=11500, accessed December 22, 2012.
[3]United States Environmental Protection Agency, URL: http://www.epa.gov/lawsregs/laws/epa.html , accessed February 15, 2013.

specific measures that can be implemented to improve energy efficiency. (Over a 5-year period, the maximum amount of funding to any single facility or building is capped at S$ 200,000.)[1]

3.6.2.2 PUB Public Utilities Board – WATER EFFICIENCY (Singapore)

Through PUB's Water Efficiency Fund, companies can receive funding for a variety of water conserving efforts. Companies with water consumption greater than 1,000m3 per month can receive funding for:

- Feasibility Study: up to 50% of the study cost, subject to a cap of S$ 50,000.
- Conducting a Water Audit: up to 50% of the audit cost, subject to a cap of S$ 5,000.
- Recycling Efforts / Use of Alternative Source of Water:
    a) Fund the company at S$ 0.40 for every m3 of potable water / 0.10 for every m3 of NEWater or industrial water saved over the economic life of the facilities or 7 years, OR
    b) Up to 50% of the capital cost of alternative water source facilities, whichever is lower and subject to a cap of S$ 1 million per project.
- Community-wide Water Conservation Campaign & Programmes: up to 50% of the cost of organizing, subject to a cap of S$ 2,000 to S$ 5,000[2].

3.6.2.3 BCA Building and Construction Authority – GREEN MARK INCENTIVE SCHEME: EXISTING BUILDINGS (GMIS-EB)

Cash Incentive Scheme:

The Green Mark Incentive Scheme for Existing Building was launched on 29 April 2009 by the Building and Construction Authority. It aims to encourage developers and building owners to carry out retrofitting works to improve the energy efficiency of their existing buildings. A cash incentive is provided to co-fund the costs of the energy efficient equipment installed in the course of such retrofitting works.

All private building owners are eligible for the GMIS-EB scheme if their buildings meet the following criteria:

- It is an existing non-residential development with gross floor area of at least 2,000m2;
- It is equipped with a central air-conditioning plant;
- It is planning to undergo retrofitting works related to energy efficiency;
- It achieves the Green Mark Certified rating[3] or higher and also the targeted level of energy savings[4].

In addition, application for the GMIS-EB scheme must be lodged before the start of the energy-related retrofitting works. The cash incentive is disbursed in two stages. The first disbursement, which is 50% of the approved grant, is paid out upon completion of the energy improvement retrofits. The final disbursement of the

[1] Singapore Government, URL: http://app.e2singapore.gov.sg/ , accessed February 3, 2013.
[2] Singapore Government, URL: http://www.pub.gov.sg/wef/Pages/default.aspx , accessed February 3, 2013.
[3] (BCA Green Mark is a green building rating system to evaluate a building for its environmental impact and performance. It is endorsed and supported by the National Environment Agency. It provides a comprehensive framework for assessing the overall environmental performance of new and existing buildings to promote sustainable design, construction and operations practices in buildings.) For more information, URL: http://www.bca.gov.sg/greenmark/green_mark_criteria.html .
[4]Singapore Government URL: http://www.bca.gov.sg/GreenMark/gmiseb.html , accessed February 3, 2013.

remaining grant is upon Green Mark certification and verification of energy savings achieved. The approved list of energy efficient equipment includes chillers, variable speed drives, Building Automation System, energy efficient lightings, motion sensors, etc.

Health Check Scheme

In addition to the co-funding cash incentive, the GMIS-EB also includes a Health Check Scheme. The objective of this scheme is to help building owners to determine the efficiency of their existing air-conditioning plants, via an energy audit.

The audit will be carried out by BCA's appointed term contractor and GMIS-EB will co-fund 50% of this audit cost. Building owners can also engage their own Energy Services Company (ESCO) to carry out the audit and claim 50% subsidy from the Health Check Scheme[1]. However, the subsidy rate will be based on BCA's term contractor's rate. This scheme is a useful starting point for building owners to determine the performance of air-conditioning plants and also to identify effective energy efficiency solutions.

3.7 Building Energy Regulations and Codes

Building energy regulations can be used to address the energy use of an entire building or building systems such as heating or air conditioning. Energy regulation is one of the most frequently used instruments for energy efficiency improvements in buildings and can play an important role in enhancing energy efficiency in buildings[2].

Building energy regulations exist in almost all developed countries more and more developing countries are currently introducing such legislation. However, the effectiveness of building energy standards varies significantly from country to country, mainly due to difficulties and resulting differences in compliance and enforcement. In developing countries, building energy standards are often ineffective or much less effective than predicted, while building energy standards exist in a number of developing countries, they are often only on paper due to insufficient implementation and enforcement, corruption and other problems[3].

In addition, the position of developing countries with respect to energy regulations implementation and enforcement is either poorly documented or not documented at all. In addition, there is a lack of consistent data, which makes it difficult to understand the underlying changes that affect energy regulation implementation in developing countries[4] .

3.7.1 Egyptian Standards and Codes

Egyptian stakeholders and government officials have looked for methods to reduce power consumption and GHG emissions. In that sense, developing energy

[1] Singapore Government URL: http://www.bca.gov.sg/GreenMark/gmiseb.html , accessed February 3, 2013.
[2]OECD (Organization for Economic Co-operation and Development), (2003). Environmentally Sustainable Buildings—Challenges and Policies. OECD, Paris.
[3] Iwaro, J., Mwasha, A., (2010), A review of building energy regulation and policy for energy conservation in developing countries, Energy Policy Journal, Volume 38, Issue 12, December 2010, Pages 7744–7755. Online version via ScienceDirect, accessed on February 5, 2013.
[4] Ibid.

efficiency building codes was a critical the first step in that process and identifying alternative paths towards energy efficiency has been a second.

- *ECP 301/1-2002* is a code for plumbing installation. Its goal is to protect public health and environment, and to prevent all parts from leakage and bad perfumes. All works have to be designed to use less water and not to deliver sewage to ground water and lakes.
- *ECP 304/2-2004* is a code for refrigerating and air conditioning. Its goal is to provide the minimum level of comfort and public health as well as to save energy[1].
- *ECP 306/1 and ECP306/2* is a code to improve building envelope energy efficiency[2].

3.7.2 Egyptian Green Building Council

The Egypt Green Building Council has been established in 2009[3], and developed a national green building rating system called The Green Pyramid Rating System (GPRS) as discussed in the previous chapter.

The initial response by the Construction Industry to establishing a Green Building Rating System and awarding Green Permits was overwhelmingly positive for several reasons including the development of logical and valuable incentive system that would encourage compliance and reward efficiency. The incentives related to a Green Permit included:

- Tax Breaks, Waivers and Postponements,
- Financial Assistance including guarantees, credit and insurance,
- Utility Concessions,
- Equipment support and finance, and
- Employee support and assistance[4].

3.7.3 Current Situation in Egypt

- Rating systems to be applied in Egypt (under construction).
- Slow movement and rarely initiatives of green practices in Egypt.
- Energy efficient codes should be periodically revised and more efforts are needed for its implementation

3.8 Methodology and Strategy of Greening Existing Buildings (Improving the Building Performance through retrofits)

The overall process of a building retrofit can be divided into five major phases (Figure 3.18). The first phase is the project setup and pre retrofit survey. In this phase the building owners, or their agents, need to first define the scope of the work and set project targets. The available resources to frame the budget and programme of work can then be determined. A pre-retrofit survey may also be required in order to better understand building operational problems and the main concerns of occupants. It is

[1] ElFiky, U., (2011), Towards a green building law in Egypt: Opportunities and challenges, Energy Procedia Journal, Volume 6, 2011, Pages 277–283. Online version via Science Direct, accessed on February 10, 2013.
[2] Ibid.
[3] URL: http://egypt-gbc.org/history.html , accessed February 10, 2013.
[4] Egyptian Green Building Council Formation & Achievements Report, October 2009. URL: http://egypt-gbc.org/downloads.html , accessed February 2, 2013.

common practice for building owners to select an experienced Energy Services Company (ESCO) to take responsibility for planning and implementing the building retrofit.

The second phase comprises an energy audit and performance assessment (and diagnostics). Energy auditing is used to analyze building energy data, understand building energy use, identify areas with energy wastes, and propose no cost and low cost energy conservation measures (ECMs). Performance assessment is employed to benchmark building energy use by using selected performance indicators or using green building rating systems. Diagnostics can be used to identify inefficient equipment, improper control schemes and any malfunctions happened in the building operation[1].

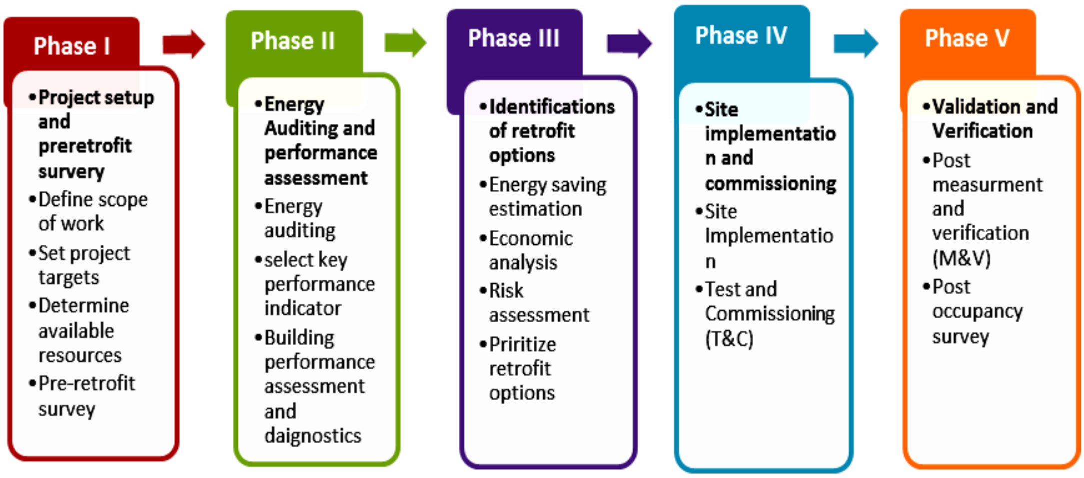

Figure 3.18 Key phases in a building retrofit programme
Source: Ma, Z., Cooper, P., et al, (2012), Existing building retrofits: Methodology and state-of-the-art, Energy and Buildings Vol.55 (2012) 889–902. Online version via ScienceDirect, accessed February 15, 2013.

The third phase is the identification of retrofit options. By using appropriate energy models, economic analysis tools and risk assessment methods, the performance of a range of retrofit alternatives can be assessed quantitatively. The retrofit alternatives can then be prioritized based on the relevant energy-related and non-energy-related factors. It is worthwhile to note that a range of no cost and low cost ECMs that might have been identified during the energy auditing.

The fourth phase is site implementation and commissioning. The selected retrofit measures will be implemented on-site. Test and commissioning (T&C) is then employed to tune the retrofit measures to ensure the building and its services systems operate in an optimal manner. It is worth noting that the implementation of some retrofit measures may necessitate significant interruption to the building and occupants operations.

The final phase is validation and verification of energy savings. Once the retrofit measures are implemented and well-tuned, standard M&V methods can be used to verify energy savings. A post occupancy survey is also needed to understand whether the building occupants and building owners are satisfied with the overall retrofit result.

[1] Ma, Z., Cooper, P., et al, (2012), Existing building retrofits: Methodology and state-of-the-art, Energy and Buildings Vol.55 (2012) 889-902. Online version via ScienceDirect, accessed February 15, 2013.

3.8.1 Retro-commissioning (RCx)

Before explaining the retrocommissioning method, I should first introduce some definitions to help understand it.

- *Commissioning (Cx):* a systematic quality assurance process that spans the entire design and construction process, helping to ensure that the new building's performance meets owner expectations. Owner expectations are listed in the Owner Project Requirement (OPR) document.
- *Retrocommissioning:* a systematic method for investigating how and why an existing building's systems are operated and maintained and for identifying ways to improve overall building performance.
- *Recommissioning:* another type of Commissioning that is applied when a building that has already been the subject of Commissioning is subjected to another Commissioning process. Ideally, a Recommissioning plan should be part of the original Commissioning plan that is drawn up during the construction of the building.
- *Commissioning Authority (CxA):* an individual hired to lead a retro/Commissioning process; the Commissioning Authority is responsible for managing the process to ensure that the owner will obtain the required performance listed in the Owner Project Requirement document[1].

Thus, Retro-commissioning is a process to improve the efficiency of an existing building's equipment and systems. It can often resolve problems that occurred during design or construction, or address problems that have developed throughout the building's life as equipment has aged, or as building usage has changed. Retro-commissioning involves a systemic evaluation of opportunities to improve energy-using systems[2].

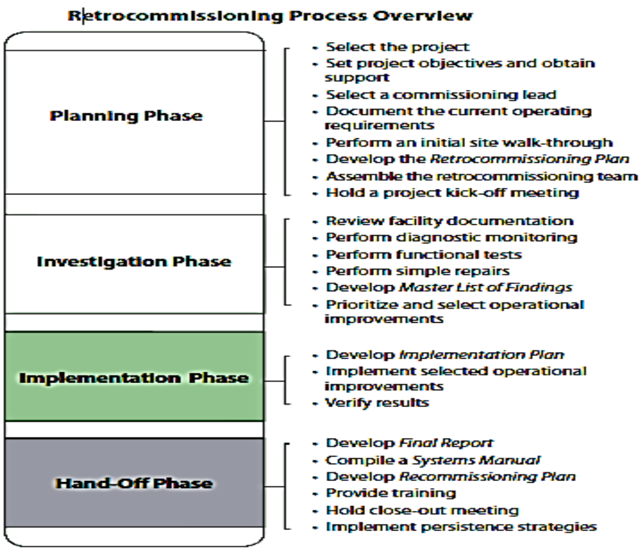

Figure 3.19 Retro-commissioning process overview
Source: Haasl, T., and Heinemeier, K., (2006), California Commissioning Guide Existing Buildings, California Commissioning Collaborative, California.

[1] Dall'o', G. et al., (2012), The Green Energy Audit, a new procedure for the sustainable auditing of existing buildings integrated with the LEED Protocols, Sustainable Cities and Society 3 (2012) 54– 65. Online version via Elsevier. Accessed on December 2, 2012.
[2] URL: http://www.institutebe.com/Existing-Building-Retrofits/Retro-commissioning-Significant-Savings.aspx , accessed February 1, 2013.

The kinds of problems that retro-commissioning will identify and fix include:

- Equipment or lighting that is on when it may not need to be
- Systems that simultaneously heat and cool
- Belts and valves that are not functioning properly
- Thermostats and sensors that are out of calibration
- Air balancing systems that are less than optimal
- Economizers that are not working as designed
- Controls sequences that are functioning incorrectly
- Variable-frequency drives that operate at unnecessarily high speeds or that operate at a constant speed even though the load being served is variable[1]

Many of these small operations and control improvements cost little or nothing to implement, yet some can have big effects. For example, sensor calibration not only improves current operations but also increases the effectiveness of diagnostic monitoring and testing.

The retrocommissioning team is typically asked to perform the following activities:

- Ensure that the building is performing efficiently and as expected:
- Recommend and implement measures that improve equipment performance
- Verify that the building owner and staff receive adequate documentation and assistance to implement improvements, as well as training on monitoring and maintaining improvements[2].

Retro-commissioning can produce significant cost savings in existing buildings. Savings vary depending on the building size, age and location, and the scope of the retro-commissioning process. Studies show that the costs of retro-commissioning activities range from $0.13 to $2.00 per square foot, while payback ranges from 0.2 to 2.1 years. Overall energy savings can reach approximately 15 percent[3]. Of the different measures typically completed as part of retro-commissioning projects, correction of operations and control measures have the shortest paybacks, while maintenance measures have longer paybacks. Design, installation, retrofit and replacement of equipment have the longest paybacks (Figure 3.20).

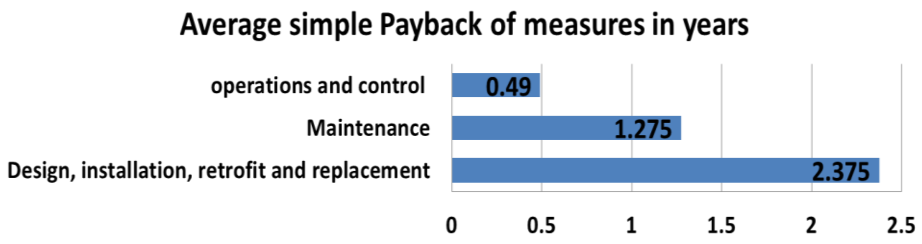

Figure 3.20 Average simple payback of retrocommossioning measures in years
Source: URL: http://www.institutebe.com/Existing-Building-Retrofits/Retro-commissioning-Significant-Savings.aspx , accessed February 1, 2013.

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[1] URL: http://www.institutebe.com/Existing-Building-Retrofits/Retro-commissioning-Significant-Savings.aspx , accessed February 1, 2013.
[2] Haasl, T., and Heinemeier, K., (2006), California Commissioning Guide Existing Buildings, California Commissioning Collaborative, California, P4.
[3] URL: http://www.institutebe.com/Existing-Building-Retrofits/Retro-commissioning-Significant-Savings.aspx , accessed February 1, 2013.

3.8.2 Energy Auditing

Energy audit programmes assist consumers in identifying opportunities for upgrading the energy efficiency of buildings. These programmes may provide trained energy auditors to conduct on-site inspections of buildings, perform most of the calculations for the building owner and offer recommendations for energy-efficiency investments or operational measures, as well as other cost-saving actions (e.g., reducing peak electrical demand, fuel-switching). The implementation of the audit recommendations can be voluntary for the owner, or mandated-such as in the Czech Republic and Bulgaria[1], which require that installations with energy consumption above a certain limit conduct an energy efficiency audit and implement the low-cost measures.

Energy audits can be classified into three levels, including Level 1: walk through assessment, Level 2: energy survey and analysis, and Level 3: detailed energy analysis[2]. For a particular project, the appropriate energy audit level can be selected by taking into account the amount of details and level of accuracy required, budget available, project targets and goals defined, and scope of work covered.

3.8.3 Quantification of buildings' energy conservation benefits

Reliable estimation and quantification of energy benefits are essential in a building retrofit decision-support system for prioritization of retrofit measures. The performance of different retrofit measures is commonly evaluated through energy simulation and modeling. There are a number of whole-of-building energy simulation packages, such as EnergyPlus, eQUEST, DOE-2, ESP-r, BLAST, HVACSIM+, TRNSYS, etc., that can be used to simulate the thermodynamic characteristics and energy performance of different retrofit measures. For instance, EnergyPlus was used by Chidiac et al.[3] and Ascione et al. to simulate the effectiveness of retrofit measures for office buildings and historical buildings.

Building information modeling (BIM) can also be used to predict the energy performance of retrofit measures by creating models of existing buildings, proposing alternatives, analyzing and comparing building performance for these alternatives and modeling improvements[4].

3.8.4 Measurement and verification (M&V) of energy savings

Measurement and verification (M&V) is the process of using measurement to reliably determine the actual savings created within an individual facility by an energy management programme[5]. The main purpose of M&V is to determine actual energy savings due to the implementation of retrofit measures. Energy savings can be

[1] IPCC, 2007: Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. P423.
[2] ASHRAE, 2011 ASHRAE Handbook – HVAC Applications, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., Atlanta.
[3] S.E. Chidiac, E.J.C. Catania, E. Morofsky, S. Foo, (2011), Effectiveness of single and multiple energy retrofit measures on the energy consumption of office buildings, Energy 36 (2011) 5037–5052.
[4] L. Tobias, G. Vavaroutsos, et al., (2009), Retrofitting Office Buildings to be Green and Energy-Efficient: Optimizing Building Performance, Tenant Satisfaction, and Financial Return, Urban Land Institute (ULI), Washington, DC.
[5] EVO, (2007), International Performance Measurement & Verification Protocol – Concepts and Options for Determining Energy and Water Savings, vol. I, Efficiency Valuation Organization, Washington, DC, USA, URL: http://www:evo-world.org. accessed February 1, 2013.

determined by Eq. (1) through calculating the difference between the energy measured (or estimated) in the pre-retrofit period and post-retrofit period after accounting for the energy differences resulting from non-energy retrofit measure factors[1].

$$E_{saving} = E_{pre\text{-}retrfo} - E_{post\text{-}retro} \pm E_{adjust} \qquad (1)$$

Where Esaving is the energy saving; Epre-retro is the energy use measured (or estimated) for a defined period in the pre-retrofit period; Epost-retro is the energy use measured (or estimated) for a defined period in the post-retrofit period; Eadjust is the difference between the energy use in the pre-retrofit period and post-retrofit period, caused by any differences in non-energy retrofit measure factors, such as weather conditions, occupancy schedules, etc.

There are many other strategies and methodologies for building retrofits, the examples discussed earlier are the most significant, other strategies like, Building performance assessment and diagnostics, Economic analysis, and Risk assessment.

3.9 Greening Buildings (retrofit) technologies

The retrofit technologies can be categorized into three groups, they are, supply side management, demand side management, and change of energy consumption patterns, i.e. human factors (Figure 3.21).

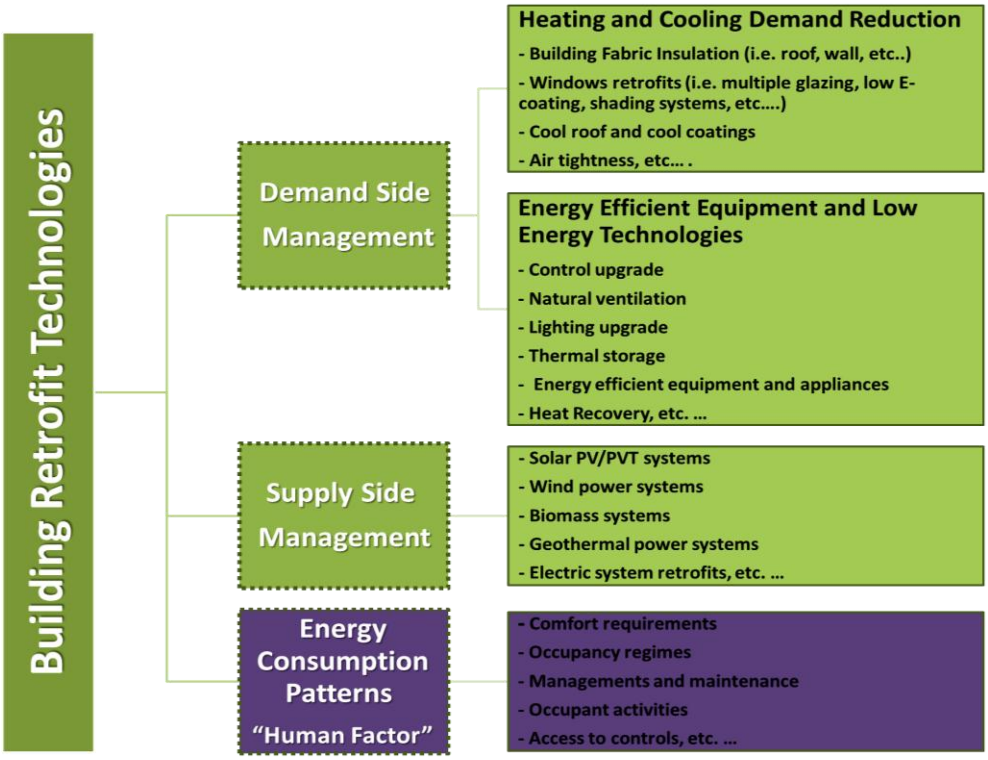

Figure 3.21 Main categories of greening buildings and retrofits technologies.
Source: Ma, Z., Cooper, P., et al, (2012), Existing building retrofits: Methodology and state-of-the-art, Energy and Buildings Vol.55 (2012) 889–902. Online version via ScienceDirect, accessed February 15, 2013.

[1] Ma, Z., Cooper, P., et al, (2012), Existing building retrofits: Methodology and state-of-the-art, Energy and Buildings Vol.55 (2012) 889–902. Online version via ScienceDirect, accessed February 15, 2013.

3.10 Egyptian Green Market Business Case

Table 3.6 Comparative Analysis of Egypt's Green Market Business Case Current situation
Source: The Researcher

	Egypt	Worldwide
Approaches (Initiatives) to Green Buildings and Greening (Retrofitting) Existing buildings	- Establishment of the Egyptian Green Building Council. - Developing the Green Pyramid Rating System (GPRS). - Arising of NGOS (Non-Governmental Organizations) i.e. Egyptian Society for Energy in Buildings & Environmental Design Research (EEER) - IBPSA - Egypt first Conference about Building Simulation Contributions to Built Environment, Cairo2013 - Go Green Expo on 25-26 May 2013, first green solution exhibition.	- Global Environmental Management Initiative (GEMI) - U.S. Department of Energy's Commercial Building Alliance - Coalition for Environmentally Responsible Economies (Ceres) - Environmental Protection Agency (EPA) Green Power Partnership - California's Comprehensive Energy Efficiency Program for Existing Buildings - Commercial Building Disclosure (CBD) Australia - Greenbuild Expo and Conference
Incentives	- There is no specific incentive program to mention; thus it needs to be established to refresh the green market in Egypt	- Federal Legislation (USA) - Incentive Schemes for Existing Buildings in Singapore - Other incentives around the world
Codes	- Building legislations and codes do not encourage people to follow green architecture. Actually in some cases, the legislation discourages people to follow any green concepts. - If existed; not efficient enough	- International Green Construction Code (IGCC) - ASHRAE Standard for High-Performance Green Building
Awareness	- Public awareness needs to focus on green building benefits especially economic benefits through: 1. Conferences, seminars and workshops at universities 2. Public media 3. Regular magazines and newspapers	- Strong awareness of Green buildings and green strategies; thus the number of certified green building in increasing every year. - Green buildings is gaining a strong reputation among owners and investors due to tenant demand
Green Technologies and strategies	- Almost all the new technologies of green buildings are imported at high value (i.e. Photovoltaic panels) - Passive strategies rarely applied in existing buildings	- Annual Exhibitions for green technologies and its application, and implementation - Training programs for workforce on the new strategies - Availability of material with certain specification for green building (i.e. LEED specifications)

3.11 Conclusion

The research field and initiatives in Egypt on the green buildings and green buildings retrofit are rare, and not applicable. Unlike the developed countries (i.e. USA) there is a large body of research on building retrofits available in the public domain. However, existing buildings continue to be upgraded at a very low rate. For instance, existing commercial building stock is currently being retrofitted at a rate of approximately 2.2% per year only[1].

[1] V. Olgyay, C. Seruto, (2010), Whole-building retrofits: a gateway to climate stabilization, ASHRAE Transactions 116 (Part 2) (2010) 244–251.

There are opportunities to improve the building energy efficiency throughout their lifecycles (existing buildings), in developed and developing countries alike. Policies are being developed to address significant market, financial, technical, awareness and institutional barriers to building efficiency. These policies will help enable critical market actors to make decisions to promote energy efficiency. They fall into six categories:

- **Building efficiency codes and standards** that require a minimum level of energy efficiency in buildings, appliances, equipment or lighting.
- **Efficiency improvement targets** that can move individual owners or entire geographies to action.
- **Policies that increase awareness, information and market transparency,** like competitions, audits, ratings and certifications, energy performance disclosure, and public awareness campaigns.
- **Financial incentives** such as grants and rebates, tax treatments, government risk mitigation guarantees, revolving loan funds, and policies that enable energy performance contracting.
- **Utility programs** like energy efficiency spending requirements, on-bill financing, advanced metering, and pricing that more accurately reflects the cost of producing electricity.
- **Human and technical capacity** development through direct assistance and workforce training. See (Figure 3.22).

Figure 3.22 Green and Energy Efficient Buildings Situation
Source:http://www.institutebe.com/energy-policy/Driving-Transformation-Energy-Efficient-Buildings2.aspx, accessed February 7, 2013.

To sum up, there is still a long way for building scientists and professionals to go in order to make existing building stock be more energy efficient and environmentally sustainable in developed countries and developing countries in specific.

Introduction

As individuals and organizations have started to emphasize the importance of conserving resources and reducing human impact on the environment (low consumption and low carbon emissions); environmental technologies is being always updated. These techniques or technologies are especially relevant to reducing the energy consumption used for heating, lighting and cooling. In addition, green building technologies make the building use less water and offer lower maintenance costs.

A recent study by the international consulting firm McKinsey & Company indicates that building energy efficiency measures such as improving insulation and water heaters and switching to low-energy lighting systems are some of the cheapest and most cost-effective ways to reduce carbon emissions worldwide[1]. It also notes that these measures would require no reduction in quality of life or comfort. Another study by a Swedish power utility finds that energy efficiency measures can save money and cut tremendous amounts of greenhouse gas emissions. Insulation improvements alone could save more than 1.7 gigatonnes of CO_2 by 2030, lighting improvement could eliminate close to 0.4 gigatonnes, and water heating improvements of about 0.5 gigatonnes[2]. According to the study, the investment costs to achieve these savings would be more than compensated by a decrease in the costs for the energy.

If appropriate retrofit methods are applied to existing public buildings, 30 to 40 percent energy savings could be achieved[3]. In summary, reducing energy consumption in existing buildings and promoting retrofit methods have become urgent priorities.

4.1 Objectives of the Analytical Part

In this part, different green strategies and technologies that could be implemented on existing office buildings will be discussed, through the study of buildings that used this certain strategy or technology, mentioning the energy reduction after its implementation compared to conventional building consumption; thus achieving the following objectives:

1. Defining the different strategies that could be implemented on existing office building to be green
2. Defining the percent of energy efficiency of each strategy (energy reduction), ***it is worth mentioning that the energy use reduction mentioned is based on the true consumption of the building and not a simulation program readings.***
3. Recognizing the motivation (incentive) of applying each strategy
4. Presenting the Empire State Building as a prototype of greening existing office buildings and green strategies applied to achieve LEED-EBOM.

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[1] McKinsey & Company, (2007), Curbing Energy Demand Growth, The Energy Productivity Opportunity, URL: http:// www.mckinsey.com/mgi/publications/Curbing_Global_Energy/index.asp , accessed December 12, 2012.
[2] Climate Map, Vattenfall, (2007).URL: http://www.vattenfall.com/www/ccc/ccc/569512nextx/573859globa/574118cost/index., accessed December 20, 2012.
[3] Ph.D., P.E., Shen, Y., Hua, J., (2012), Effectiveness of Energy Retrofit Methods in Public buildings in China Report, Institute for Building Efficiency, Johnson Controls, Rocky Mountain Institute (RMI), Washington DC.

4.2 Methodology of the Analytical Approach

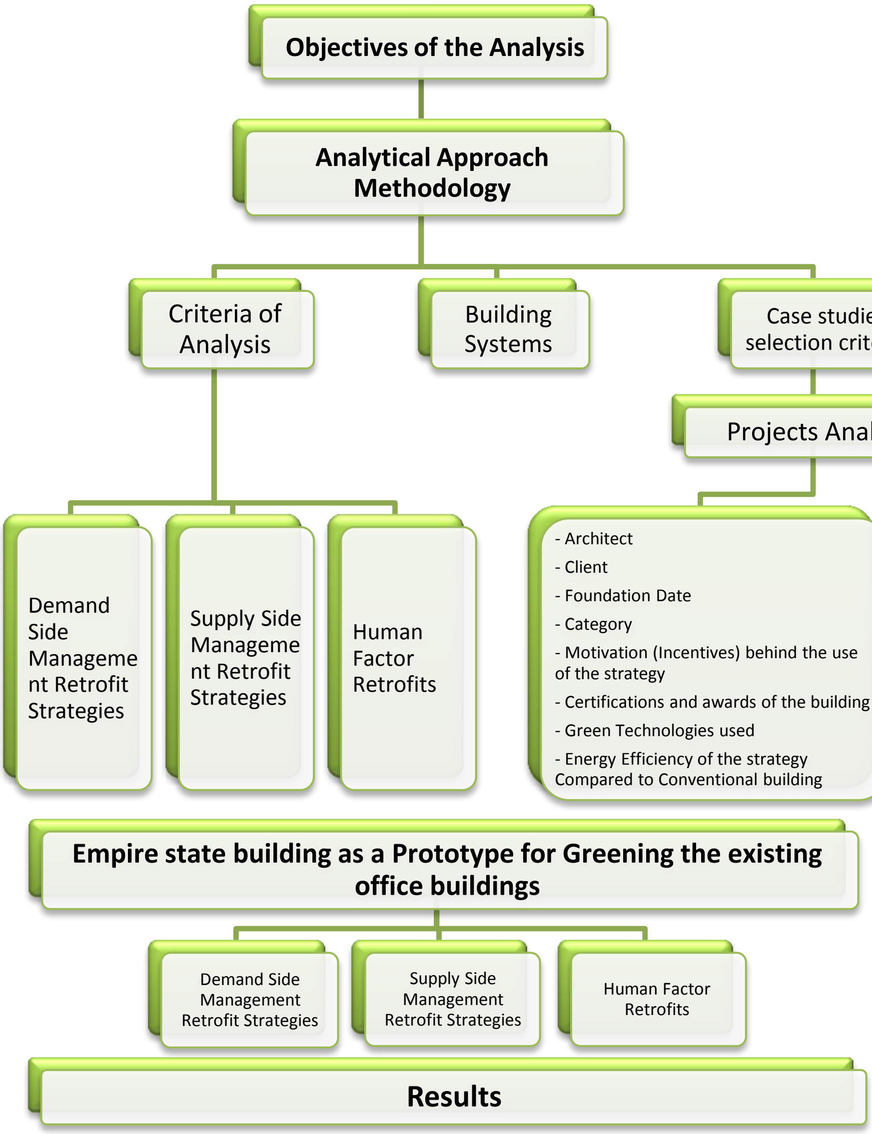

Figure 4.1 Methodology of the Analytical Part
Source: The Researcher

4.3 Basics for Case Studies Selection and Analysis

- Case studies include different green rating systems certified buildings
- Different incentives in each case
- Case studies in different locations worldwide
- Each strategy discussed is applied on an existing building (retrofitted) or newly constructed, but all are applicable to existing buildings.
- There is no time limit in the selected projects
- The scale of the project is not a limit

4.4 Building Systems

According to Stewart Brand, a building is composed of six layers of change[1]. See (Figure 4.2):

1. Site: The geographical settings, the urban location, and the legally defined lot.
2. Structure: The foundations and load bearing elements. ***(Doesn't count in green retrofits).***
3. Skin (Envelope): Exterior surfaces of a building, Walls and Roof, ***(A major element in green retrofits).***
4. Services: The working guts of a building, communication wiring, electrical wiring, plumbing, sprinkler system, HVAC, and moving parts like elevators and escalators. ***(A major element in green retrofits, but will not be discussed but for the electrical lighting system upgrade).***
5. Space Plan: The interior lay out, walls, floors, ceilings, and doors.
6. Stuff (Furnishings): Chairs, desks, phones, pictures, appliances, etc. ***(Energy efficient appliances play an important role in green retrofits).***

The discussion will focus on the building envelope retrofits, lighting system upgrade, and energy efficient appliances.

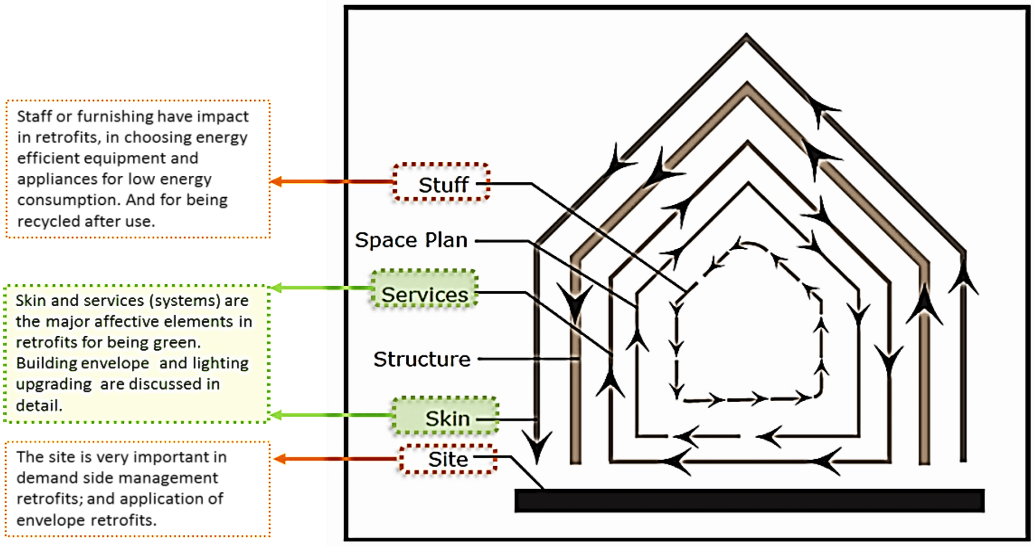

Figure 4.2 Building Layers and Systems.
Source: Brand, S., (1997), How buildings learn what happens after they are built, Penguin Books, USA.

4.5 Demand Side Management (DSM) Retrofits

Whole building retrofits, or greening; means installing more energy savings measures and addressing all possible energy end-uses. The way to do that is not to look at individual technologies incrementally, but to combine technologies and optimize the performance of the building as a whole. Through this approach, an individual building could realize *30 to 50 percent* energy savings[2], whereas the single-technology approach generally yields 1 and 5 percent whole-building savings. Thus

[1] Brand, S., (1997), How buildings learn what happens after they are built, Penguin Books, USA.
[2] Smith, K., Bell, M., (2011), Going Deeper: A New Approach for Encouraging Retrofits Report, Institute for Building Efficiency, Johnson Controls, Rocky Mountain Institute (RMI), Washington DC. Online report URL: http://www.institutebe.com/InstituteBE/media/Library/Resources/Existing%20Building%20Retrofits/Issue_Brief_DEEP_Programs_for_Retrofits.pdf , accessed March 22, 2013.

bundling of energy savings measures significantly improves the outcome for the utility and the energy consumer.

4.5.1 Heating and Cooling Demand Reduction

Space heating, cooling, and ventilation account for the largest amount of end-use energy consumption in both commercial and residential buildings. In the commercial sector they are responsible for 34 percent for energy used on site and 31 percent of primary energy use[1].

4.5.1.1 Building Envelope

The building envelope – the interface between the interior of the building and the outdoor environment, including the walls, roof, and foundation – serves as a thermal barrier and plays an important role in determining the amount of energy necessary to maintain a comfortable indoor environment relative to the outside environment[2]; Minimizing heat transfer through the building envelope is crucial for reducing the need for space heating and cooling.

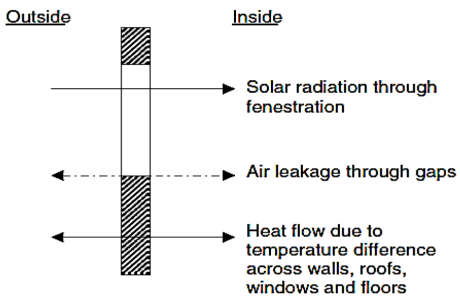

Figure 4.3 Heat gain/loss mechanisms for building envelopes.
Source: Jayamaha, L., (2007), Energy-Efficient Building Systems Green Strategies for Operation and Maintenance, McGraw-Hill books, USA, P. 246.

4.5.1.1.1 Windows Retrofits (fenestration)

Windows, exterior doors, and skylights influence both the lighting and the HVAC requirements of a building. In addition to design considerations (the placement of windows and skylights affects the amount of available natural light), materials and installation can affect the amount of energy transmitted through the window, door, or skylight, as well as the amount of air leakage around the window components. New materials, coatings, and designs all have contributed to the improved energy efficiency of high-performing windows, doors, and buildings. Some of the advances in windows include: multiple glazing, the use of two or more panes of glass or other films for insulation, which can be further improved by filling the space between the panes with a low-conductivity gas, such as argon, and low-emissivity (low-e) coatings, which reduce the flow of infrared energy from the building to the environment[3]. In commercial office buildings, an estimated 10 to 40 percent reduction

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[1] Center for climate and Energy Solutions, URL: http://www.c2es.org/technology/factsheet/BuildingEnvelope , accessed April 5, 2013.
[2] Ibid.
[3] Center for climate and Energy Solutions, URL: http://www.c2es.org/technology/factsheet/BuildingEnvelope , accessed April 5, 2013.

in lighting and HVAC costs is attainable through improved fenestration[1]. See (Figure 4.4).

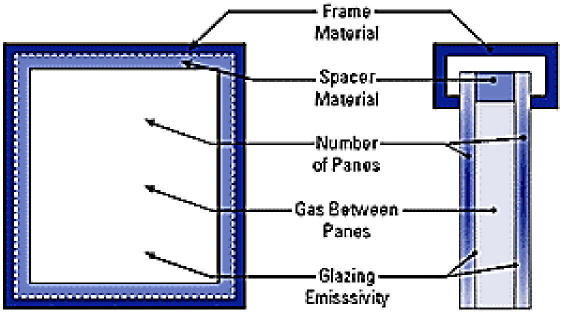

Figure 4.4 Factors affecting window performance.
Source: Ander, G. D. "Windows and Glazing." Whole Building Design Guide, updated 18 June 2010. URL: http://www.wbdg.org/resources/windows.php?r=minimize_consumption , accessed April 5, 2013.

To fully specify a window system, it is necessary to specify the following characteristics:

- Window U-value
- Window Solar Heat Gain Coefficient (SHGC), or shading coefficient (SC)
- Glass Visible Transmittance ($T_{vis\text{-}glass}$)

For specific aesthetic and performance objectives specify:

- Tints (colors) and Coatings[2]. See (Figure 4.5)

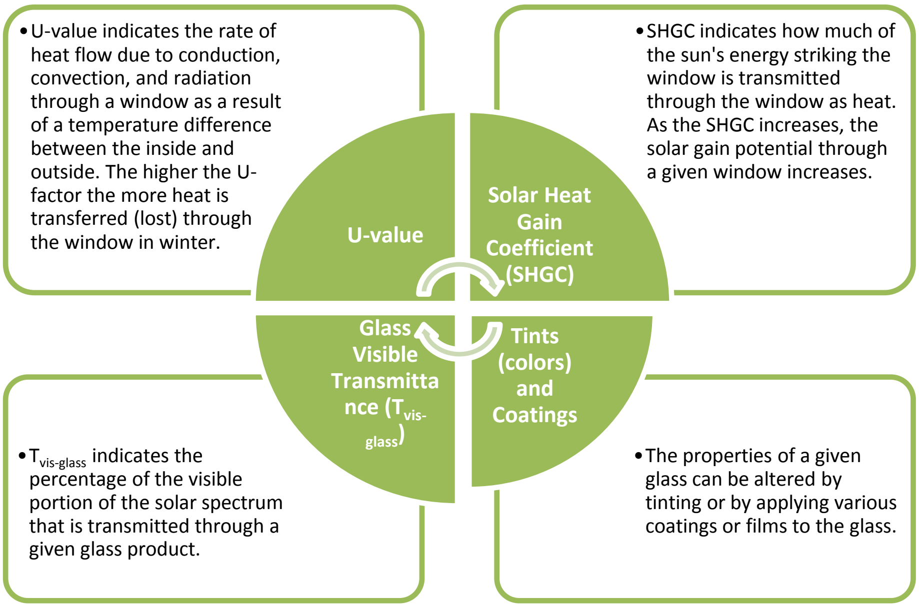

Figure 4.5 Specifying Windows and Glazing
Source: The Researcher.

[1] Ander, G. D. "Windows and Glazing." Whole Building Design Guide, updated 18 June 2010. URL: http://www.wbdg.org/resources/windows.php?r=minimize_consumption , accessed April 5, 2013.
[2] Ibid.

Case Study 1: Wipro Technologies Development center, Gurgaon

Architect	Eminent architectural firm, M/s Vidhur Bharadwaj & Associates	 [1]
Client	Wipro Technologies	
Founded in	-	
Location	Gurgaon (India)	
Category	Office building	
Certifications and Awards	LEED NC Platinum rated (2005)[2]	
Motivation	Acquiring LEED certification	
Green Technologies	Green Reflective glass (Windows Retrofits)	
Energy Efficiency Compared to Conventional building	Glass (SGG Antelio plus emerald glaze) had contributed reducing energy requirement of the building by **50%** on the base case[3] high performance glass reduced the energy requirement by **5.6%**[4].	

Reflective glasses come with reflective –metallic- coating that filters heat and let optimum light into the building[5].

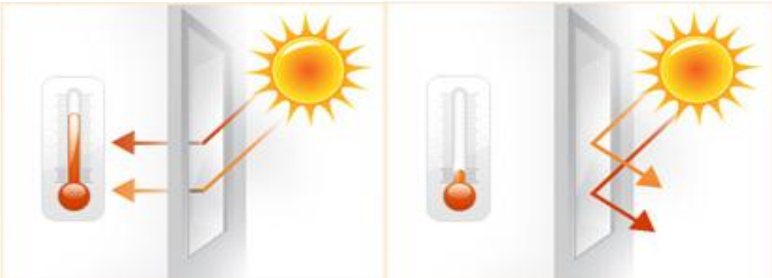

Figure 4.6 **Left:** Ordinary Glass Allows a lot of heat to pass through glass. **Right:** REFLECTIVE CONTROL GLASS: Reduce the heat gaininside the building, and thus reduces electricity and cooling costs Allow optimum light (natural daylighting) inside the building, and thus reduces the cost for artificial lighting during the day.
Source: URL: http://www.glassisgreen.com/how-glass-works.php , accessed March 2, 2013.

Case Study 2: Argonne National Laboratory, Argonne, Illinois

Architect	HDR architects[6]	 [7]
Client	Argonne's Energy Sciences	
Founded in	-	
Location	Argonne, Illinois (U.S.A)	
Category	Office/Lab building	
Certifications and Awards	LEED- NC 2010 (Gold) [8]	
Motivation	Acquiring LEED certification, Energy use reduction	

[1] URL: http://www.google.com.eg/url?sa=i&source=images&cd=&cad=rja&docid=-6ogzAki2S8KaM&tbnid=O9YRf1ZHpfHYHM:&ved=0CAcQjB0wAA&url=http%3A%2F%2Fwww.glassisgreen.com%2Fview-green-projects.php&ei=d2UyUbKXOYWMswbvloDgAQ&psig=AFQjCNFAAaog6ZeVn2IdEXWAyd08lEokmw&ust=1362343671963809 , accessed March 2, 2013.
[2] U.S. Department of Energy, URL: https://buildingdata.energy.gov/content/gurgaon-development-centre-wipro-ltd , accessed March 2, 2013.
[3] URL: http://www.scribd.com/doc/90353998/wipro , accessed March 2, 2013.
[4] Ibid.
[5] URL: http://www.glassisgreen.com/how-glass-works.php , accessed March 2, 2013.
[6]Argonne National Laboratory, URL: http://web.anl.gov/esb/index.html ,accessed April 5, 2013.
[7]URL: http://web.anl.gov/esb/images/high_resolution/Cam_7.jpg , accessed April 4, 2013.
[8]Argonne National Laboratory, URL: http://web.anl.gov/esb/index.html ,accessed April 5, 2013.

Green Technologies	High-performance windows selective to west and north orientations (Low U factor and SHGC windows and skylights)
Energy Efficiency Compared to Conventional building	High-performance windows reduce electric consumption by **20%** and natural gas by **30%**, lowering the building's greenhouse gas impact by **55 tons/year**[1].

High performance windows allow natural light to freely enter, during winter, long-wave heat energy radiating from indoor objects is reflected back keeping indoor warm while lowering heating costs. In the summer, outdoor long wave heat energy, radiating from objects is reflected back outside, lowering cooling costs. (Figure 4.7).

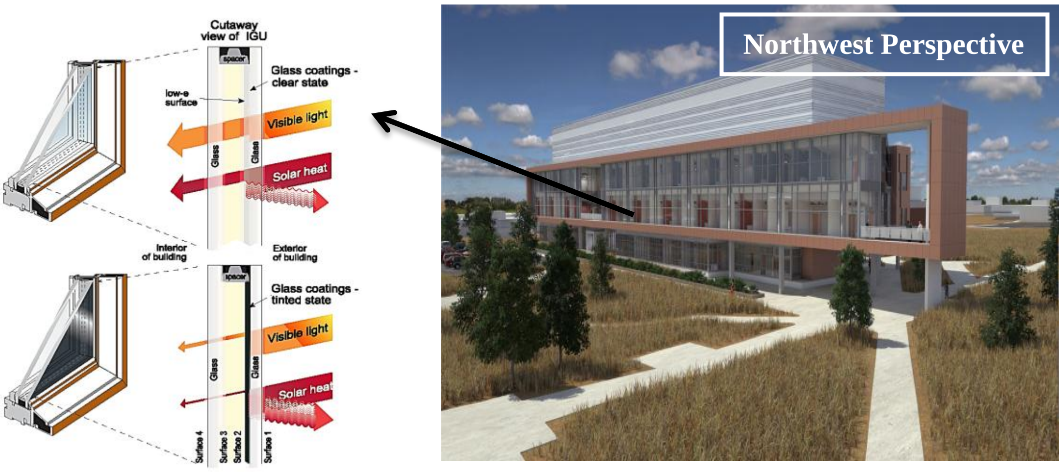

Figure 4.7 High Performance Glazing in Argonne National Laboratory (North and West Façade)
Source: Argonne National Laboratory, URL: http://web.anl.gov/esb/index.html ,accessed April 5, 2013.

Case Study 3: Senior citizens' apartments (Switzerland)

Architect	Dietrich Schwarz	 [2]
Client	-	
Founded in	2004	
Location	Switzerland	
Category	Residential Complex Building	
Certifications and Awards	-	
Motivation	Smart technology use, Energy use reduction	
Green Technologies	Prisms to reflect sunlight	PCM materials to store energy
	Insulation glass with Phase change materials PCM (Salt Hydrate), Intelligent management of solar radiation (latent heat-storing glass façade)	
Energy Efficiency Compared to Conventional building	PCM produces large percentage reductions in cooling electricity for months where the cooling load is small, but the most significant energy savings occur in months when it is most needed, that is, when the cooling load is large. A building with PCM could reduce its total energy use by more than **15%**[3].	

On the south side of this complex the architect installed a new design of a latent heat-storing insulation glazing system filled with salt hydrate over an area of 148m2. Called GLASSXcrystal, the 78 mm wide system is con-structed like an ordinary triple

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[1]Ander, G. D. "Windows and Glazing." Whole Building Design Guide, updated 18 June 2010. URL: http://www.wbdg.org/resources/windows.php?r=minimize_consumption , accessed April 5, 2013.
[2] Ritter, A., (2007), Smart Materials in Architecture, Interior Architecture and Design, Birkauser-publisher for architecture, Germany, P 171-172.
[3] Phase Change Energy Solutions, URL: http://www.phasechange.com/index.php/en/energy-saving , accessed May 18, 2013.

insulation glazing unit, but with a light-directing prism panel outside and a PCM panel inside, consisting of polycarbonate containers filled with a salt hydrate mixture, which stores heat at +26°C to +28°C[1].

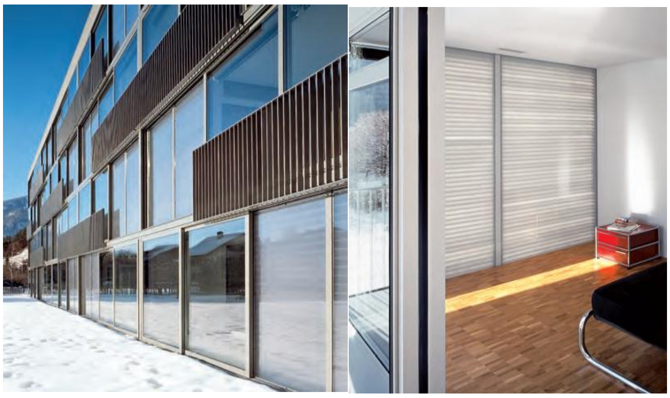

Figure 4.8 Senior citizens' apartments: view of south facade. Side view of south facade. Inside view of latent heat-storing facade.
Source: Ritter, A., (2007), Smart Materials in Architecture, Interior Architecture and Design, Birkauser-publisher for architecture, Germany, P 171-172.

In summer the solar radiation is reflected back outside by the prismatic panels. During the winter the lower sun angle allows the solar radiation to pass almost unimpeded into the facade construction, where it hits the PCM panel, is converted into thermal radiation and stored by the melting of the salt hydrate. If the room temperature falls below +26°C, the salt hydrate crystallises and releases its stored heat energy into the room.

The sun-shading photovoltaic Louvre-like elements are integrated in the façade, the charge state of this latent heat storing glass façade can be observed directly from its optical appearance, which is determined by the different phases of the salt hydrate: if the facade looks opaque (seen from outside through the prismatic panels or from the inside), then the salt hydrate is uncharged. If it appears translucent (seen from outside through the prismatic panels) or transparent (from the inside, with no printed pattern), the salt hydrate is being charged or is fully charged[2].

Figure 4.9 outside detail of latent heat-storing facade, uncharged state (opaque). Detail of latent heat-storing facade, charged state (translucent).
Source: Ritter, A., (2007), Smart Materials in Architecture, Interior Architecture and Design, Birkauser-publisher for architecture, Germany, P 171-172.

[1]Ritter, A., (2007), Smart Materials in Architecture, Interior Architecture and Design, Birkauser-publisher for architecture, Germany, P 171-172.
[2]Knaack, U., Klein, T., (2009), The Future Envelope 2- Architecture – Climate – Skin, IOS Press under imprint Delft University Press, The Netherlannds.

- **The Mechanism of Light Directing Insulation System with Macro encapsulated PCM**

Insulation glazing system consisting of four panes positioned one behind the other with external integrated light-directing prismatic plastic panels and internal integrated transparent plastic containers filled with salt hydrate. The system provides passive acclimatization of the facade and can be used in almost the same way as conventional insulation glazing systems[1].

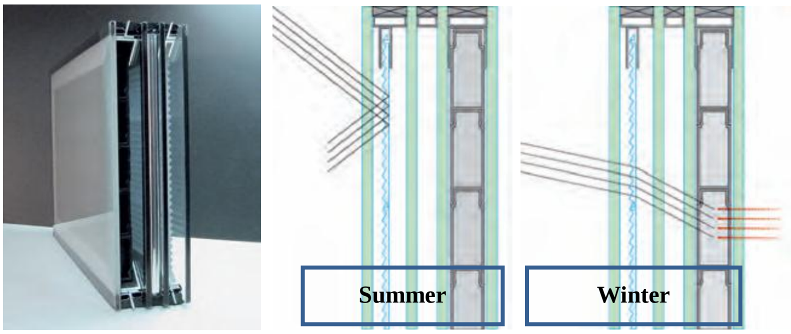

Figure 4.10 Section through light-directing insulation glazing system with salt hydrate PCM. Operating principle at high and low solar positions.
Source: Ritter, A., (2007), Smart Materials in Architecture, Interior Architecture and Design, Birkauser-publisher for architecture, Germany, P 167-169.

Advantages of the phase-change materials (PCM)
• latent heat storage materials, an efficient way of storing thermal energy (solar energy, industrial waste heat), excess heat can be stored and can be dissipated during times of need
• ability to reduce energy consumption for space conditioning and reduce peak loads
• improvement of occupant comfort, and potential for application in retrofit projects
• PCMs can absorb free energy; PCM thermal storage can shift most of the electrical load for buildings with mechanical air conditioning from peak to off-peak periods. If applied to enough buildings, this would reduce the requirement for peak power generation, and therefore greenhouse gas emissions[2]
Barriers to PCM Installation
• Risk of leakage through expansion.
• Risk of fire.
• Low internal heat transfer rate.
• Low cycle-life.
• Perceived efficacy of the system.
• Cost of the system[3]

4.5.1.1.2 Shading Systems

Shading devices can be used to minimize the transmission of direct solar radiation through windows. Classified to internal and external shading devices. External shading devices, such as louvers and overhangs, installed outside the building envelope help to reduce transmission of direct radiation into the building by intercepting direct radiation before it reaches the glazing. Interior shading devices,

[1]Ibid, P 167-169.
[2]Vuceljic, S., APPLICATION OF SMART MATERIALS IN RETROFITTING HOMES CAN HELP HOUSING ENERGY EFFICIENCY, Published paper, Faculty of architecture of Union University, Belgrade.URL: http://www.europaforum.or.at/site/energy-housing.net/dateien/Vavan_Vuceljic_Paper.pdf , accessed March 22, 2013.
[3] Susman, G., Using Phase Change Materials to Reduce Energy Consumption in Buildings, MSc in Sustainable Energy – Technologies and Management.Brunel University, West London. On Line Version URL: http://materialsknowledge.org/docs/Marie%20Curie%20Poster%20Presentation%20(Gideon%20Susman).pdf ,accessed May 17, 2013.

such as curtains and blinds, can also be used but are less effective at reducing solar gains than the external shading devices since the solar radiation first enters the conditioned space and is then reflected back through the glazing before being absorbed by the conditioned space.

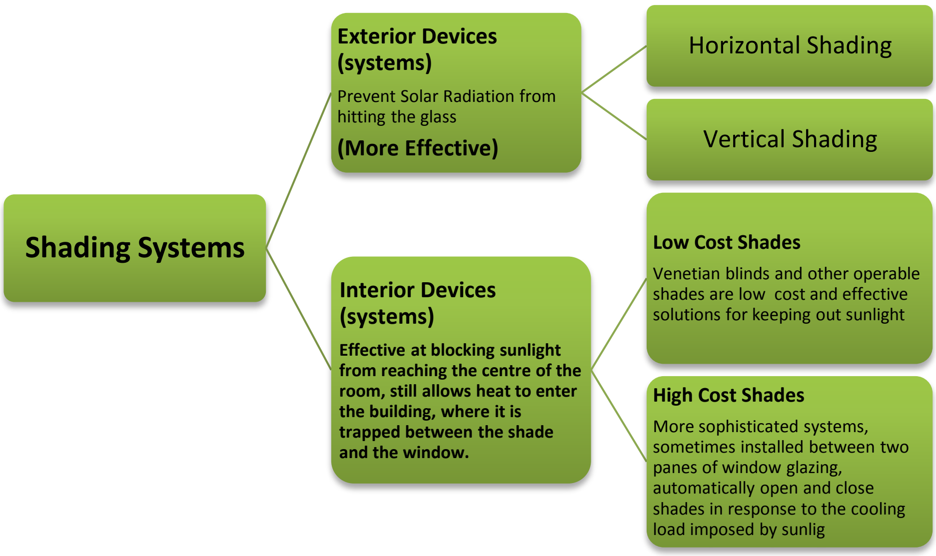

Figure 4.11 Shading Systems Matrix
Source: The Researcher

Case Study 4: Trafalgar House office building, Croydon

Architect	PRC Architects [1]	 [2]
Client	ING Property Income Ltd	
Founded in	2006[3]	
Location	Croydon	
Category	office building	
Certifications and Awards	Excellent rating by BREEAM	
Motivation	Acquiring BREEAM certification, Energy use reduction.	
Green Technologies	Aerofins: a range of louvre systems consisting of Aerofoil, Aerowing and Aeroscreen. Panel Systems: a range of panel louvre systems consisting of 84R, 70/1325, 100R, 110HC[4].	
Energy Efficiency Compared to Conventional building	Solar shading helps to reduce heat gain during warmer months. it is possible to reduce the total cooling load of the air conditioned buildings by approximately **7%** by employing an efficient shading strategy[5]	

The adjustable aerofin system consists of adjustable aerofoils, aerowings oraeroscreens interconnected by a driving rod, which is driven by an actuator. (Figure 4.12). By effectively reducing the amount of solar radiation entering the building due to Sun Control Systems, the amount of energy needed to cool the building is

[1]URL: http://www.barbourproductsearch.info/trafalgar-house-croydon-news011794.html , accessed April 6 2013.
[2]URL: http://www.mero-schmidlin.com/raisedfloor/projects.htm , accessed April 6, 2013.
[3]Ibid.
[4]URL: http://www.barbourproductsearch.info/solarcontrol-louvres-prod004691.html , accessed April 6, 2013.
[5] M. Santamouris, A. Argiriou, E. Daskalaki, C. Balaras and A. Gaglia, "Energy Characteristics and Saving Potential in Office Building," Solar Energy, vol. 52, no.1, 1994, pp. 59-66.

immediately decreased. Therefore, the capacity of the cooling equipment can be reduced, resulting in lower initial investments and operational costs.

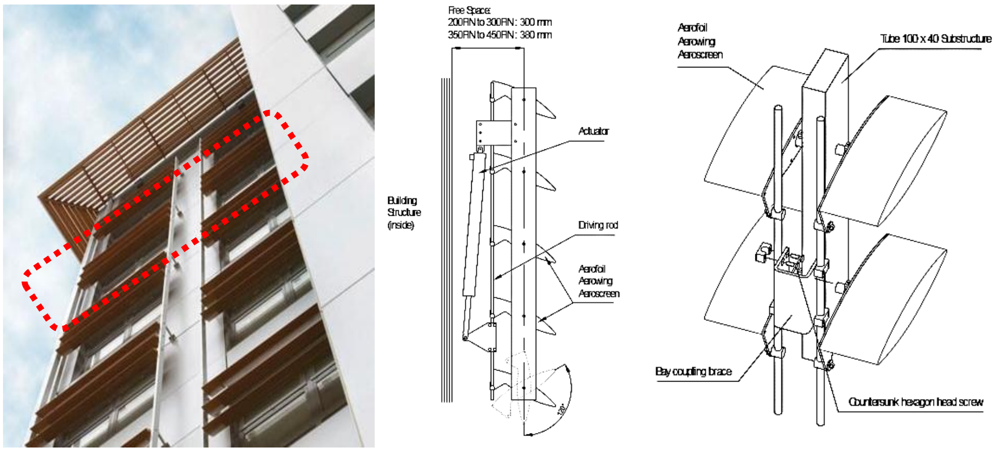

Figure 4.12 Aerofin system mechanism and adjustments.
Source: URL: http://www.barbourproductsearch.info/solarcontrol-louvres-prod004691.html , accessed April 6, 2013.

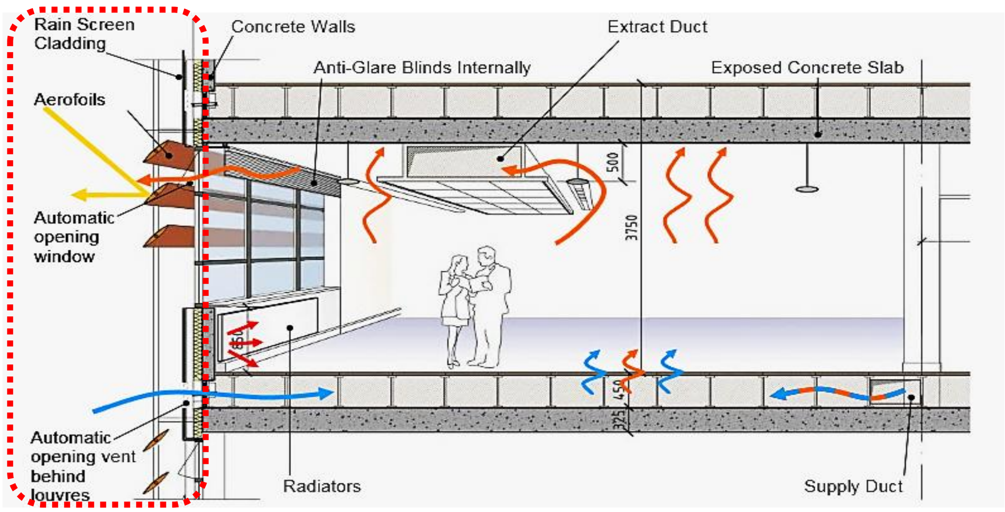

Figure 4.13 Wall section through the building showing the panel system.
Source: Hensen, J., et al, Solar Shading how to integrate solar in sustainable buildings, RHEVA GUIDBOOK NO. 12, HUNTER DOUGLAS, URL: http://www.rehva.eu/fileadmin/events/eventspdf/REHVA_Supporters_Seminar_-_Frankfurt__15.04.2010/Presentation_of_the_REHVA_Guidebook_on_Solar_Shading.pdf , accessed April 6, 2013.

Case Study 5: Xceed Headquarters (Smart village) Egypt

Architect	Egyptian Consultant Group (ECG) [1]
Client	Xceed Company
Founded in	2005
Location	Smart Village (Egypt)
Category	Office Building
Certifications and Awards	Not Certified
Motivation	Aesthetic, Energy use reduction

[2]

[1] URL: www.elofoq.com/projects. Accessed April 8, 2013.
[2] URL: http://egyptoutsourcing.blogspot.com/2010/10/egyptian-bpo-firm-xceed-plans-two-fold.html , accessed July 7, 2013.

Green Technologies	fixed sunscreens and sunshades were adopted in the office building's elevations
Energy Efficiency Compared to Conventional building	Solar shading helps to reduce heat gain. it is possible to reduce the total cooling load of the air conditioned buildings by approximately **7%** by employing an efficient shading strategy[1]

A careful study of the sun Paths & building orientation during the design developed the sunshades system shown in (Figure 4.14).

Figure 4.14 Four row of horizontal steel louvers on the western façade.
Source: URL: http://www.alicoegypt.com/index2.php , accessed July 7, 2013.

Case Study 6: EPA Region 8 Headquarters (United States)

Architect	Zimmer Gunsul Frasca Architects LLP/Opus A&E, Inc.[2]	
Client	Environmental Protection Agency (EPA) company	
Founded in	2006	
Location	Denver Colorado United States	
Category	Office Building	
Certifications and Awards	LEED Gold-rated building	
Motivation	Energy use reduction, Acquiring LEED certification, Glare reduction	
Green Technologies	Vertical and Horizontal blinds applied to windows (interior), motorized with sun-tracking controls set by celestial clock. The tilt of the blinds changes automatically three times a day, controlling glare and reducing heat loads.[3]	
Energy Efficiency Compared to Conventional building	Over 75% of unwanted heat transfer takes place through windows, making energy-efficient window coverings essential for year-round savings. highly reflective blinds can reduce heat gain by around **45%**[4]	

[1] M. Santamouris, A. Argiriou, E. Daskalaki, C. Balaras and A. Gaglia, "Energy Characteristics and Saving Potential in Office Building," Solar Energy, vol. 52, no.1, 1994, pp. 59-66.
[2] URL: http://www.hunterdouglascontract.com/referenceprojects/article.jsp?pId=8a4383491172d6110111fb77e54e0409 , accessed April 8, 2013.
[3] Ibid.
[4] URL: http://energy.gov/energysaver/articles/energy-efficient-window-treatments , accessed May 18, 2013.

Figure 4.15 Horizontal window blinds in a meeting room.
Source: URL: http://www.hunterdouglascontract.com/referenceprojects/article.jsp?pId=8a4383491172d6110111fb77e54e0409 , accessed April 8, 2013.

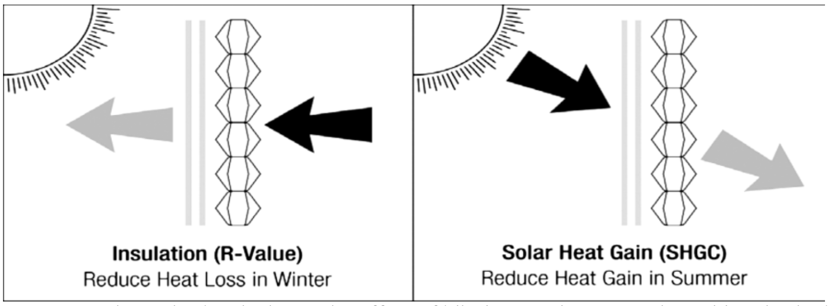

Figure 4.16 A schematic sketch shows the effect of blinds on Solar Heat gain and loss in the building envelope.
Source: URL: http://www.hunterdouglascontract.com/windowcoverings/AluminumBlinds/VerticalBlinds.jsp , accessed April 8, 2013.

4.5.1.1.3 Ventilated Double-skin Facades (VDF)

The double skin is a system involving the addition of a second glazed envelope which can create opportunities for maximizing daylight and improving energy performance. In the summer, the double façade can reduce solar gains as the heat load against the internal skin can be lessened by the ventilated cavity. A natural stack effect often develops in the solar heated cavity, as absorbed solar radiation (the glass, the structure and blinds) is re-radiated. In the winter, the double façade will act as a buffer zone between the building and the outside, minimizing heat loss, and improving U-values[1]. See Figure (4.17)

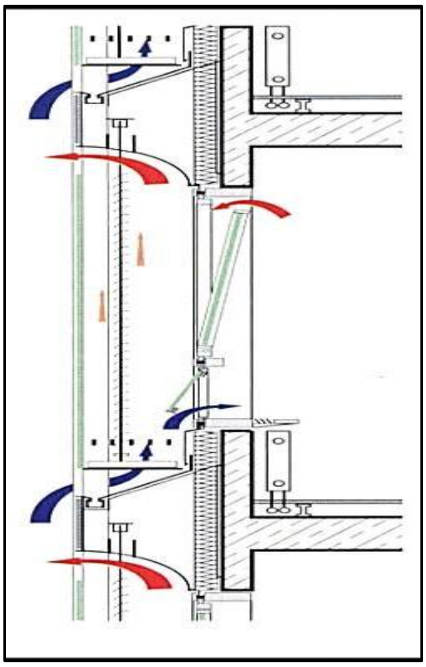

Figure 4.17 The concept of ventilated double skin façade
Source: URL: http://www.canadianarchitect.com/asf/enclosure_design_strategies/enclosure_strategies/enclosure_strategies.htm , accessed April 12, 2013.

[1]Wigginton, M., Harris, J., (2002), **Intelligent skins**, Architectural Press publications, London, England. P41-42.

Case Study 7: SUVA Insurance Company (Switzerland)

Architect	Herzog & de Meuron Architekten	Original Building 1950
Client	(SUVA)	 [1]
Founded in	1988–1993	
Location	Basel (Switzerland)	
Category	Office building	
Certifications and Awards	-	
Motivation	Energy use reduction, improve building's thermal performance	
Green Technologies	VDF - The inner windows of the existing building were replaced with a high performance timber window, with aluminium outer facing.	New Façade 1993  [2]
Energy Efficiency Compared to Conventional building	The new skin of structural silicon glazing panels consists of a tri-partite band of operable windows at each level, designed to enhance daylight penetration with prismatic glass, allow a degree of natural ventilation with openable windows and improve the building's overall thermal performance. In summer, the lower windows are opened to cool the stone façade, whereas in winter they remain closed to build up a thermal buffer between the two façades	

The original six-storey building had been constructed in the 1950s[3] and was typical of the period, with a regular arrangement of hole-in-the-wall windows and sandstone cladding. The architects were commissioned to over clad the existing building and improve its thermal and lighting performance. The existing sandstone façade remains intact behind a new glazed skin set 100mm - structural silicon glazing panels in aluminum frames- in front of the original.

The new glazed outer skin consists of a tri-partite band of computer controlled windows. An *upper prismatic panel* is adjusted according to solar angles, a *low level parapet window* is closed in winter and opened in summer to create a greenhouse effect in front of the heavyweight parapet, and a *central vision window* can be electronically opened from inside. See (Figure 4.18) and (Figure 4.19).

[1] Wigginton, M., Harris, J., (2002), **Intelligent skins**, Architectural Press publications, London, England. P. 177-142.
[2] Ibid. P. 177-142.
[3] Ibid. P. 177-142.

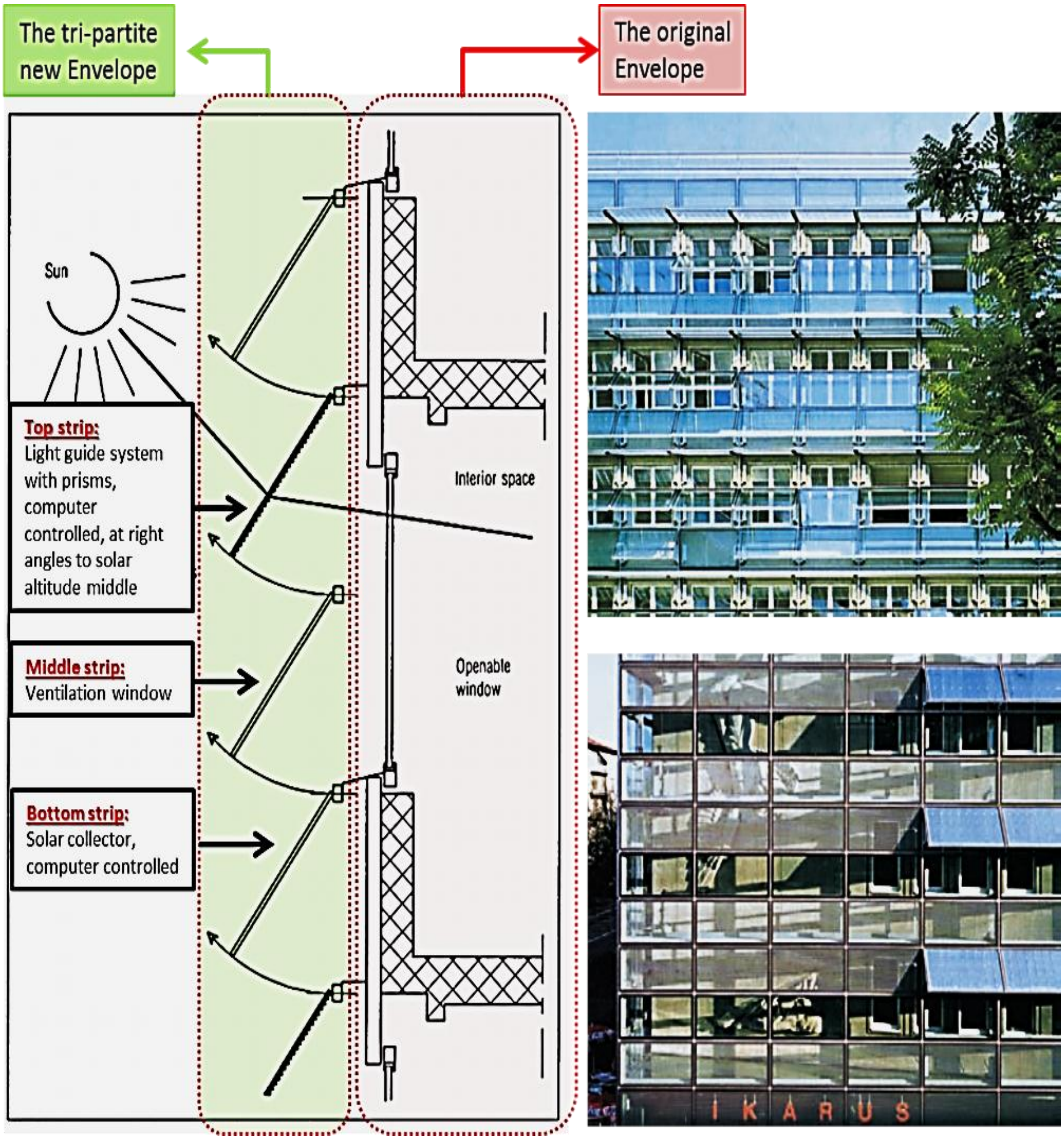

Figure 4.18 Section shows the tri-partite band of computer controlled windows
Source: Wigginton, M., Harris, J., (2002), Intelligent skins, Architectural Press publications, London, England. P. 177-142.

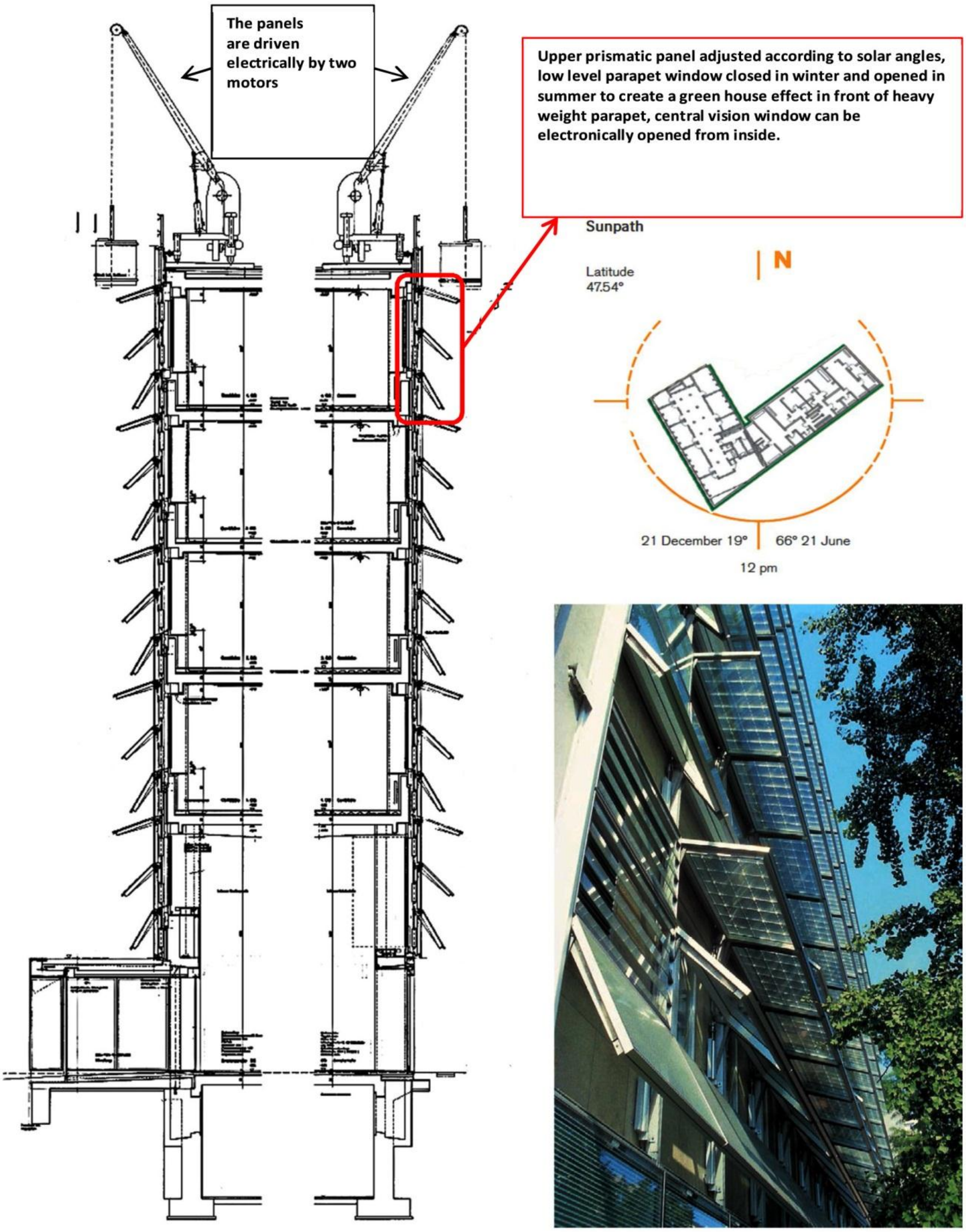

Figure 4.19 Automated VDF façade section
Source: Wigginton, M., Harris, J., (2002), Intelligent skins, Architectural Press publications, London, England. P. 177-142.

4.5.1.1.4 Whole Envelope Replacement (Re-Skinning)

Primarily for safety reasons after a marble panel fell from the façade and others appeared ready to fail. The marble, which will be recycled, is being replaced by fretted glass spandrel panels which attempt to give it a similar appearance to the original marble. The project also improves energy efficiency and aims for LEED certification.

Case Study 8: First Bank Building (FCP) Toronto, Canada


[2]

Architect	Bregman + Hamann Architects Edward Durell Stone & Associates[1]
Client	Brookfield Properties
Founded in	1975 ,Replacement Completion 2012
Location	Toronto, Canada
Category	Office Building
Certifications and Awards	LEED Canada-EB:O&M Gold certified, Zero footprint Re-Skinning Awards, Finalist Honorable Mention for Innovative Technology
Motivation	Safety precautions after the marble in the elevation fell, and Acquiring a LEED EBOM certification at the same time. Aesthetical motivation as well.
Green Technologies	Triple-glazed laminated glass with ceramic fritting in a triangular pattern to create the 2.4 by 3-metre panels of glass. Each one replaces eight marble panels.[3]
Energy Efficiency Compared to Conventional building	The re-skinning took place within a spectrum of retrofit strategies. Many of the strategies focus on energy optimization

The replacement required removing 45,000 slabs of marble weighing 90 kilos each; some from as high up as 275 meters; a three-storey movable platform with 14 separate sections was designed, it would be suspended from the top of the building and slide up and down as work was completed on each floor. See (Figure 4.20) and (Figure 4.21).

Figure 4.20 First Canadian Place image from time-lapse camera looking south-east.
Source: BH Architects, http://bharchitects.uberflip.com/i/65329 , accessed May 6, 2013

[1] URL: http://en.wikipedia.org/wiki/First_Canadian_Place , accessed May 6, 2013.
[2] URL: http://www.bharchitects.com/en/projects/92 , accessed May 6, 2013.
[3] Vukets, C., (2011), First Canadian Place — the big peel $100-million revamp changing tallest building in Canada from the outside in.URL: http://www.thestar.com/business/2011/05/20/first_canadian_place_the_big_peel.html , accessed May 6, 2013.

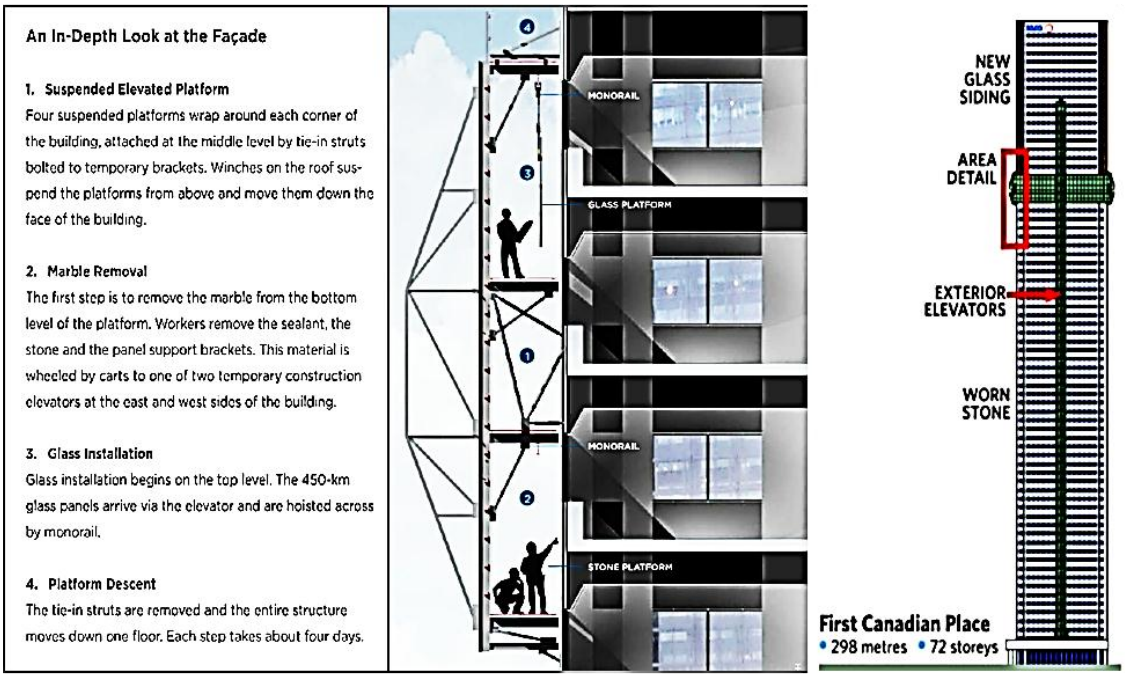

Figure 4.21 The movable platform detail designed for re-cladding the building
Source: BH Architects, http://bharchitects.uberflip.com/i/65329 , accessed May 6, 2013

4.5.1.1.5 Building Fabric Insulation (Opaque Envelope)

Heat naturally flows from a warmer to a cooler space; insulation provides resistance to heat flow, thereby reducing the amount of energy needed to keep a building warm in the winter and cool in the summer. Up to 40 percent of the energy used to heat or cool a building is cause by air leakage[1]; thus consuming more energy to maintain constant indoor temperature. However, as much as 30 percent of this energy expenditure can be eliminated by proper insulation[2]. Insulation is the ability to resist heat flow, or R-value[3]; Good insulation could lower the energy need for heating and cooling.

4.5.1.1.5.1 External wall insulation (EWI)

External wall insulation comprises an insulation layer fixed to the outside of an external wall, using a combination of mechanical fixings and adhesive depending on the material used, with a protective render or cladding finish.

- **Green Wall**

Living walls and green façades create their own specific microclimate, quite different from surrounding conditions. Depending on height, orientation and the location of surrounding buildings, the façade is subject to extreme temperature fluctuations (hot during the day and cool at night), with constant exposure to sunlight and wind. Hard surfaces of concrete and glass encourage runoff of rainwater into the sewage system. Plants hold water on their leaf surfaces longer than building materials

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[1]Attmann, O., (2010), Green Architecture Advanced technologies and Materials, McGraw Hill books, United States of America.P. 85.
[2]Ibid, P. 85.
[3]Center for climate and Energy Solutions, URL: http://www.c2es.org/technology/factsheet/BuildingEnvelope , accessed April 5, 2013.

and the processes of transpiration and evaporation, can add more water into the air. The result of this is a more pleasant climate in the urban area.

Between façade and the dense vertical green layer (both rooted in soil and not rooted in soil based systems) a still standing air layer exist. Still standing air has an insulating effect; green façades can therefore serve as an "extra insulation" of the building façade. Also direct sunlight on the façade is blocked by the vegetation. This blocking of the sunlight ensures that the temperature will be less high inside the building. In winter, the system works the other way round and heat radiation of the exterior walls is isolated by evergreen vegetation. In addition, the dense foliage will reduce the wind speed along the façade and thus also helps to prevent that the walls will cool. As a consequence every decrease in the internal air temperature of 0.5 C will reduce the electricity use for air-conditioning up to 8%[1].

The Thermal benefits for green walls or plant covered cladding systems can be used as a new engineering tool for architects, building owners, as an "extra insulation" layer. This technical/thermal green" strategy of increasing exterior insulation properties of vertical surfaces stimulates upgrading or retrofitting of existing (under-insulated) façades without the added cost of interior or traditional exterior insulation systems.

Case Study 9: Aquaquest, the Marilyn Blusson Learning Centre, Vancouver Aquarium

Architect	Clive Grout, Doug Hamming, Stantec Architecture Ltd. [2]	
Green Wall Designer & Landscape Architect:	Randy Sharp, Sharp & Diamond Landscape Architecture Inc.	
Client	Vancouver Aquarium	
Founded in	2006[3]	
Location	Vancouver, B.C., Canada	
Category	Commercial Building	
Certifications and Awards	LEED Gold and ISO 14001 certifications in time for Earth Day 2009	
Motivation	Acquiring LEED certification, aesthetic	
Green Technologies	Living green wall on the south side of native plants, which measures 3 meters by 15.2 meters[4]. The 7,000 plants are mostly native species. It is estimated to have cost $50,000.[5]	
Energy Efficiency Compared to Conventional building	Living green wall can cut energy costs by **23 per cent**[6], 44% less GHG emissions than reference building [7]	

[1]Dewidar, K., Abd El Latif, R., (2011), The Future Belongs to those Who Believe in the Beauty of their Dreams Living Architecture The New Architectural Modernism, 4TH URBENVIRON INTERNATIONAL CONGRESS ON ENVIRONMENTAL PLANNING AND MANAGEMENT, Green Cities: a Path to Sustainability , December 10 – 13, 2011 Cairo and El-Gouna, Egypt.
[2] URL: http://www.greenroofs.com/projects/pview.php?id=552 , accessed April 26, 2013.
[3] Ibid.
[4] Ibid.
[5] Colonist, T., (2007), 'Green' wall a living, breathing divider There are a lot of reasons to get excited about Randy Sharp's "green wall.", URL: http://www.canada.com/topics/lifestyle/story.html?id=2426c27d-8a58-44d3-b40e-06c5a2a02712 , accessed April 26, 2013.
[6] Loh, S., (2008), Living walls – a way to green the built environment, TEC 26, URL: http://www.environmentdesignguide.com.au/media/TEC26.pdf , accessed April 26, 2013.
[7] URL: http://www.sustainabuild.com/vancouver/downloads/2009/max_ritcher.pdf , accessed April 26, 2013.

The first modular living wall installation in North America. The Green Wall Panels were pre-grown in a greenhouse, delivered to the site and installed in one day to create an instant green wall. The modular panels make it possible to lift any section of the wall and replace the plants if they die or develop problems.

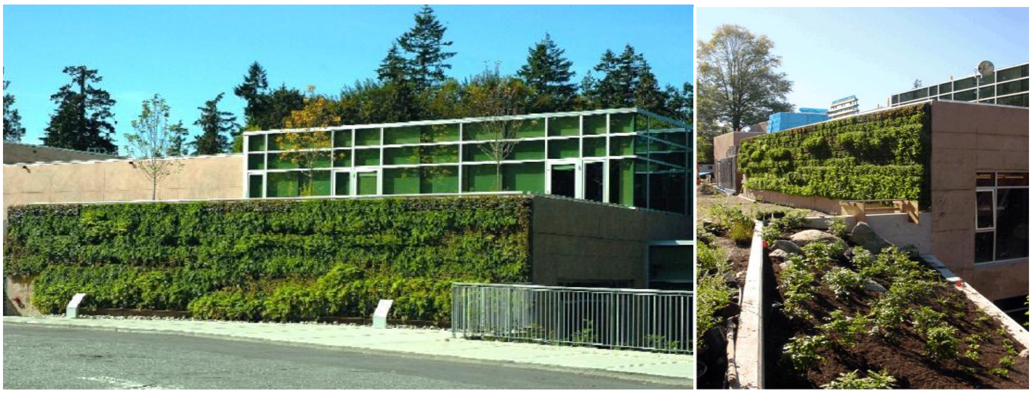

Figure 4.22 Front view of the Aquaquest Learning Center showing the living green wall.
Source: URL: http://www.greenroofs.com/projects/pview.php?id=552 , accessed April 26, 2013.

4.5.1.1.5.2 Roof

Roof design and materials can reduce the amount of air conditioning required in hot climates by increasing the amount of solar heat that is reflected, rather than absorbed, by the roof. In addition, roofs also offer several opportunities for installing on-site generation systems. Solar photovoltaic (PV) systems can either be installed as a rooftop array on top of the building or a building-integrated photovoltaic system can be integrated into the building as roofing tiles or shingles[1].

- **Green Roof**

Green roofs (vegetated roofs) are engineered ecosystems that rely on vegetation to provide services such as reduction of roof temperature[2]. A number of advantages and features have been cited for use of green roofs, including low maintenance planting, improved building aesthetics, controlled rainwater runoff, cleaner air, reduced dust and smog levels, and improved thermal performance by helping to keep the building warm in the winter and cool in the summer. Green roofs help with city greening, mitigating urban heat island effects, and lowering urban stormwater runoff[3].

Green roofs are typically classified as being either an intensive or extensive roof; Intensive green roofs are often used on commercial buildings in order to have large green areas that incorporate all sizes and types of plants. These roofs use grasses, ground covers, flowers, shrubs and even trees. They often include paths and walkways that travel between different architectural features to provide space where people can interact with the natural surroundings. Intensive green roofs, sometimes termed "rooftop gardens", utilize planting mediums that have greater depth than extensive green roofs; the deeper soil allows intensive roofs to accommodate large

[1] Center for climate and Energy Solutions, URL: http://www.c2es.org/technology/factsheet/BuildingEnvelope , accessed April 5, 2013.
[2] Wolf, D., and J.T. Lundholm, 2008. "Water Uptake in Green Roof Microcosms: Effects of Plant Species and Water Availability", Ecol. Eng., 33 (2): 179–186.
[3] Berndtsson, J.,C., L. Bengtsson, and K. Jinno, 2009. "Runoff Water Quality from Intensive and Extensive Vegetated Roofs", Ecol. Eng., 35 (3): 369–380.

plants and various plant groupings. Intensive green roofs require more maintenance than extensive green roofs because of the plant varieties they will support.

Table 4.1 Comparison of different types of green roofs
Source: URL: http://www.greenrooftechnology.com/green-roof-types , accessed April 13, 2013.

		Intensive	Extensive
Green Roof Types	**Depth of material**	More than 15 cm	Less than 15 cm
	Accessibility	Accessible	Inaccessible
	Fully saturated weight	290-267.7 Kg/m3	72.6-169.4 Kg/m3
	Plant Diversity	High	low
	Cost	High	low
	Maintenance	High	low
	Irrigation	yes, automatic/flood	no, not recommended

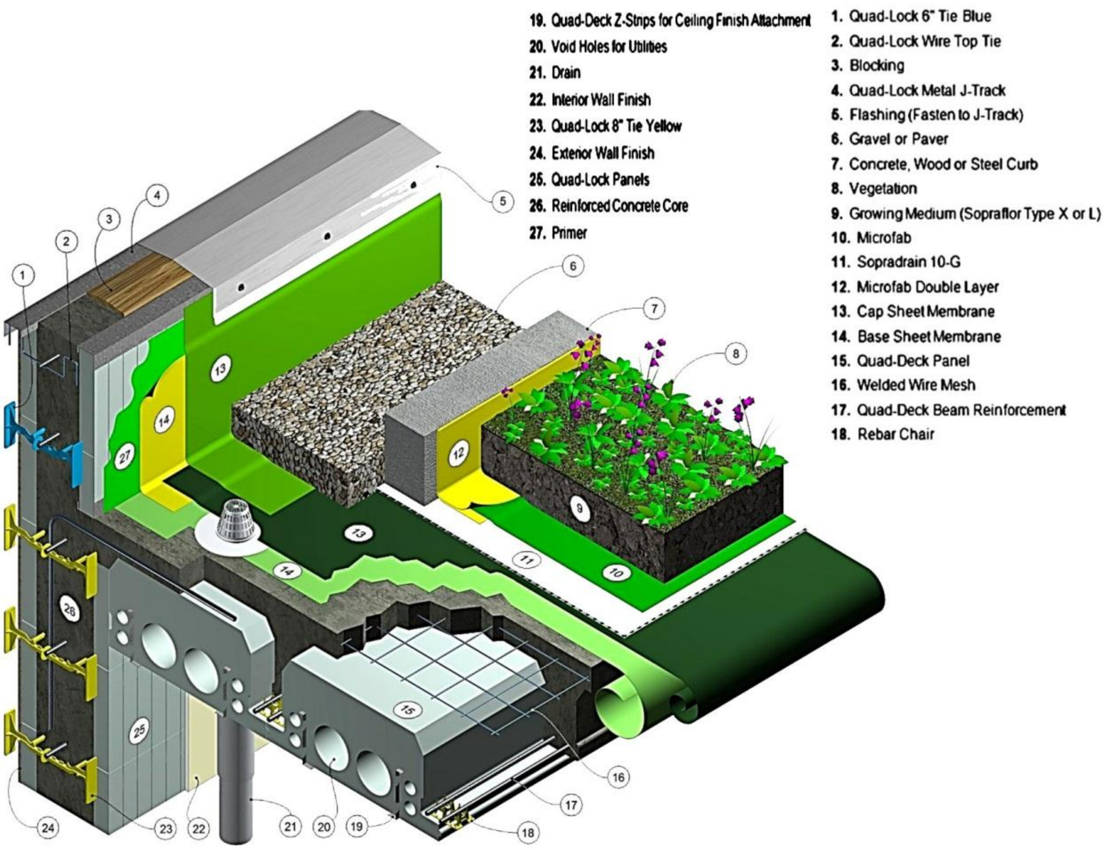

Figure 4.23 Typical detail for a green roof installation (LEED accredited) Quad-Lock.
Source: Quad-Lock Fast and Integrated Green System, AlBenaa-AlAraby Magazine Sept. 2011: P. 93.

Existing buildings can be retrofitted with green roofs to help save energy. Thermal performance indicated a significant reduction (~40%) of a building cooling load during the summer period[1], over 60% of the heat gain was mitigated by vegetated roof systems[2].

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[1] Kirby, J.et al, (2011), Energy reductions resulting from implementation of an extensive green roof in the South-eastern United States, Department of Civil, Construction, and Environmental Engineering, Facilities Management Department, University of Alabama at Birmingham. 4TH URBENVIRON INTERNATIONAL CONGRESS ON ENVIRONMENTAL PLANNING AND MANAGEMENT, Green Cities: a Path to Sustainability , Cairo 2011.
[2] Ibid.

Case Study 10: Hulsey Center, University of Alabama (United States)

Architect	KPS Group, Inc.[1]
Client	University of Alabama at Birmingham (UAB)
Founded in	2004
Location	Birmingham, Alabama
Category	
Certifications and Awards	-
Motivation	Energy use reduction
Green Technologies	New implemented Green Roof
Energy Efficiency Compared to Conventional building	Reductions in natural **gas, water**, and **electricity** have averaged **15%, 22%,** and **20%**, respectively.


[2]

Figure 4.24 Top: Construction phase for installing a pilot vegetative roof on top of Hulsey Center.
Bottom: Vegetative roof on top of Hulsey Center (June 2009)
Source: Robert W. Peters, Ronald D. Sherrod and Matt Winslett (2013). Energy Savings Resulting from Installation of an Extensive Vegetated Roof System on a Campus Building in the Southeastern United States, New Developments in Renewable Energy, Prof. Hasan Arman (Ed.), ISBN: 978-953-51-1040-8, InTech, DOI: 10.5772/55997. Available from: http://www.intechopen.com/books/new-developments-in-renewable-energy/energy-savings-resulting-from-installation-of-an-extensive-vegetated-roof-system-on-a-campus-buildin ,accessed April 12, 2013.

· Cool Roof

Cool roof is a highly reflective surface, commonly are white colored roofs, Most of the roofs in the world are dark-colored. In the heat of the full sun, the surface of a black roof can increase in temperature; this heat increase can cause negative effects on cooling energy use and environments.

[1] URL: http://www.goldenconstruction.com/pr-edu-uab-hulsey.html , accessed April 12, 2013.
[2] URL: http://www.uab.edu/map/hc , accessed April 12, 2013.

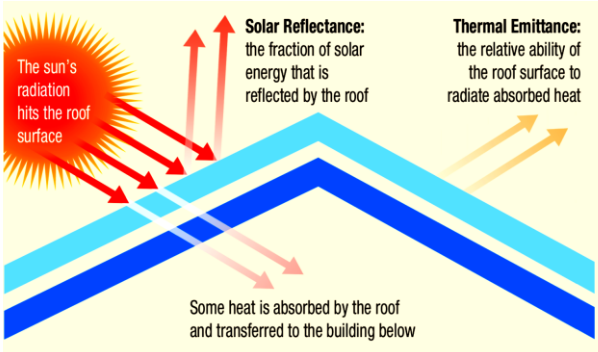


Figure 4.25 Cool Roof Mechanism
Source: US Department of energy, Energy Efficiency and Renewable Energy fact sheet, URL: http://www1.eere.energy.gov/buildings/pdfs/cool_roof_fact_sheet.pdf , accessed April 22, 2013.

Advantages:
· Reduced building heat-gain, as a white or reflective roof typically increases only 5–14 °C [1]above ambient temperature during the day
· Save of up to 15% the annual air-conditioning energy use of a single-story building[2]
· Improved thermal comfort in buildings that do not have air conditioning
· Help in mitigating the urban heat island effect[3]

Figure 4.26 Cool Roof (Reflective white colored)
Source: URL: http://anenvironmentblog.files.wordpress.com/2010/04/cool_roof1_zne91.jpg , accessed April 22, 2013.

Case Study 11: Scottsdale Insurance Company (Scottsdale, AZ)

Architect	-
Client	Scottsdale Insurance Company
Founded in	Cool Roof installed 2008
Location	Arizona
Category	Office building
Certifications and Awards	-
Motivation	Energy use reduction
Green Technologies	Installed self-adhered, insulated, dual-modified Polyglass PolyKool roofing system.
Energy Efficiency Compared to Conventional building	Electricity consumption was cut from 719,000 kilowatts to 663,000 kilowatts in a year (August 2008- August 2009) a **7.79%** decrease (or $5,450) in electricity required to cool the building (much more energy efficient)[4].

[1] URL: http://en.wikipedia.org/wiki/Reflective_surfaces_%28geoengineering%29#Case_study , accessed April 22, 2013.
[2] US Department of energy, Energy Efficiency and Renewable Energy fact sheet, URL: http://www1.eere.energy.gov/buildings/pdfs/cool_roof_fact_sheet.pdf , accessed April 22, 2013.
[3] Urban, B., Roth, K., (2011), Guidelines for Selecting Cool Roofs, U.S. Department of Energy, URL: http://heatisland.lbl.gov/sites/heatisland.lbl.gov/files/coolroofguide_0.pdf , accessed April 22, 2013.
[4] Walker, C., Cool Roof Case Study - Are White Roofs Cooler and More Energy Efficient than Non-white Roofs, URL: http://www.onsetcomp.com/application_stories/cool-roof-case-study , accessed April 23, 2013.

The original roof system was a ballasted EPDM over 4" of R-20 roof insulation on a concrete roof deck, and blanketed by 2" of river rock[1]. The new cool roof system installed by Starkweather Roofing in 2008 consisted of 3" of R-19 ISO board insulation with a tight-set roofing adhesive glued to the concrete roof deck, and a self-adhesive Polyglass Eastoflex SAV base sheet and PolyKool cap sheet over the top.

Figure 4.27 Scottsdale Insurance Company before and after cool roof installation
Source: Walker, C., Cool Roof Case Study - Are White Roofs Cooler and More Energy Efficient than Non-white Roofs, URL: http://www.onsetcomp.com/application_stories/cool-roof-case-study , accessed April 23, 2013.

Figure 4.28 Installation of EPDM membrane on the roof
Source: URL: http://www.starkweatherroof.com/Firestone.htm , accessed April 23, 2013.

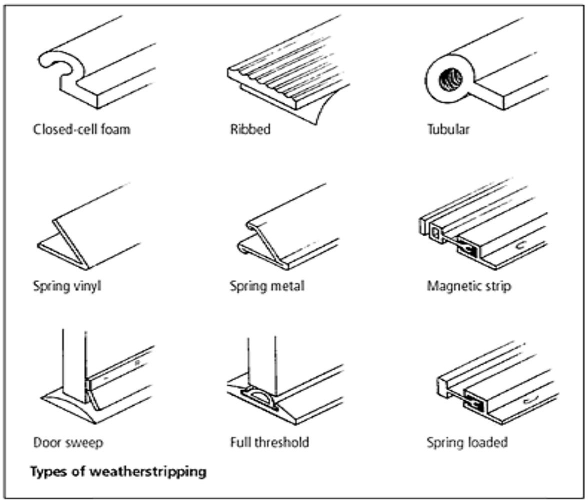
4.5.1.1.6 Air Leakage control

Air leakage through building envelope can be a cause of energy wastage in buildings. Air leakage represents up to 24% of space cooling/heating energy use[2]. Leakage can occur due to infiltration, which is the leaking of untreated air into the building and exfiltration, which is the leaking out of treated air[3]. Some common means of reducing such air leakage through building structures include weather-stripping, use of automatic doors, vestibules, and air curtains.

- ***Weather-stripping***: Weather-stripping involves the sealing of gaps around exterior doors and windows to prevent air leakage. (Figure 4.29)
- ***Automatic doors:*** opened and closed automatically using sensors, which can detect the movement of people or doors that have hydraulic or spring loaded mechanisms to simply close the doors when opened.

[1] Ibid.
[2] Canada Mortgage and Housing Corporation, (2007), Air Leakage Control Manual Existing Multi-Unit Residential Buildings guide, Canada. URL: http://www.cmhc-schl.gc.ca/odpub/pdf/65847.pdf , accessed May 24, 2013.
[3] Jayamaha, L., (2007), Energy-Efficient Building Systems Green Strategies for Operation and Maintenance, McGraw-Hill books, USA, P. 254.

- ***Vestibules:*** intermediate compartments that act as air locks between the exterior and interior of buildings to minimize air leakage at doorways. They usually have two sets of automatic or revolving doors so that the interior of the building is not directly exposed to the exterior.
- ***Air curtains***: Air curtains can be installed over open doorways to prevent air leakage.



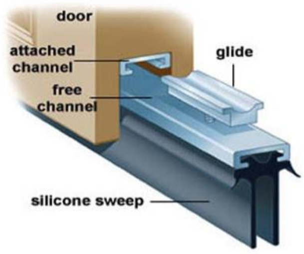


Figure 4.29 Types of weather stripping
Source: URL: http://www.daviddarling.info/encyclopedia/W/AE_weatherstripping.html , accessed April 20, 2013.

Advantages of Air Leakage Control Systems	
space cooling/heating energy cost savings;	enhanced occupant comfort; and
improved envelope durability;	Better HVAC system performance[1].

Case Study 12: 21-storey apartment tower , Ottawa, Ontario

Architect	-	 [2]
Client	-	
Founded in	1970's	
Location	Ottawa, Ontario	
Category	Multi-Unit Residential Building	
Certifications and Awards	-	
Motivation	Energy use reduction, Enhancing building HVAC performance.	
Green Technologies	Air Leakage control measures (Sealing doors and windows)	
Energy Efficiency Compared to Conventional building	Annual Energy Savings from ALC [KWh], 165,000 KWh, corresponding to a **12%** reduction in energy use.	

An analysis of energy use was done, and air leakage was estimated to account for 33% of the building heat loss[3]. Retrofits cost in 1990 $54,800 , Payback Period 5.7 years[1]. (Table 4.2) shows the impact of air leakage controls.

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[1]Canada Mortgage and Housing Corporation, (2007), Air Leakage Control Manual Existing Multi-Unit Residential Buildings guide, Canada. URL: http://www.cmhc-schl.gc.ca/odpub/pdf/65847.pdf , accessed May 24, 2013.
[2] Ibid, P.41.
[3] Canada Mortgage and Housing Corporation, (2007), Air Leakage Control Manual Existing Multi-Unit Residential Buildings guide, Canada. URL: http://www.cmhc-schl.gc.ca/odpub/pdf/65847.pdf , accessed May 24, 2013.

Air Leakage control measures used included:

- sealing all shafts (top and bottom)
- sealing exterior envelope leaks
- sealing exterior doors
- sealing exterior windows

Table 4.2 Estimated impact of air leakage by component at Ottawa case study building
Source: Canada Mortgage and Housing Corporation, (2007), Air Leakage Control Manual Existing Multi-Unit Residential Buildings guide, Canada, P. 42. URL: http://www.cmhc-schl.gc.ca/odpub/pdf/65847.pdf , accessed May 24, 2013.

Component	Type of airsealing	Cost of airsealing [1990 $]	Demand reduction [kW]	Unit cost [$/kW]
Shafts	Caulking and Sealing	828	11.5	72
Building Envelope	Caulking and Sealing	2,719	5.2	523
Exterior Door	Weatherstripping and caulking	15,180	22	690
Miscellaneous	Caulking and Sealing	7,879	10.3	765
Windows	Weatherstripping and caulking	28,210	36	783
		$54,816	**85 kW**	**$645/kW**

4.5.2 Energy Efficient Equipment and Low Energy Technologies

You can reduce energy, save money and help the environment by buying and using "green" equipment. Energy efficiency retrofits (upgrade) can reduce the operational costs, particularly in older buildings, as well as help to attract tenants and gain a market edge.

4.5.2.1 Lighting Upgrade

The reduction in the use of energy in buildings has been identified as a major objective, of which electrical energy for lighting is a significant factor. The production of artificial (electrical) light is the most inefficient process in a building. Lighting accounts for between a third and a half of the energy use in office buildings[2] and significant savings in energy can be obtained by rational using of daylight associated with control systems. Lighting upgrades in commercial and institutional facilities generate an average project payback period of a little more than two years, with a 45 percent return on investment, according to the Energy Cost Savings Council[3]. The low efficiency of the typical lighting system results in producing a substantial amount of heat and can be responsible for as much as 30% of a commercial building's cooling load[4]. Advanced lighting controls can reduce lighting energy consumption by 50 percent in existing buildings[5].

[1] Ibid, P.41.
[2] Vuceljic, S., APPLICATION OF SMART MATERIALS IN RETROFITTING HOMES CAN HELP HOUSING ENERGY EFFICIENCY, Published paper, Faculty of architecture of Union University, Belgrade.URL: http://www.europaforum.or.at/site/energy-housing.net/dateien/Vavan_Vuceljic_Paper.pdf , accessed March 22, 2013.
[3] DiLouie, C., (2009), Lighting Upgrades: Opportunities in Existing Buildings, URL: http://www.facilitiesnet.com/lighting/article/Lighting-Upgrades-Opportunities-in-Existing-Buildings--11033 , accessed April 26, 2013.
[4] Vuceljic, S., APPLICATION OF SMART MATERIALS IN RETROFITTING HOMES CAN HELP HOUSING ENERGY EFFICIENCY, Published paper, Faculty of architecture of Union University, Belgrade.URL: http://www.europaforum.or.at/site/energy-housing.net/dateien/Vavan_Vuceljic_Paper.pdf , accessed March 22, 2013.
[5] DiLouie, C., (2010), Lighting Control for Existing Buildings- Lighting is a target for energy-efficiency improvements because it's profitable, URL: http://www.buildings.com/article-details/articleid/8495/title/lighting-control-for-existing-buildings.aspx , accessed April 29, 2013.

Case Study 13: Host Street, Bristol

Architect and lighting design	Jeremy Johnson-Marshall	
Client	Kinneir Dufort Design Ltd.	
Founded in	1977	
Location	Bristol (UK)	
Category	Office building	
Certifications and Awards	Not Certified	
Motivation	Maximizing day lighting in office parts	
Green Technologies	Day Lighting	
Energy Efficiency Compared to Conventional building	-	

Host Street, existing nineteenth century listed industrial building, where 'new use 'demanded additional floor space in the roof which had seen no daylight, and had been converted into offices, studios and prototyping workshops for a firm of industrial designers.

The top floor however was limited by 1.7m headroom below heavy roof trusses, and to gain the extra space required it was decided to remove the existing roof and to raise it, allowing the addition of an extra floor. This created the opportunity, to consider the entry of natural light to the newly created floor areas[1].

The new roof matched the old at the front, but a glazed gable was included at the rear, allowing daylight to penetrate to the new floor areas. The proposals permitted better daylight to the new areas than that available to those below.

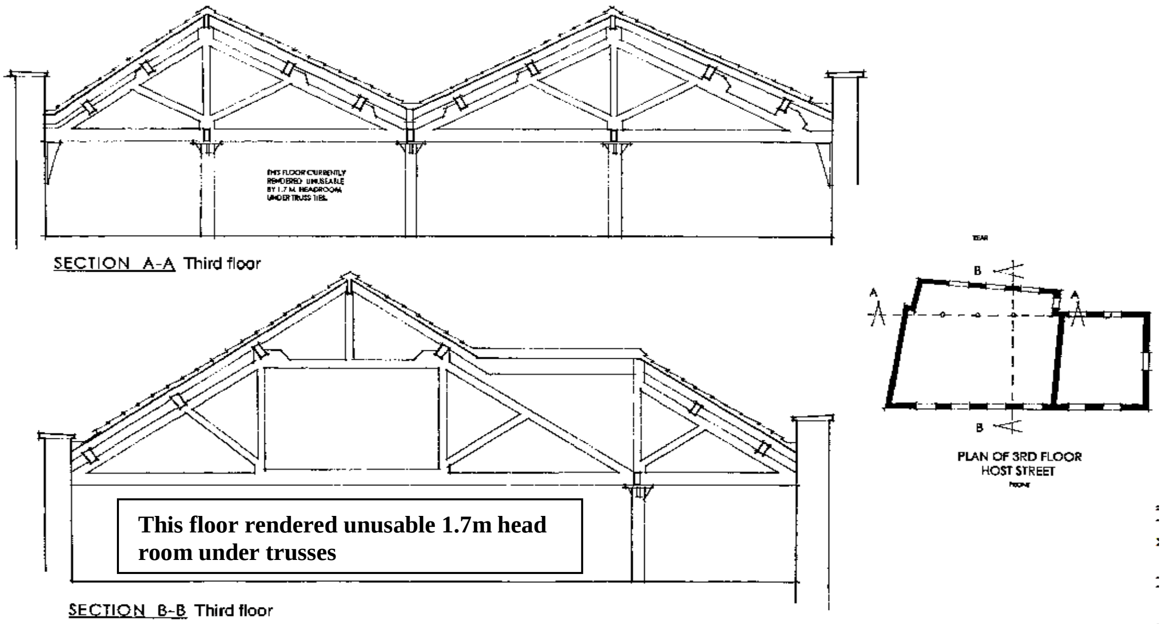

Figure 4.30 Original roof section. This shows the 1.7m headroom
Source: Phillips, D., (2004), Day lighting Natural Light in Architecture, Architectural Press, An imprint of Elsevier, Oxford.

[1] Phillips, D., (2004), Day lighting Natural Light in Architecture, Architectural Press, An imprint of Elsevier, Oxford.

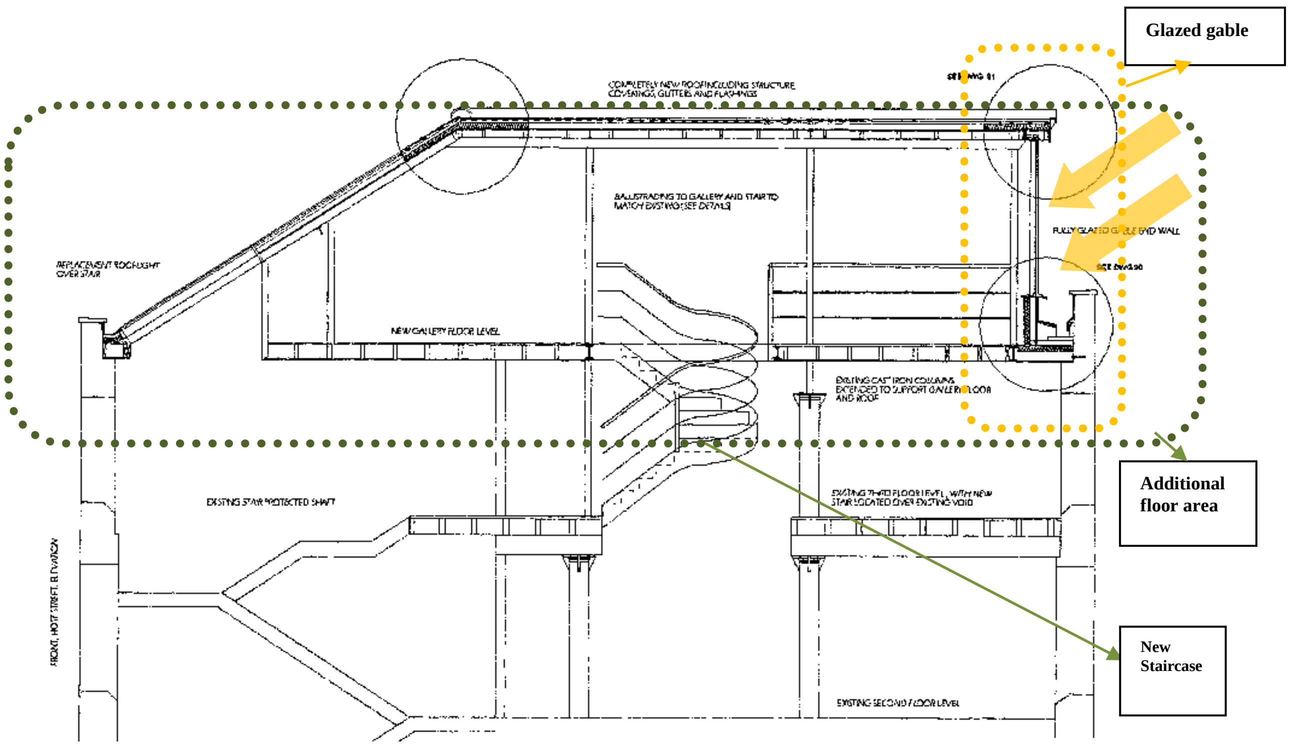

Figure 4.31 New section showing the additional floor
Source: Phillips, D., (2004), Day lighting Natural Light in Architecture, Architectural Press, An imprint of Elsevier, Oxford.

Figure 4.32 Interior. View up the new staircase

Figure 4.33 Interior. View showing the new floor area
Source: http://www.marshallandkendon.co.uk/lb_host_street.htm , accessed February 26, 2013.

Case Study 14: Alliance Center, (Denver)

Architect	-	 [1]
Client	Alliance for Sustainable Colorado	
Founded in	1908 (Retrofits completion 2006)[2]	
Location	Denver, CO	
Category	Office Building	
Certifications and Awards	LEED-EB Gold and LEED-CI Silver - Energy Star Leader- USGBC National Award for Education by an Organization	
Motivation	Acquiring LEED certification	
Green Technologies	**Lighting** System upgrade (Nearly 1,000 40-watt T-12 lamps with magnetic ballasts were replaced with 32-watt T-8 lamps with high-efficiency electronic ballasts)[3] **Day lighting:** Super-efficient ballasts installed on the fifth-floor east wing include photocell sensors that dim the lights when sufficient daylight is present. Many office suites include translucent wall panels which allow the interior office spaces to receive natural daylight. The sixth-floor windows feature window shade screens which help to control light and glare levels and reduce heating gains and losses.	
Energy Efficiency Compared to Conventional building	Reduction in lighting energy consumption by approximately **40%** and paid for itself in approximately 2.5 years[4].	

Inside every fluorescent light fixture is ballast that regulates the flow of electrical current through the lamps. The super-efficient electronic ballasts on the 5th floor incorporate a sensor with a photocell that detects natural light. The photocell automatically dims the ballast to balance the amount of artificial light with incoming natural light to maintain a constant, optimal light level for working, (Figure 4.34). The benefits of this ballast are that it's dimmable and that the maximum output of light can be limited by setting switches in the ballast so that offices will not be over lit and energy will be saved.

By allowing a precise light level setting and "harvesting daylight", the power consumption of these fixtures is reduced by 30% to 50% over current building standards[5].

Figure 4.34 Left: The T-8 lamps and high efficiency electronic ballasts that were installed Middle: photocell that detects natural light. Right: Occupancy sensor.
Source: Saieg, P., The Alliance for Sustainable Colorado, URL: http://www.sustainablecolorado.org/alliance-center/building-features , accessed April 29, 2013.

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[1] URL: http://www.bikedenver.org/news/janbfb/ , accessed April 29, 2013.
[2] New building institute, (2012), URL: http://newbuildings.org/alliance-center-case-study , accessed April 29, 2013.
[3] Ibid.
[4] Ibid.
[5] Saieg, P., The Alliance for Sustainable Colorado, URL: http://www.sustainablecolorado.org/alliance-center/building-features , accessed April 29, 2013.

Occupancy sensors, which detect when a room is unoccupied and turn off the lights, have been installed throughout the Alliance Center. Conversely, when someone enters a room, the lights automatically turn on. The sensors are able to detect motion from up to 35 feet away, with an area as large as 900 sq. feet[1]. If adequate daylight is present, the sensors will hold lights off until natural light levels drop, regardless of occupancy.

Case Study 15: United Nations (UN) Headquarters Nairobi, Kenya

Architect	-	 [2]
Client	UNEP and UN-HABITAT	
Founded in	Completed 2011[3]	
Location	Nairobi, Kenya	
Category	Office Building	
Certifications and Awards	-	
Motivation	Energy use reduction, a goal to build a green, energy neutral building.	
Green Technologies	Low energy fluorescent lighting, together with a daylight sensing and presence detection system significantly reduces energy use while ensuring adequate light to work by[4].	
Energy Efficiency Compared to Conventional building	**50%** reduction in lighting energy consumption. savings of up to **70 %** on lighting costs can be gained[5]	

Philips has supplied energy efficient lighting solutions (savings of up to 70%)[6] for the UN's new sustainable building headquarters in Nairobi.

The lighting solution consists of high quality TL5 fluorescent systems, with controls that automatically dim or turn off the lighting when no one is present or when natural daylight is able to compensate. With no light switches in office areas the risk of lights being left on overnight is eliminated. The lighting systems are connected to the building management system which enables usage to be monitored and adjusted, providing even greater efficiencies on maintenance.

Savings from the new lighting solutions are very significant when compared to conventional lighting. If the new building was powered via an on-grid connection (and not with solar energy as in this case) the total lighting savings during a 10 year period would amount to the equivalent of 1000 tons of CO_2. This would mean a reduction in operational lighting costs of around 50% and a payback period of only 3.5 years[7].

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[1] Ibid.
[2] URL: http://www.lighting.philips.com/pwc_li/main/shared/assets/images/project/UN_Headquarters/new-unon-morning-image-bb_hires.jpg , accessed May 26, 2013.
[3] URL: http://en.wikipedia.org/wiki/United_Nations_Office_at_Nairobi, accessed May 27, 2013.
[4] United Nations Environment Programme Report, (2011), Building for the future A United Nations showcase in Nairobi, UNEP Division of Communications and Public Information. Online version via URL: www.unep.org/gc/gc26/Building-for-the-future.pdf, accessed May 25, 2013.
[5] Ibid, p. 22.
[6] URL: http://www.lighting.philips.com/main/projects/un_headquarters_nairobi.wpd , accessed May 26, 2013.
[7] Ibid.

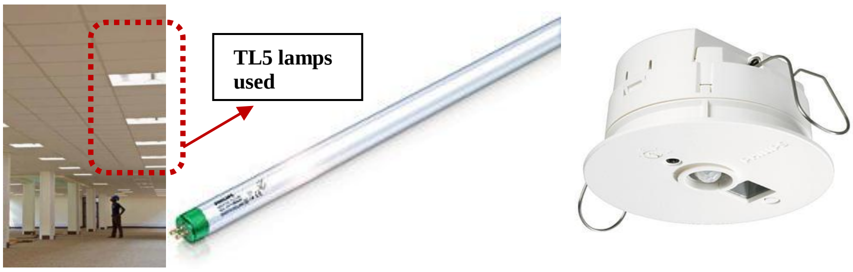

Figure 4.35 Left: Interior shot showing artificial lighting system. Middle: TL5 fluorescent lamp used in the UN building. Right: OccuSwitch DALI sensor used.
Source: URL: http://www.lighting.philips.com/main/projects/un_headquarters_nairobi.wpd , accessed May 26, 2013.

Case Study 16: Toyota Motor Corporation Head Office

Architect	Overall supervision: Toyota Motor Class 1 Architect's Office, Basic design + blueprint drawings: Nikken Sekkei, Execution design: Shimizu Corporation	
Client	Toyota Motor Corporation	
Founded in	2005	
Location	Toyota City, Aichi Prefecture	
Category	Office Building	
Certifications and Awards	- CASBEE (S) - - 2nd Sustainable Building Awards, Examination Committee Encouragement Prize (Institute for Building Environment and Energy Conservation, 2007) - 46th SHASE Awards of Technology, Category in Building Mechanical Service System (The Society of Heating, Air-Conditioning and Sanitary Engineers of Japan, 2008)[1]	
Motivation	Acquiring CASBEE certification, Energy use reduction	
Green Technologies	Mirror duct for natural light	
Energy Efficiency Compared to Conventional building	-	

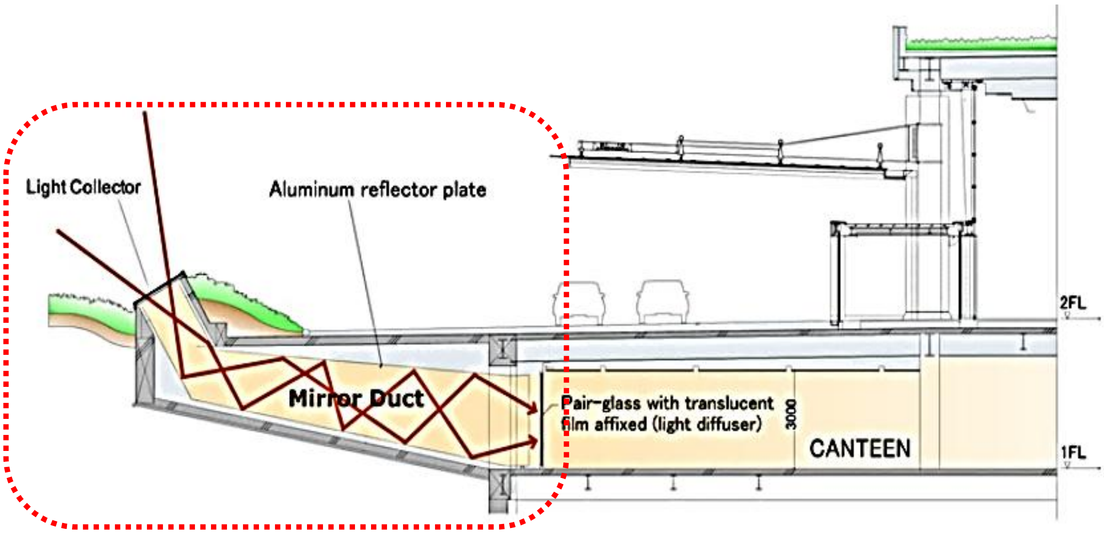

Figure 4.36 Mirror duct cross section.
Source: Japan Sustainable building data base, URL: http://www.ibec.or.jp/jsbd/AD/features.htm , accessed May 11, 2013.

[1] Japan Sustainable building data base, URL: http://www.ibec.or.jp/jsbd/AD/features.htm , accessed May 11, 2013.

Natural light for the underground staff canteen is captured through openings above ground, carried through high efficient light duct, and delivered from the side, marking a bright and clean dining space. This system uses one of the largest mirror ducts in Japan, with a lateral light emitting surface measuring 3m in height by 24.9m in length[1]. It is used as a place of relaxation for office workers.

Figure 4.37 Left: Photo of cafeteria brightly lit by mirror duct. Middle: Interior photo of mirror duct. Right: Light collection part of mirror duct.
Source: Japan Sustainable building data base, URL: http://www.ibec.or.jp/jsbd/AD/features.htm , accessed May 11, 2013.

4.5.2.2 Energy Efficient Equipment and Appliances

Huge energy savings have translated into lower utility bills for consumers and businesses through using energy efficient equipment. The American Council for an Energy-Efficient Economy projects total electricity savings to reach 341 billion kilowatt hours/year by 2020, or 7.8% of total projected U.S. energy consumption[2]. By 2020, savings from already existing standards should reach 4.2 quadrillion British thermal units (quads), equivalent to the annual energy use of about 23 million American households. As consumers and businesses replace appliances and equipment, these savings will continue to grow.

Equipment and appliances are plug loads; Plug loads often have external or internal power supplies so that most or all of the energy is used as low-voltage direct-current electricity. Examples include personal computers, televisions, monitors, and portable device chargers. As of 2010, plug loads consume approximately 15% of all building energy use, and that consumption is expected to grow to 29% in 2030[3].

For example, low cost energy monitors save up to 40 %[4] of electricity consumption in an office building.

Energy label makes it easy for purchasers to distinguish energy-efficient office products and equipment. (Figure 4.38)

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[1] Ibid.
[2] Hildt, N., (2001), Appliance and Equipment Efficiency Standards: New Opportunities for States, American Council for an Energy-Efficient Economy and Northeast Energy Efficiency Partnerships. Available online via URL: http://www.efficientpowersupplies.org/pages/Appliance%20Standard%20Awareness.pdf , accessed May 13, 2013.
[3] URL: http://www.energy.ca.gov/research/buildings/appliances.html , accessed May 13, 2013.
[4] Kubba, S, (2012), Handbook of green building design and construction LEEDs, BREEAM, and GREEN GLOBES An Essential Tool for Planning, Buildings, and Managing Superior Green Construction Projects, ButterWorth Hienemann, ELSEVIER, USA, P. 302.

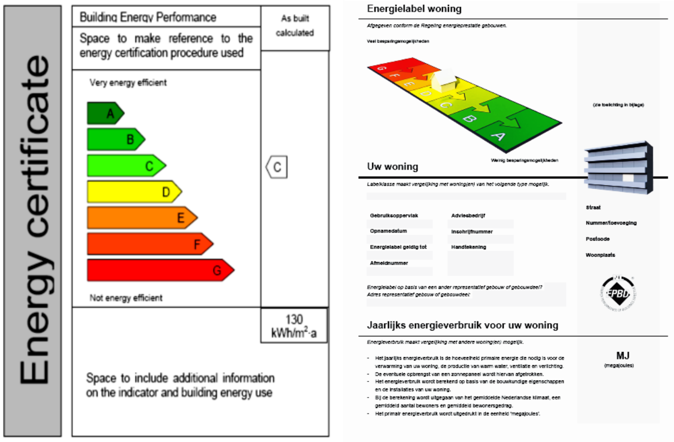

Figure 4.38 Two examples of energy certificates including numerical indicator and ranking.
Source: Khalil, E., (2013), Energy Performance Analyses in Low Carbon Buildings, Public lecture, Cairo university, Egypt.

4.6 Supply Side Management Retrofits (SSD)

To achieve a significant reduction in energy consumption apart from the standard energy-efficiency methods listed earlier in this chapter, innovative technologies should be implemented, including renewable energy.

4.6.1 Solar Photovoltaic System

A solar site survey must be done before installing any photovoltaic system; this will ensure that you actually get enough sun on your collector to make it worthwhile. Vertical façades and steeply sloped roofs tend to suffer a big loss in the ability to generate electricity in exchange for higher public visibility.

With the PV modules facing the sky (on roof), it is possible to improve the yield by installing PV modules on trackers to follow the sun from east to west during the day, and from north to south during seasonal changes[1].

<u>Case Study 17: Econcern Headquarter Köln, Germany</u>

Architect	Benthem Crouwel Architects, Aachen	
Client	HIBA Grundbesitz GmbH & Co.KG	
Founded in	2008	
Location	Germany	
Category	office complexes	
Certifications and Awards	Certified with DGNB GOLD label 01/09	
Motivation	Acquiring DGNB Label, energy neutralization.	
Green Technologies	photovoltaic installation on the roof power is fed directly into the grid	Capacity PV installation: 32 kWp[2]
	A high-quality building shell with heat insulation and triple-glazed windows[3]	
Energy Efficiency Compared to Conventional building	Primary energy: 116 kWh/m2/a **<u>70%</u>** < than conventional office buildings Heating: < 10kWh/m2/a 1L oil/ m2/a (5 times less)	

[1] Singapore Building and Construction Authority, Handbook for Solar Photovoltaic (PV) Systems,URL: www.bca.gov.sg/publications/.../handbook_for_solar_pv_systems.pdf, accessed May 28, 2013.
[2] URL: http://www.energystate.de/detail.php?lang=en&kat=project&id=152 , accessed March 22, 2013.
[3] Ibid.

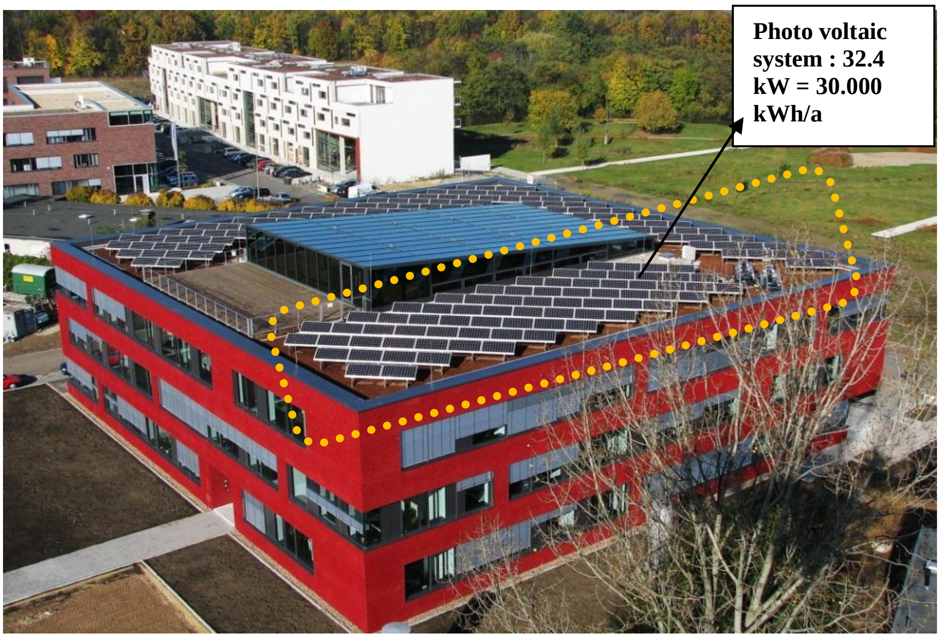

Figure 4.39 Econcern Headquarter Köln
Source: URL: http://www.benthemcrouwel.nl/portal_presentation/offices/etrium , accessed March 2, 2013.

Case Study 18: Yokohama Dia Buiiding (Yokohama-shi)

Architect	Basic design:Mitsubishi Jisho Sekkei Inc Detail design:Mitsubishi Jisho Sekkei Inc+Takenaka Corporation	 [1]
Client	Mitsubishi Logistics Corporation	
Founded in	2009	
Location	Kinkochou, Kanagawa-ku, Yokohama-shi	
Category	Complex office building	
Certifications and Awards	CASBEE S (excellent)	
Motivation	Acquiring CASBEE label, Energy generation.	
Green Technologies	Solar power system integrated with building materials[2]	
Energy Efficiency Compared to Conventional building	The generated electricity amounts to about 40,000 kWh yearly[3], which covers part of the demand in the building.	

Solar panels are installed on the west side of the building with the cell density designed at 50% to ensure the view while shielding sunrays on the west elevation. Air-conditioning loads reduction is thus achieved. Behind the panels, Fine Floors catwalks and louvers are installed to admit air and treat the exhaust air, reducing loads from air conditioning.

[1] Japan Sustainable Data Base, URL: http://www.ibec.or.jp/jsbd/AO/index.htm , accessed May 11, 2013.
[2] Ibid.
[3] Ibid..

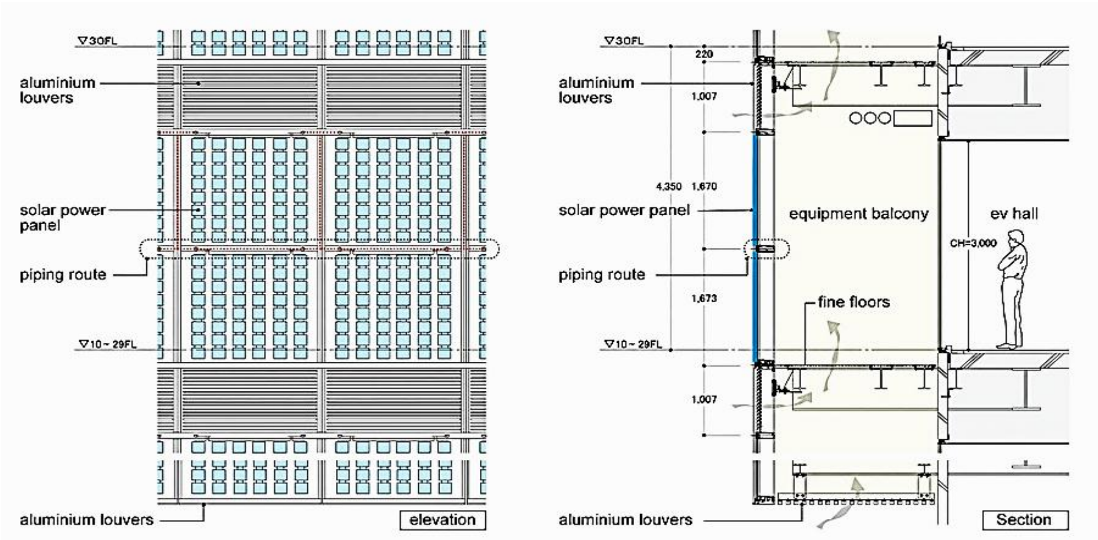

Figure 4.40 solar power panels system.
Source: Japan Sustainable Data Base, URL: http://www.ibec.or.jp/jsbd/AO/tech.htm , accessed May 11,2013.

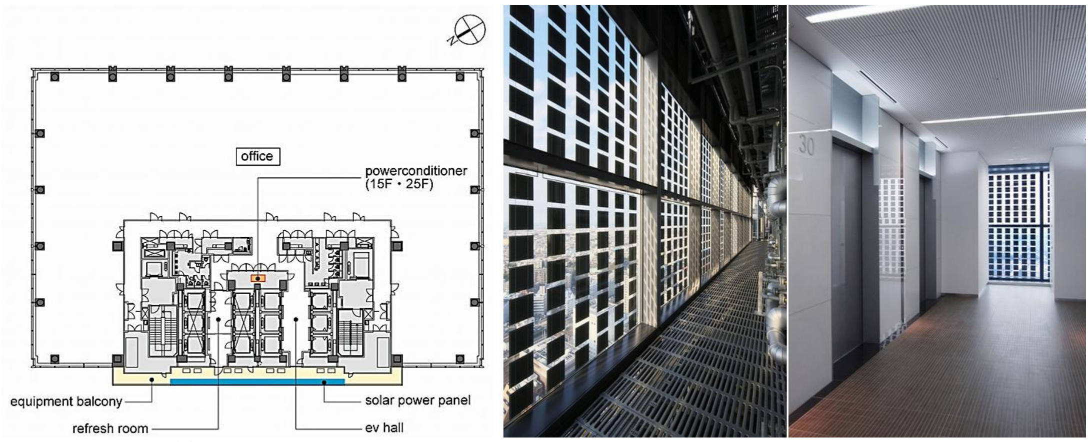

Figure 4.41 Right: Typical floor plan. Middle: Building utilities balcony. Left: EV hall in typical floor plan.
Source: Japan Sustainable Data Base, URL: http://www.ibec.or.jp/jsbd/AO/tech.htm , accessed May 11,2013.

4.6.2 Wind Power System

The amount of energy generated depends on varius factors, such as the speed and direction of the wind. Wind power is clean and reliable. But it can produce noise.

Case Study 19: San Francisco Public Utilities Commission Headquarters

Architect	KMD Architects[1]	 [2]
Client	City and County of San Francisco Public Utilities Commission	
Founded in	2012	
Location	San Francisco California, United States	
Category	Class A Office Building	
Certifications and Awards	LEED Platinum certification	
Motivation	Achieving a long-term cost savings, acquiring LEED certification	

[1] American Institute of Architects, URL: http://www.aiatopten.org/node/265 , accessed May 28, 2013.
[2] Ibid.

Green Technologies	Wind turbine tower at the north façade.	
Energy Efficiency Compared to Conventional building	Wind turbine will help to produce up to **7 %** of the building power.	

The building will produce up to 7% of its own power needs from renewable photovoltaic and wind sources; will provide $118 million in energy cost savings over 75 years; and will require 45% less energy to illuminate the interior through daylight-harvesting and advanced lighting design, compared to typical Class A office buildings[1].

The north façade was specifically shaped to respond to the prevailing winds on site to maximize the energy generation potential of the integrated wind turbines. It channels the wind through the turbines, minimizing turbulence and optimizing wind speed.

Figure 4.42 View of the Wind Tower form the side and Wind Tower with the Firefly installation
Source: American Institute of Architects, URL: http://www.aiatopten.org/node/265, accessed May 28, 2013.

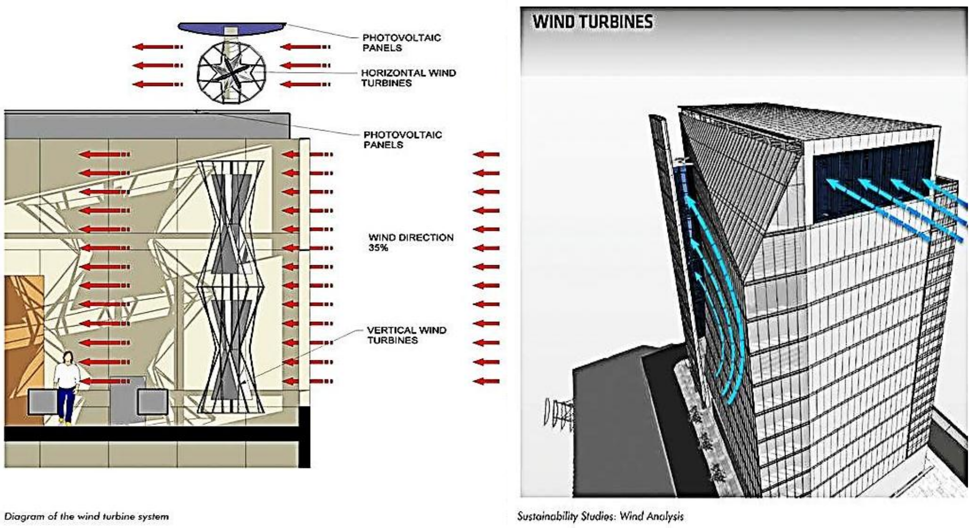

Figure 4.43 Wind turbine diagram & Wind Analysis.
Source: American Institute of Architects, URL: http://www.aiatopten.org/node/265 , accessed May 28, 2013.

[1] American Institute of Architects, URL: http://www.aiatopten.org/node/265 , accessed May 28, 2013.

4.6.3 Geothermal Power System

Geothermal energy is produced by using the heat below the earth's surface; geothermal resources have the potential to provide a tremendous amount of energy, up to 50,000 times more energy than all earth's oil and gas resources combined[1]. Geothermal energy is clean, and regional. But it has problems with accessibility, potential environmental damage (erosions, and sedimentations), and it is very expensive technology.

Case Study 20: Clock Shadow Building

Architect	Continuum Architects + Planners	 [2]
Client	Fix Development	
Founded in	2012[3]	
Location	United States	
Category	Mixed – Use	
Certifications and Awards	-	
Motivation	A vision to transform a vacant brownfield site into an environmentally sustainable building that provides a home for occupants that share a commitment to community and environmental values	
Green Technologies	27 Geothermal wells are drilled directly below the first floor system slab, and other green technologies. See (Figure 4.44)	
Energy Efficiency Compared to Conventional building	The geothermal wells allow the building to be **50 %** more efficient. (Building conserves 62% of energy from baseline one).	

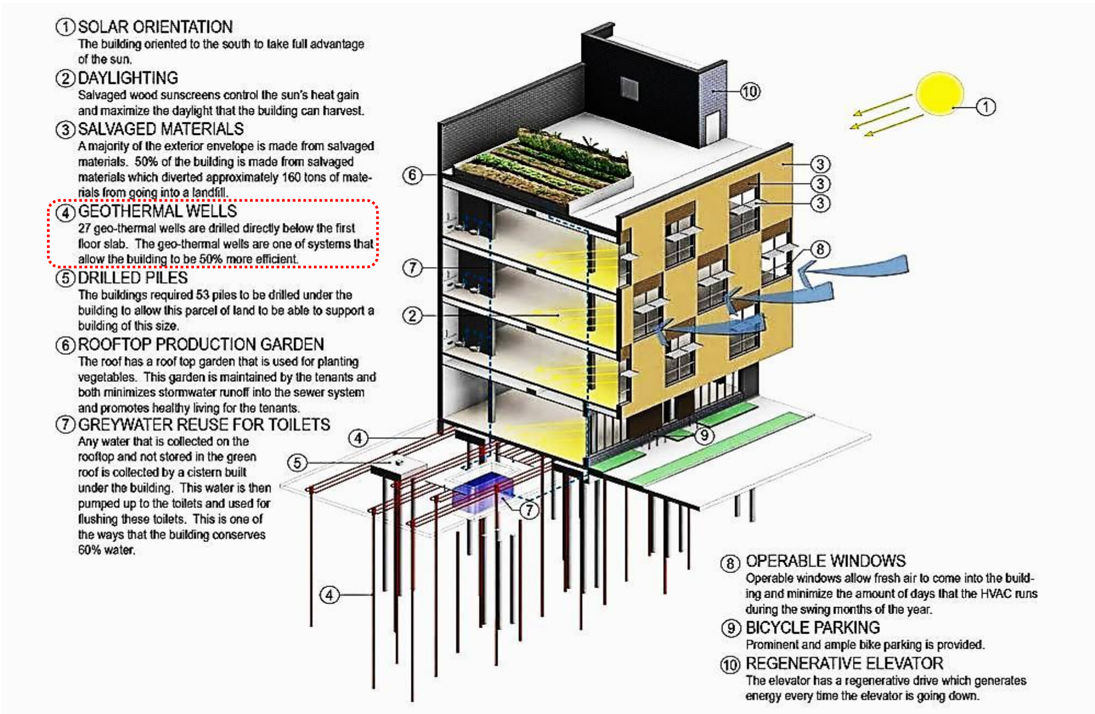

Figure 4.44 A diagram showing the technologies used in the building including the geothermal system.
Source: American Institute of Architects, URL: http://www.aiatopten.org/node/216 , accessed May 28, 2013.

[1] Attmann, O., (2010), Green Architecture Advanced Technologies and Materials, McGraw-Hill Books, United States, P. 78-79.
[2] American Institute of Architects , URL: http://www.aiatopten.org/node/216 , accessed May 28, 2013.
[3] Ibid.

4.7 Energy consumption Patterns "Human Factor"

Building owners will have no incentive to invest to save energy if all the savings accrue to tenants who are obliged to pay the bills anyway. Similarly, tenants may not wish to spend money on things that belong to, or will revert to, the owner, even if the investment would be repaid over their remaining tenancy. Thoughtful discussions can often resolve these difficulties, and lead to sensible actions with sharing of costs, risks and savings.

Practically, energy consumption in a modern office building is a very complex organizational issue involving four important elements:

- Energy management policies/regulations made by the energy management division of an organization.
- Energy management technologies installed in the office building (e.g. metering, monitoring, and automation of switch-on/off technologies).
- Types and numbers of the electric equipment and appliances in the office building (e.g. lights, computers and heaters).
- Energy users' behavior of using electric equipment and appliances in the office building[1]. (Figure 4.45).

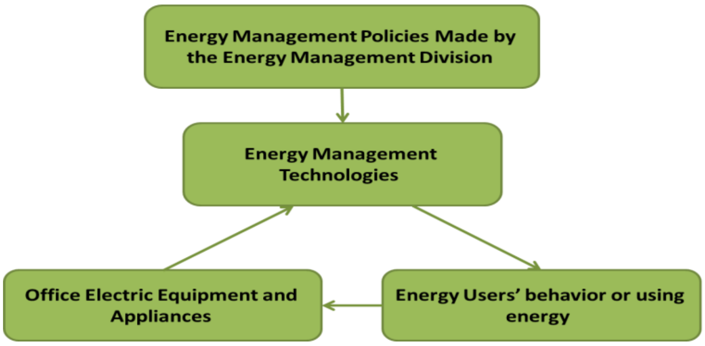

Figure 4.45 The four elements in office energy consumption
Source: T. Zhang, et al., (2011), Modelling electricity consumption in office buildings: An agent based approach. Energy and Buildings Journal, doi:10.1016/j.enbuild.2011.07.007

4.7.1 Comfort Requirements

Ensuring, or even maximizing, occupant comfort is an important goal in the operation of any office building, some of these buildings allow the individual control of room temperature that enable the occupants to create optimal comfort conditions for themselves[2], There are also a number of approaches that control the rooms automatically .

4.7.2 Promoting "green behavior" in the use of existing buildings

There is a lack of good quality studies of attempts to "green" individuals' actual behavior, despite that, there are new techniques likely to prove effective in both the home and work environment.

[1] T. Zhang, et al., (2011), Modelling electricity consumption in office buildings: An agent based approach. Energy and Buildings Journal, doi:10.1016/j.enbuild.2011.07.007
[2]Schumann, A., et al, Learning User Preferences to Maximize Occupant Comfort in Office Buildings, Cork Constraint Computation Centre, University College Cork, Ireland.

4.7.2.1 Feedback Technique

Feedback can help to increase awareness of the value and the use of resources. Within existing buildings, retrofitting feedback devices on or near machines and technology may be an effective way to connect individuals with their consumption. See (Figure 4.46).

Providing individuals with information can help to both strengthen the argument for changing their behaviors, and show how they can go about doing this. That leads to behavioral changes, and could help reduce energy consumption between 15% and 25% [1]in some cases. Information on how to use devices and appliances efficiently, together with the impact of their use, should be placed near appliances.

Figure 4.46 Example of a commercially available feedback device (Ideal for monitoring usage in the office).
Source: The Wattson, URL: http://www.diykyoto.com/uk/aboutus/wattson-xl, accessed July 13, 2013.

4.7.2.2 Social Pressure

Group or social pressure should be harnessed to help support behavioral change. In a work context this may involve the use of group goals or competitions between departments. Worker participation is important in designing interventions and policies, and representatives should be consulted about specific barriers they will encounter. See (Table 4.3).

Table 4.3 Techniques and approaches to help change the way occupants act in existing buildings.
Source: Challenger, R., Clegg, C., Davis, M., Jofeh, C., (2010), Understanding and promoting "green behaviour" in the use of existing buildings, The Arup Journal 1/2010, P 19.

Leadership	Strong, clear, and consistent leadership (business, community or political) is required to communicate the need to change and prevent "green" actions from being marginalised.
Ownership	Involve workers (or home users) in the design and implementation of new technologies or change programmes, so as to maximize acceptance.
Information	Provide occupants with procedural "how to" information, clearly explaining how to use technologies efficiently and avoid operational error.
Feedback	Provide feedback on resource use or consumption, close to consuming devices, and thus connect users to their physical usage and raise awareness of consumptive behaviours.
Competition	Use the power of social pressure between groups of employees or households, thus giving a competitive edge to changing behaviour.
Reward	Offer rewards or incentives to help incentivise individuals or groups to change their actions or usage initially and break ingrained habits.
Make it easy	Convenience is key to enticing people to change their behaviours in the first instance and to increase the likelihood of sustaining these changes over time.
Integration	Consider the problem in socio-technical terms: technology may be part of the solution, but changes to social structures (work processes or domestic patterns) may be needed to support effective usage.

[1]Vassileva, L., et al, (2013), Energy consumption feedback devices' impact evaluation on domestic energy use, Applied Energy, Volume 106, P. 314, online version via http://www.sciencedirect.com/science/article/pii/S0306261913000688, accessed July 13, 2013.

4.8 Empire State Building

Whole (deep) energy retrofit is a whole-building analysis and construction process that uses "integrative design" to achieve much larger energy savings than conventional energy retrofits. Addressing many systems at once. It is most economical and convenient to take this approach on buildings with overall poor efficiency performance. A deep energy retrofit typically results in savings of 30 percent or more, perhaps spread over several years, and may significantly improve the building value[1].

An example of a deep commercial retrofit is the Empire State Building. Working with diverse stakeholders including the Rocky Mountain Institute and Johnson Controls, the owner has nearly completed a major retrofit expected to save 38 percent of the building's energy consumption with a ***three-year simple payback*** on the energy-saving investments[2]. See (Table 4.4).

Table 4.4 Empire State Building Review
Source: The Researcher

Architect	William F. Lamb (architectural firm Shreve, Lamb and Harmon)	 [3]
Client/ Owner	Anthony Malkin/ Empire State Building Company	
Founded in	1931[4]	
Location	Midtown Manhattan, New York City	
Category	Commercial office building "102-story skyscraper"	
Certifications and Awards	Gold LEED-EBOM (2011)[5]	
Total Floor Area	257,211 m^2	
Motivation	Reducing carbon foot print, energy efficiency, energy use reduction, achieving LEED certification. Prove or disprove the economic viability of whole-building energy efficiency retrofits. Create a replicable model for whole-building retrofits.	
Retrofitting Date	2009	
Retrofitting companies	Energy Service company ESCo, and Johnson Controls[6].	
Retrofitting Type	Whole building retrofits (Deep)	
Budget	$550 Million for the entire remodel, $106 million for energy related projects.	
Sustainability Consultant	Jones Lang Lasalle	
Exploratory study duration	1 year	

[1] Fuerst, F., McAllister, P., (2009), New Evidence on the Green Building Rent and Price Premium, Paper presented at the Annual Meeting of the American Real Estate Society, Monterey, CA.
[2] Smith, K., Bell, M., (2011), Going Deeper: A New Approach for Encouraging Retrofits Report, Institute for Building Efficiency, Johnson Controls, Rocky Mountain Institute (RMI), Washington DC. Online report URL: http://www.institutebe.com/InstituteBE/media/Library/Resources/Existing%20Building%20Retrofits/Issue_Brief_DEEP_Programs_for_Retrofits.pdf , accessed March 22, 2013.
[3] URL: http://en.wikipedia.org/wiki/File:Empire_State_Building_from_the_Top_of_the_Rock.jpg , accessed March 28, 2013.
[4] URL: http://en.wikipedia.org/wiki/Empire_State_Building , accessed March 28, 2013.
[5] Ibid.
[6] Yudelson, J. (2010), Greening existing buildings, McGraw-Hill books, USA, P. 11-12.

Goals	- Develop a replicable model for retrofitting buildings in a cost-effective way - Develop practices to lower energy consumption costs by as much as 20 percent - Increase overall environmental benefits of building retrofit through an integrated sustainability approach to maximize opportunities and market advantage - Encourage the team to be objective and creative in its approach - Develop a model that is marketable to existing and prospective tenants - Coordinate with the ongoing capital projects within the building - Develop a financial structure that is efficient and achievable[1]
Energy Efficiency Compared to Conventional building	38%, And save (a minimum of) 105,000 metric tons of CO2 over the next 15 years.
Annual energy cost savings	$4.4 Million[2], Investment 20 Million $[3].

4.8.1 Project Development Process

A collaborative team was formed to develop the optimal retrofit solution through an iterative process that involved experience, energy and financial modeling, ratings, metrics. The project development process included the Clinton Climate Initiative (CCI), Johnson Controls Inc. (JCI), Jones Lang LaSalle (JLL), Rocky Mountain Institute (RMI), the Empire State Building operations (ESB)[4] and many other contributors. (Figure 4.47) shows the project development process on the retrofit time line.

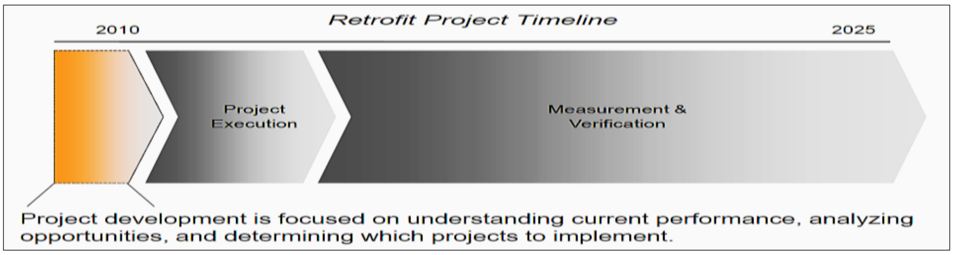

Figure 4.47 Retrofit Project Timeline
Source: Campbell, L., et al, Empire State Building Case Study Cost-Effective Greenhouse Gas Reductions via Whole-Building Retrofits: Process, Outcomes, and What is Needed Next, Online via: URL: http://www.esbnyc.com/documents/sustainability/ESBOverviewDeck.pdf , accessed June 8, 2013.

Audits, workshops, presentations, analyses, reports are implemented to determine the optimal package of retrofit projects involved identifying opportunities, modeling individual measures, and modeling packages of measures. 8 measures will be implemented.

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[1] Johnson Controls, URL: http://www.johnsoncontrols.com/content/us/en/products/building_efficiency/esb.html, accessed June 9, 2013.
[2] Harrington, E., and Carmichael, C., (2009), Project Case Study: Empire State Building, Rocky Mountain Institute Report, Via URL: http://www.rmi.org/Content/Files/ESBCaseStudy.pdf, accessed June 9, 2013.
[3] Ibid, P. 11-12.
[4] Campbell, L., et al, Empire State Building Case Study Cost-Effective Greenhouse Gas Reductions via Whole-Building Retrofits: Process, Outcomes, and What is Needed Next, Online via: URL: http://www.esbnyc.com/documents/sustainability/ESBOverviewDeck.pdf , accessed June 8, 2013.

Figure 4.48 Team Organization Chart.
Source: Campbell, L., et al, Empire State Building Case Study Cost-Effective Greenhouse Gas Reductions via Whole-Building Retrofits: Process, Outcomes, and What is Needed Next, Online via: URL: http://www.esbnyc.com/documents/sustainability/ESBOverviewDeck.pdf , accessed June 8, 2013.

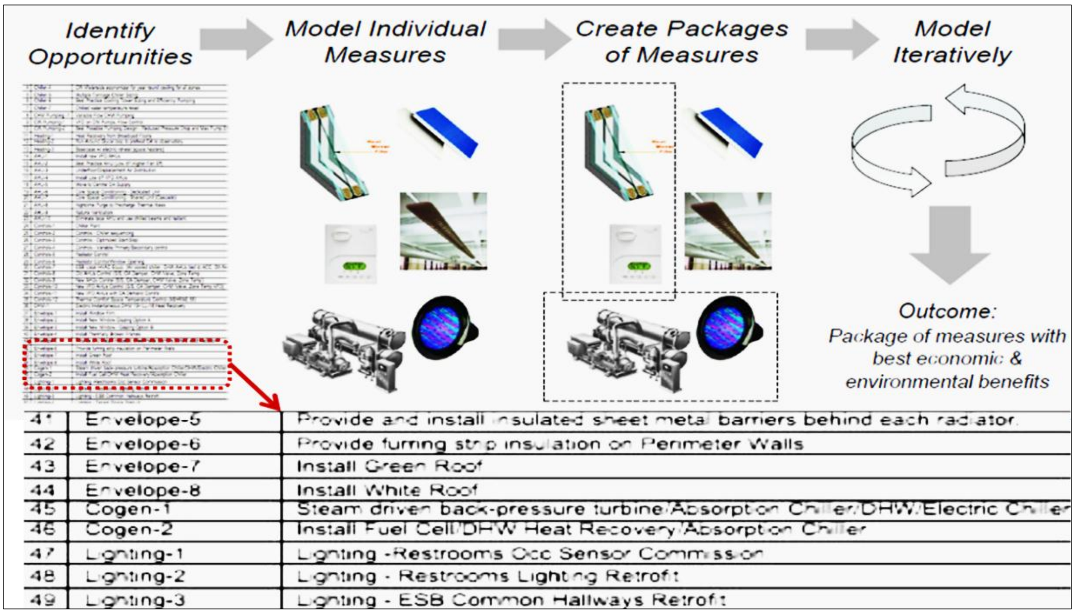

Figure 4.49 Reaching the Best Economic and Environmental package Process.
Source: Campbell, L., et al, Empire State Building Case Study Cost-Effective Greenhouse Gas Reductions via Whole-Building Retrofits: Process, Outcomes, and What is Needed Next, Online via: URL: http://www.esbnyc.com/documents/sustainability/ESBOverviewDeck.pdf , accessed June 8, 2013.

4.8.2 Implementation Process

Three different stakeholders will implement the *8 savings measures* (Building Windows, tenent energy management, air handling yunits, demande control ventilation, daylighting, lighting and plugs, direct digital controls DDC, chiller plant retrofit, and radiative barriers) over a 5-year period using various implementation mechanisms. (60+ energy efficiency ideas narrowed to 8).

Energy and CO_2 savings in the optimal package result from 8 key projects are shown in (Figure 4.50).

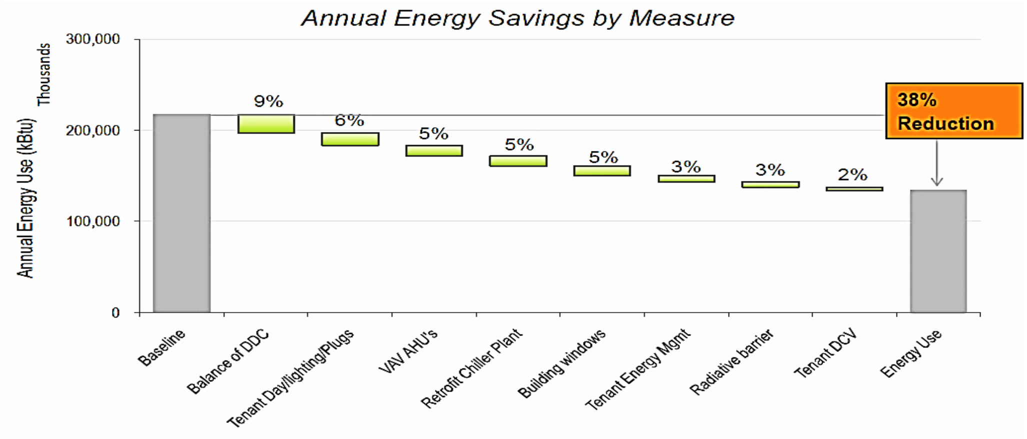

Figure 4.50 Energy and CO_2 savings in the optimal package result from 8 key project Packages.
Source: Campbell, L., et al, Empire State Building Case Study Cost-Effective Greenhouse Gas Reductions via Whole-Building Retrofits: Process, Outcomes, and What is Needed Next, Online via: URL: http://www.esbnyc.com/documents/sustainability/ESBOverviewDeck.pdf , accessed June 8, 2013.

4.8.3 Heating and Control Demand Reduction

4.8.3.1 Windows Retrofits (Fenestration)

Remanufacture (on site) existing insulated glass units (IGU) within the Empire State Building approximately 6,500 double-hung windows to include suspended coated film and gas fill. This more than triples the insulating value of each window. The total capital cost for this measure was $4.5 million and the annual energy savings is projected to be $410,000[1].

Figure 4.51 Left: New windows installed in the Empire State building.Right: The temporary window refurbishing production line at Empire State Building
Source: Harrington, E., and Carmichael, C., (2009), Project Case Study: Empire State Building, Rocky Mountain Institute Report, Via URL: http://www.rmi.org/Content/Files/ESBCaseStudy.pdf, accessed June 9, 2013.

Benefits of the New Windows System
Increased occupant comfort through warmer winter and cooler-summer glass surfaces
Blocked winter heat loss three times better than the existing windows
Greatly reduced heating and cooling HVAC loads
99+percent ultraviolet blockage to protect both furnishing and occupants
Directional “tuning” to enhance north window day lighting and south-elevation solar heat rejection
Freedom from glass-surface condensation due to super insulation.

[1] Harrington, E., and Carmichael, C., (2009), Project Case Study: Empire State Building, Rocky Mountain Institute Report, Via URL: http://www.rmi.org/Content/Files/ESBCaseStudy.pdf, accessed June 9, 2013.

4.8.3.2 Building Fabric Insulation (Opaque Envelope)

Install more than six-thousand insulated reflective barriers[1] behind radiator units located on the perimeter of the building, to direct more heat into the building rather than losing it through the wall to the outside. Radiators will also be cleaned and thermostats will be repositioned to the front side of the radiator for easier control. The total capital cost for this measure was $2.7 million and the annual energy savings is projected to be $190,000.

Benefits of the Radiative Barrier	
* Reduced heating costs	* Increased occupant comfort

Figure 4.52 Radiative barrier installed in the Empire State building.
Source: Campbell, L., et al, Empire State Building Case Study Cost-Effective Greenhouse Gas Reductions via Whole-Building Retrofits: Process, Outcomes, and What is Needed Next, Online via: URL: http://www.esbnyc.com/documents/sustainability/ESBOverviewDeck.pdf , accessed June 8, 2013.

4.8.4 Energy Efficient Equipment and Low Energy Technologies

4.8.4.1 Lighting Upgrade

This measure involves reducing lighting power density in tenant spaces, installing dimmable ballasts and photo sensors for perimeter spaces, and providing occupants with a plug load occupancy sensor for their personal workstation. This will be implemented within the green pre-built spaces and will appear as recommendations within the tenant design guidelines. The total capital cost for this measure was $24.5 million and the annual energy savings is projected to be $941,000[2].

Benefits of the Lighting upgrade
Lower cooling demand due to less heat from electric lights and equipment
Improved visual quality

4.8.4.2 Energy Efficient Equipment and Appliances

To meet the reduced loads of the new spaces, heating and cooling systems were upgraded with the most efficient systems available.

[1] Radiant barriers or reflective barriers inhibit heat transfer by thermal radiation. URL: http://en.wikipedia.org/wiki/Radiant_barrier, accessed June 9, 2013.
[2] Harrington, E., and Carmichael, C., (2009), Project Case Study: Empire State Building, Rocky Mountain Institute Report, Via URL: http://www.rmi.org/Content/Files/ESBCaseStudy.pdf, accessed June 9, 2013.

4.8.4.2.1 Chiller Retrofit

The team reused the shells of the existing industrial electric chillers and replaced the tubes, valves and motors with high efficiency equipment. The chiller plant retrofit project includes the retrofit of four industrial electric chillers in addition to upgrades to controls, variable speed drives, and primary loop bypasses. The total capital cost for this measure was $5.1 million and the annual energy savings is projected to be $675,000[1].

4.8.4.2.2 VAV (Variable Air Volume) Air Handling Units

When tenant turnover occurs, existing constant volume units will be replaced with variable air volume units using a new air handling layout (two floor-mounted units per floor instead of four ceiling-hung units). VAV air handlers are more intelligent than constant volume units providing greater control. The total capital cost for this measure was $47.2 million and the annual energy savings is projected to be $702,000[2].

Benefits of Air Handling Units Retrofits
Greater occupant comfort and control Improved visual quality
Lower utility bills
Reduced electricity demand

4.8.4.2.3 Control Upgrade (Monitoring Energy Systems)

a) *Tenant Energy Management, Monitoring, and Sub metering:*
Provide tenants with access to online energy and benchmarking information as well as sustainability tips and updates. Tenants will have access to a digital dashboard showing energy use in real time and comparing it to past use and other tenants. The total capital cost for this measure was $365,000 and the annual energy savings is projected to be $396,000[3].

Benefits Included
Live energy use feedback
Comparison charts can encourage reduction of energy use

b) *Demand Control Ventilation:*
Measuring CO2 concentrations inside the building will determine appropriate levels of outside air to be brought to the building. This will improve air quality while also reducing energy use (by not conditioning unnecessary amounts of outside air). Capital costs for this measure was included in the cost for the direct digital controls and the annual energy savings is projected to be $117,000.

Benefits of Demand Control Ventilation Retrofit	
Reduced cooling and heating demand	
Monitoring of indoor air quality	
Increased occupant comfort	Reduced energy bills

[1]Ibid.
[2] Ibid.
[3] Ibid.

c) <u>Direct Digital Controls (DDC):</u>

Involves upgrading the existing, piecemeal and primarily pneumatic control systems at the Empire State Building to comprehensive, consistent digital controls. The total capital cost for this measure was $7.6 million and the annual energy savings is projected to be $741,000. This measure involves control upgrades for the following building systems (Refrigeration Plant Building Management System- Condenser Water System Upgrades- Chiller Water Air Handling- DX Air Handling Units- Exhaust Fans- Stand Alone Chiller Monitoring- Misc. Room Temperature Sensors- Electrical Service Monitoring)[1].

Benefits of DDC Upgrade	
Providing greater flexibility	Lower utility bills
More intelligence built into the systems	
Increased occupant comfort and control	

4.8.5 8 Key Projects Capital Costs and Payback Period

Table 4.5 The 8 key Projects capital cost and payback period.
Source: Harrington, E., and Carmichael, C., (2009), Project Case Study: Empire State Building, Rocky Mountain Institute Report, Via URL: http://www.rmi.org/Content/Files/ESBCaseStudy.pdf, accessed June 9, 2013.

Key Projects	Capital cost	Annual energy savings	Payback period (years)
Windows retrofits	$4.5 Million	$410.000	10
Radiative barrier	$2.7 Million	$190.000	14
Tenant day lighting plugs	$24.5 Million	$941.000	25
Chiller retrofit	$5.1 Million	$675.000	7
VAV air handling units	$47.2 Million	$702.000	60
Tenant energy management	$365000	$396.000	9 Months
Tenant DCV	$ (Included in DDC)	$117.000	-
Direct digital control DDC	$7.6 Million	$741.000	10

4.8.6 Energy Consumption Patterns (Human Factor)

- The human factor appears in the main motivation behind greening the Empire State building; that was the desire to prove or disprove the cost effectiveness of energy efficient retrofits, and reduce greenhouse gas emissions, based on the owner's awareness.
- The design documentation phase was centered on a final report assessing the tenant energy usage.
- The tenant energy management program had 4 basic components:
  1- Establish electric sub-metering for each tenant so that energy used by tenant can be displayed and compared to industry norms via a dashboard linked to the building web page.
  2- Identify key building personnel to be the face of the program, suggest each tenant designate a point of contact, and provide training to the contact so that they understand the basics.
  3- Provide education through online training, and seasonally specific recommendations and best practices for tenants to reduce their carbon foot print.

[1] Ibid.

- Numeric data was translated into visual data (i.e. charts and graphs), so that managers could spot trends and act on them.
- Tenant participation to drive energy savings:
    a. Aggressive guidelines and incentives for tenants to achieve energy savings of about 6 percent[1].
    b. The pre-built design[2] that has been created using e-Quest program, would help the team establish design principles for all the tenant spaces.
    c. Tenants could review the pre-built spaces model.
    d. The sub-metering program of all tenant spaces will inform tenants of their energy use; thus it will drive tenants to focus on energy efficiency, calculate their carbon foot print, and follow the building guidelines on recommended strategies such as day lighting.
    e. Tenant incentive programs were implemented such as *"Feebate"* plan where tenants that missed sustainability targets would pay fees that might be redistributed to those that exceeded sustainability targets.

4.9 Conclusion

- The incremental cost of retrofitting older building or existing building to achieve improved energy performance is more expensive than the incremental cost of achieving the same performance in a new building
- Most utility programs today support single energy savings measures. These projects are simple to implement and evaluate results, but they do not take a whole-building perspective and so leave a major portion of the efficiency opportunity untouched. For example, a building owner may get a utility incentive by upgrading a packaged air conditioner to a more efficient model, but miss the opportunity to eliminate the unit by upgrading windows, increasing insulation, and reducing lighting and plug loads. Many utility programs would incentivize the air conditioner only.
- The Empire State Building's approach is far from mainstream, and rebates and incentive programs do not generally support the installation of a suite of technologies.
- Deep retrofits require an integrated design approach, and team work.
- Green behavior and collaboration of building tenants have a great effect on green retrofits in existing buildings.
- Choosing the suitable strategy depends upon many factors to avoid the risks:

- What does the owner want to achieve
- Budget and time scale requirements
- Occupancy of the building during refurbishment or greening

- There is infinite number of green strategies and technologies that can be applied on existing buildings (office), but not all of them can be applied in Egypt according to some considerations that will be discussed in the next chapter.

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[1]Baczko, K., et al, A landmark sustainability program for the Empire State building A model for optimizing energy efficiency, sustainable practices, operating expenses and long term value in existing buildings, Online via URL: http://www.institutebe.com/InstituteBE/media/Library/Resources/Existing%20Building%20Retrofits/ESB-White-Paper.pdf, accessed August 23, 2013.

[2] *Pre-built spaces between 53rd and 75th floors, features Energy Star-rated appliances, tenant-controlled HVAC systems, recycled-content and reclaimed interior finishes, natural daylighting, and submetered electricity*. DEL PERCIO, S., (2011), Empire State Building to Lease Full Floor of LEED-Eligible Pre-Built Offices, Greenbuildingsnyc- commercial property leasing and sales, Manhattan. Online viaURL: http://www.greenbuildingsnyc.com/2011/10/19/empire-state-building-to-lease-full-floor-of-leed-eligible-pre-built-offices/ , accessed August 28, 2013.

5 Introduction

In this chapter, a survey for assessing green strategies and technologies to be applied in Egypt has been carried out via (www.esurveycreator.com); this survey came out with some points to be taken into consideration when applying a certain strategy in Egypt.

5.1 Objectives of the Practical Part

Based on the survey, the following objectives could be achieved:

1. Recognize the factors that affect the implementation of each green strategy or technology in Egypt
2. Assessing each strategy, and its opportunities to be implemented in Egypt
3. Defining the barriers of greening existing office buildings in Egypt

5.2 Methodology of the Practical Part

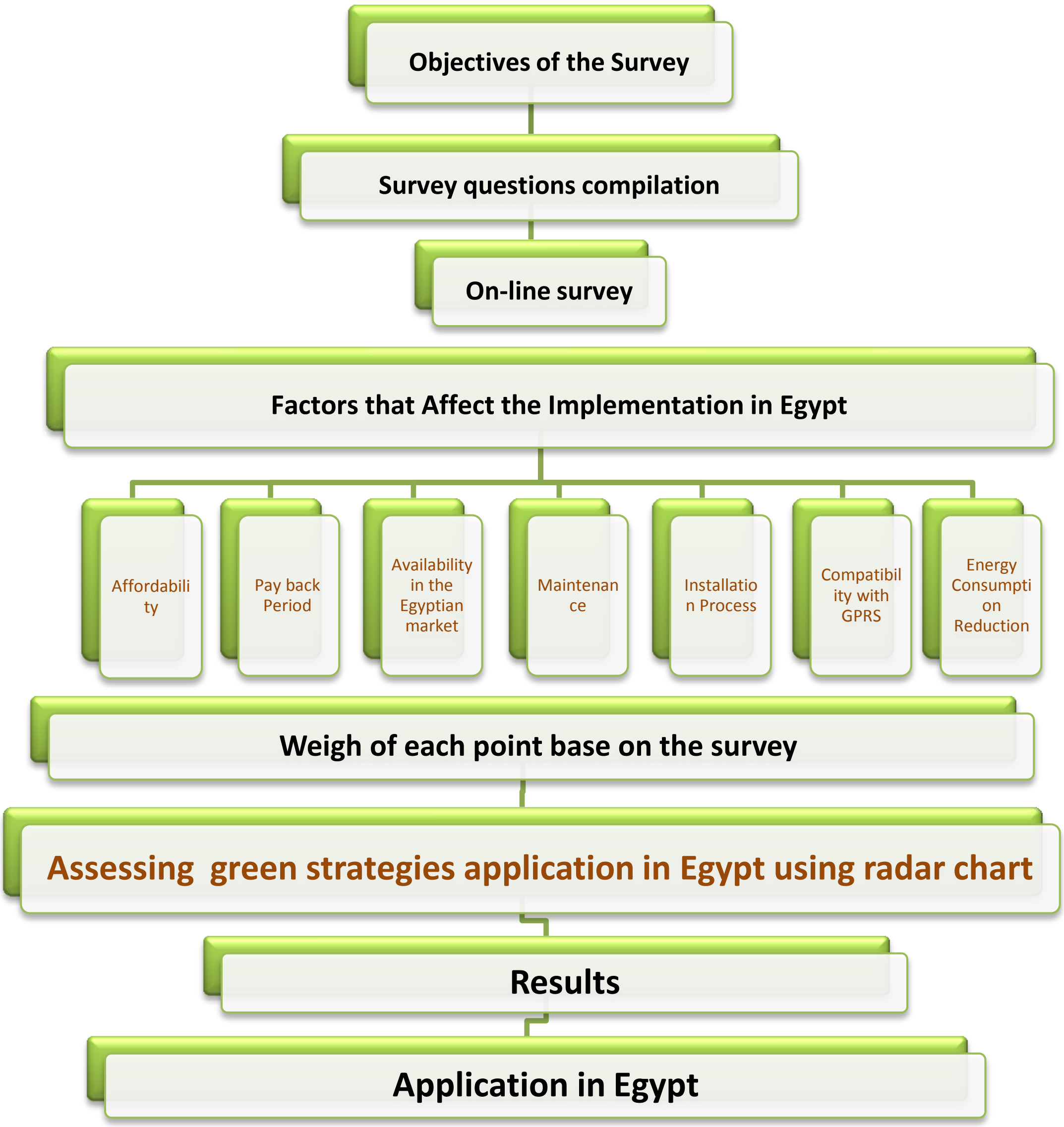


Figure 5.1 Methodology of the practical part
Source: The Researcher

5.3 On-line Survey

The survey conjoined a set of questions trying to find out what are the most important factors affecting the application of a certain strategy in Egypt.

5.4 Questions Deriving

The questions, mainly the set of questions that focus on the factors that affect the application in Egypt were derived from the previous chapters; in chapter 3, the main barriers to greening the existing buildings are higher cost and long payback period, other factors like energy use reduction and maintenance are derived from different green rating systems (i.e.LEED and GPRS).

5.5 Survey Directing

The survey is directed to architects, architectural companies and offices, engineers, green consultants and academic professors.

5.6 Survey Results[1]

Participants of this survey reached ***74 participants*** *(73.33% females and 26.67% males)*, more than *79% architects*, *2.47 % environmental engineers*, and other occupations like *Urban & Landscape Designers with 8.64%*, *civil engineer*, *assistant professors*, *teaching assistants from different universities*, *LEED Projects Coordinator*, *researcher in the field of sustainable architecture and urbanism*, *site engineers*. See (Figure 5.2).

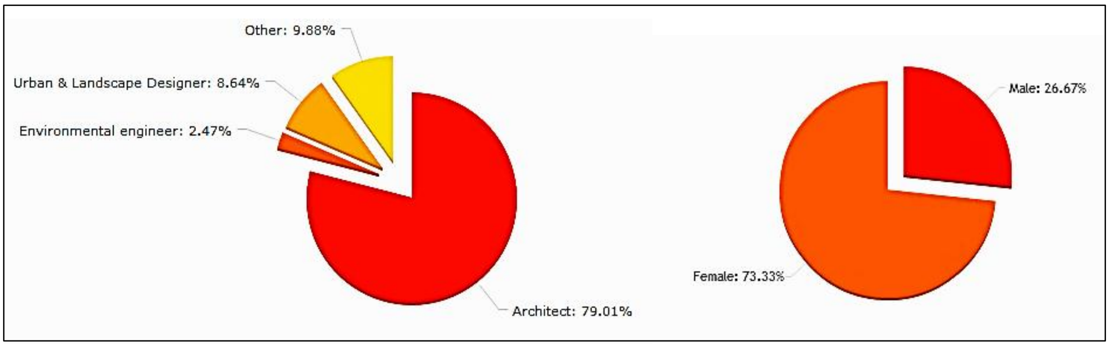


Figure 5.2 Disciplines of the survey participants.
Source: Online survey.

(Figure 5.3) shows the participants' place of work (Engineering office, either a small or major company in Egypt, other included Cairo university, Private Egyptian universities i.e. GUC and BUE, academies, research center, engineering office abroad, Contracting company in UAE, Major consultant Office in Egypt), freelancers, and their experience in the architectural field.

[1] Complete Survey , appendix A.

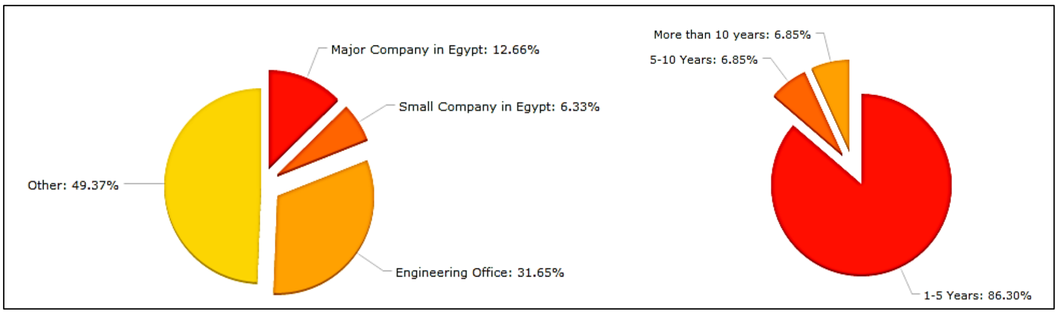


Figure 5.3 Left: participants' work organizations. Right: Participants' experience in the architecture field
Source: Online survey.

The majority of their work organizations don't work with green strategies or technologies, but the organizations that work with green technologies, mainly using Energy Efficient Equipment and Low Energy Technologies. (Figure 5.4) and (Figure 5.5).

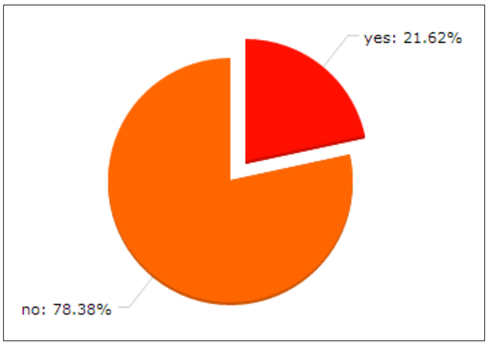


Figure 5.4 Piechart shows the answer to the question if their company/office works with green technologies or strategies.
Source: Online survey.

Other included:
- Not applying green technologies
- paper recycling , reducing energy consumption , natural lighting for toilets , corridors & studios
- greening public areas and sustainable food production
- building material by compressed earth blocks
- teaching all these strategies, but not actually applying them
- Applying natural ventilation

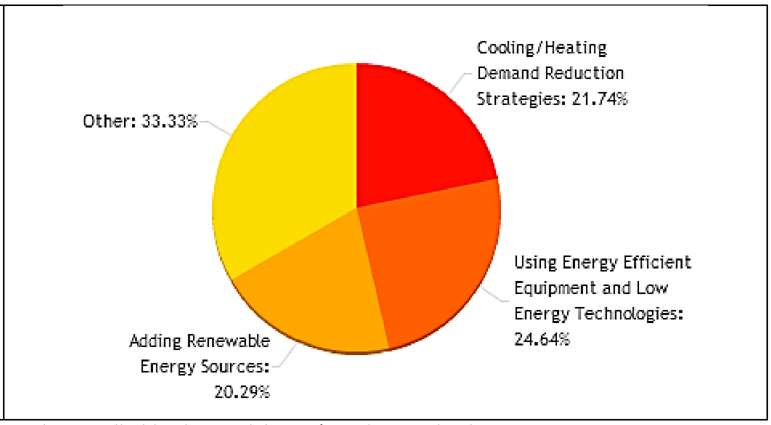


Figure 5.5 Green strategies used or applied in the participants' work organizations.
Source: Online survey.

Participants were asked about their motivation (Incentive) when applying a green strategy to an existing building; (Figure 5.6) shows the possible answers. It is worth mentioning that prototyping is one of the motivations in the greening of the Empire State Building as mentioned in the previous chapter.

Other included:
- prototyping (creating a prototype that could be used for educational purposes ,or encourage other clients support green concepts through real numbers & applications)
- decrease pollution and be economical
- save the earth, lessening the harmful effect on the environment
- zero building
- satisfaction of users , saving environment
- improving quality of life

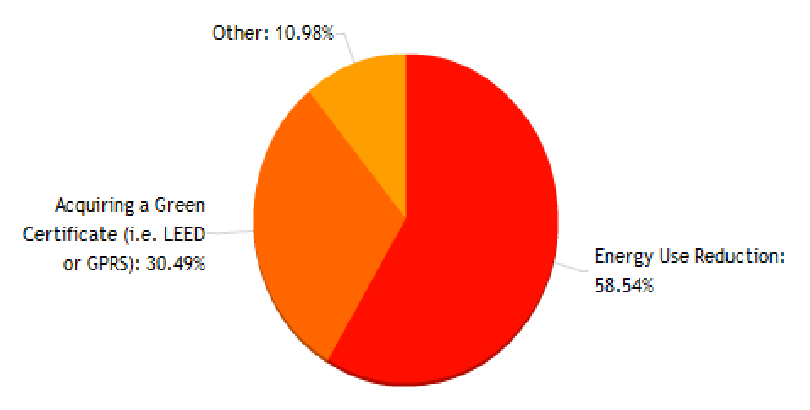


Figure 5.6 Motivation behind applying green strategies on existing buildings.
Source: Online survey.

(Figure 5.7) shows the most significant factors taken into considerations when applying a green strategy to an existing building in Egypt, the options were (Affordability, Payback Period, Availability in the Egyptian market, Maintenance, Installation process, Energy use reduction, Compatibility with GPRS, all of them).

Other included:
- interaction with the sociophysiology issue

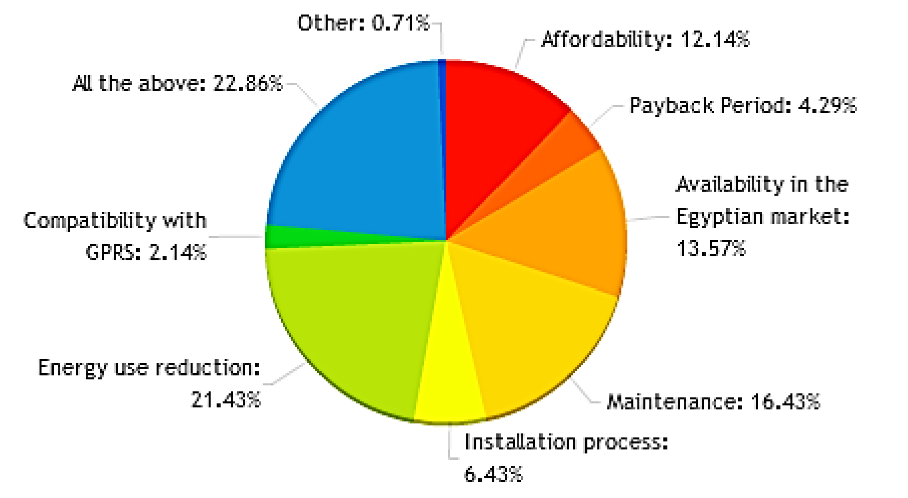


Figure 5.7 the most significant factors affecting applying a green strategy to an existing building in Egypt.
Source: Online survey.

Participants were asked to arrange the previous mentioned factors according to their importance if the strategy to be applied in Egypt, the answers were in the form of a matrix as shown in (Figure 5.8); energy use reduction was the most significant factor to be taken into consideration when applying a green strategy.

Number of participants: 70

	1 (1)		2 (2)		3 (3)		4 (4)		5 (5)		6 (6)		7 (7)		Ø	G
	Σ	%	Σ	%	Σ	%	Σ	%	Σ	%	Σ	%	Σ	%		
Affordability	21x	30.00	19x	27.14	6x	8.57	8x	11.43	7x	10.00	4x	5.71	5x	7.14	2.90	70%
Payback Period	7x	10.14	10x	14.49	6x	8.70	10x	14.49	11x	15.94	15x	21.74	10x	14.49	4.35	63%
Availability in the Egyptian market	22x	31.43	19x	27.14	9x	12.86	4x	5.71	7x	10.00	7x	10.00	2x	2.86	2.77	70%
Maintenance	15x	21.74	15x	21.74	8x	11.59	8x	11.59	11x	15.94	10x	14.49	2x	2.90	3.33	73%
Installation process	8x	11.59	10x	14.49	12x	17.39	14x	20.29	9x	13.04	10x	14.49	6x	8.70	3.87	68%
Energy use reduction	31x	44.29	9x	12.86	16x	22.86	5x	7.14	3x	4.29	3x	4.29	3x	4.29	2.44	83%
Compatibility with GPRS	5x	7.14	9x	12.86	6x	8.57	7x	10.00	9x	12.86	11x	15.71	23x	32.86	4.87	52%

Ø = Respective average per line in points
G = Respective weighing of the importance of each line in % (0% unimportant / 100% very important)

Figure 5.8 Matrix shows the level of importance of each factor when applying a green strategy to an existing building in Egypt, (The final percent G is calculated automatically in the survey results).
Source: Online survey.

Payback period, it makes you abandon the project if its range 5-10 years, as the participants answered. See (Figure 5.9). It is worth mentioning that a previous study performed by Turner Constructions (2012) mentioned in chapter 3, concludes that 80% of executives would accept a payback of 5 - 9 years.

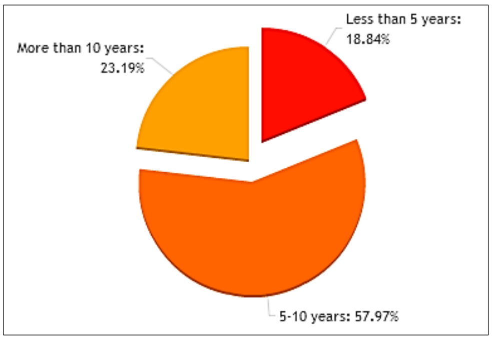


Figure 5.9 Payback period that leeds to abondening the project.
Source: Online survey.

When asked about the GPRS (Green Pyramid Rating System), the compatibility of a green strategy with it encourages the applicant to use the strategy takes approximately 64% as shown in (Figure 5.10).

Other included:
- ***Compatibility with LEED***
- Don't know.

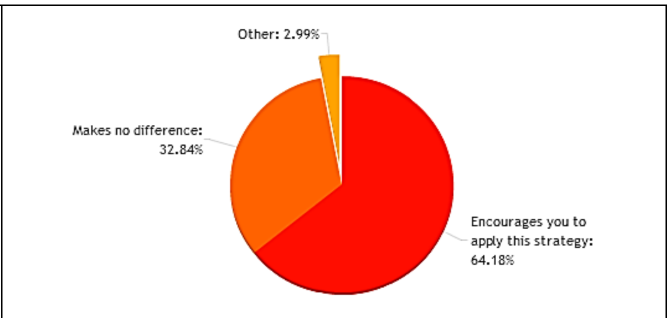


Figure 5.10 Compatibility with GPRS.
Source: Online survey.

When asked about recommending a major renovation or applying more than 2 strategies the answer was yes with approximately 67%.

Other included:

- scale of the project
- the cost and how my client is willing to give, also the availability and validity to apply these strategies on the buildings
- the type of the project and the budget of the client
- time schedule
- according to the site demands
- depends on the client

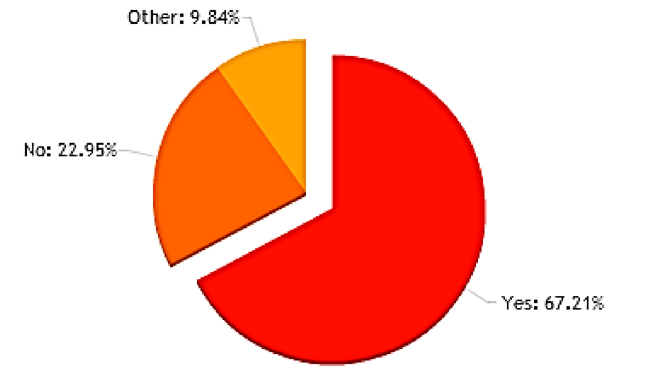


Figure 5.11 Recommending a major renovation for projects.
Source: Online survey.

5.7 The Methodology of the Assessment Method

The following part is to discuss how to fill in the table of assessment to get the final radar chart of application in Egypt.

5.7.1 Affordability:

This point depends on the owner's financial state and either he is willing to pay for this strategy or not. But there are some technologies that have low affordability (i.e. solar photovoltaic cells). This point is filled by the architect after consulting the owner.

5.7.2 Payback Period:

Is the length of time required to recover the cost of an investment, The payback period of a given investment or project is an important determinant of whether to undertake the position or project, as longer payback periods are typically not desirable for investment positions. To calculate a more exact payback period:

Payback Period (years) = Amount to be initially invested / Estimated Annual Net Cash Inflow

Low: less than 5 years
Medium: 5-10 years
High: More than 10 years.

5.7.3 Availability:

This point estimates either the technology is available in the Egyptian market or not through the number of companies offering this technology. But the availability doesn't take into consideration if this strategy is local /regional or imported. One of the targets of this survey is for the importing companies to guide them either the strategy is applicable in Egypt or not, thus helps marketing it.

5.7.4 Maintenance:

This point judges either the technology needs high maintenance or not.

5.7.5 Installation Process:

This point judges the difficulty of the installation process of the new applied technology, (i.e. LED lamps can be replaced on spot without the need to replace the fixtures of the lighting systems).

5.7.6 Energy use Reduction:

The more the strategy reduces in energy the higher rate it takes and compared to the (Model) of all the retrofitted office buildings - The Empire State Building – it achieved a whole building reduction in energy of 38% ; the following table expresses the rate to be taken.

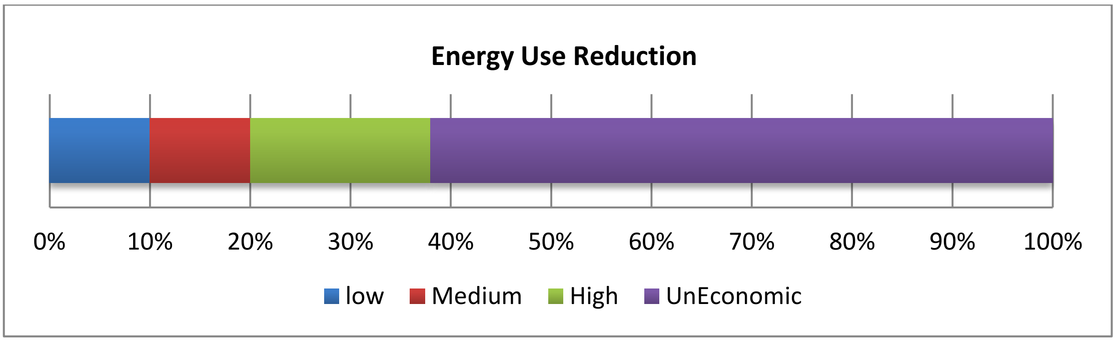


Figure 5.12 Energy use reduction guide.
Source: The researcher.

5.7.7 Compatibility with GPRS:

This point judges the compatibility of the applied technology with the GPRS, the more point it gains the more it could be applied in Egypt according to the Egyptian rating system.

5.8 Assessing Green Strategies and Technologies to be Applied in Egypt

From the survey results we can determine the order or the importance of each factor affecting the implementation of a green strategy in Egypt. (Figures 5.7 and 5.8) give the same result that is summarized in (Figure 5.13).

Each factor is represented in the radar chart (Figure 5.14), takes its value according to the (Table 5.2) - (High, Medium, Low), represented in constant value and its multiples (i.e. 5-10-15), and then according to the weight of each point (determined from the on-line survey), the final result appears in the shaded area of the chart, the more the shaded area (strength of points) the more this strategy is applicable in Egypt.

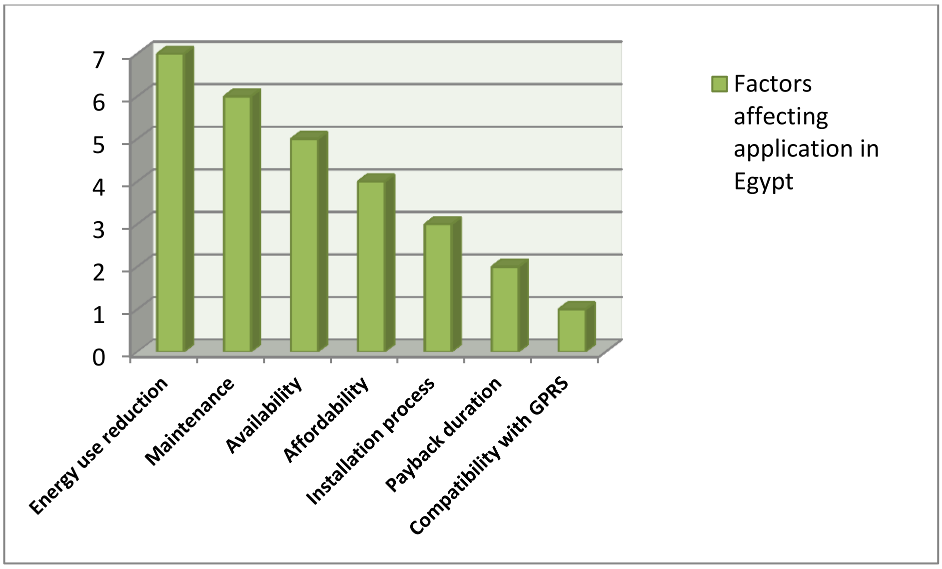


Figure 5.13 order according to the importace of each factor Energy use reduction is the most important factor.
Source: The Researcher

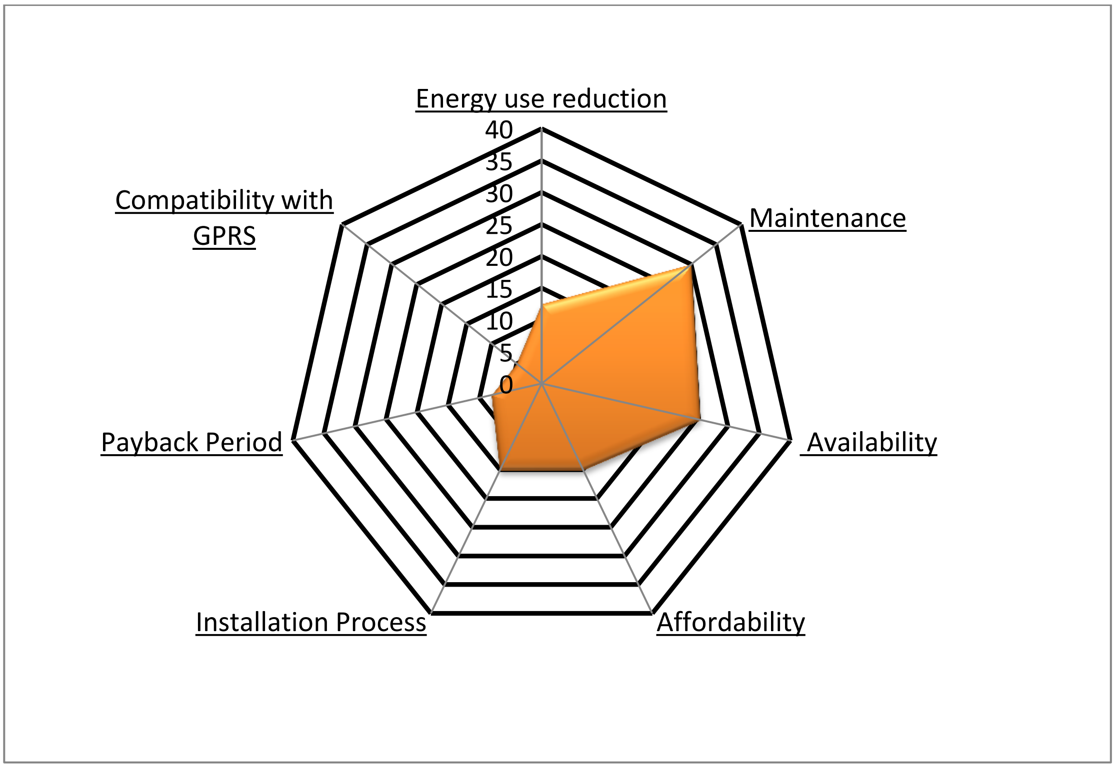
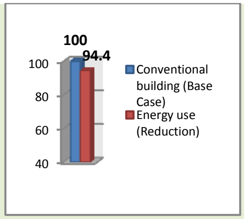
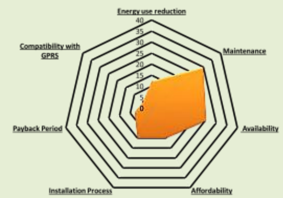
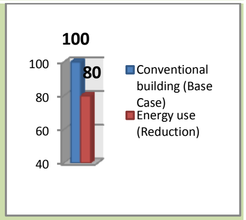
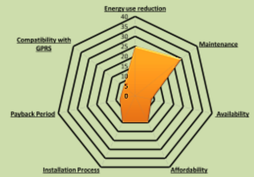
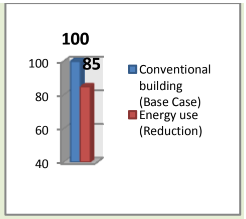
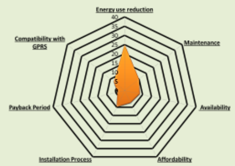
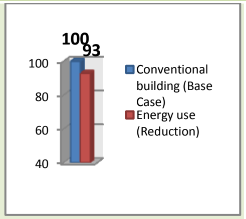
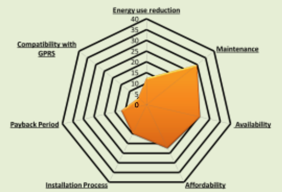
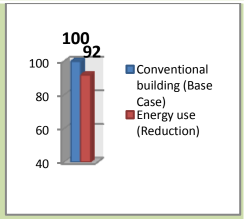
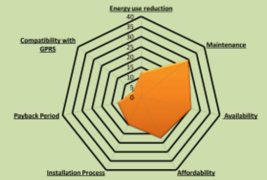
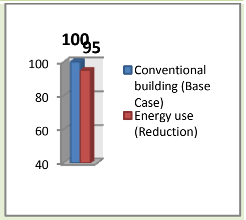
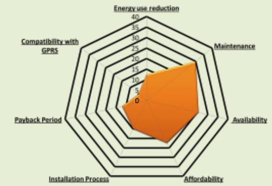


Figure 5.14 Radar chart for application in Egypt.
Source: The Resercher.

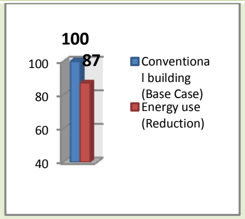
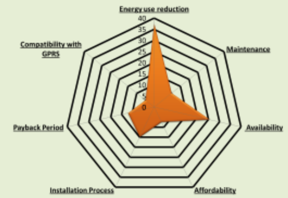
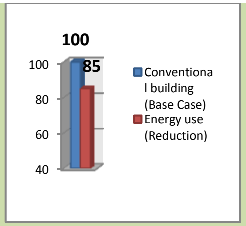
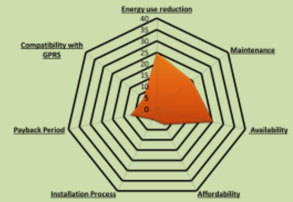
(Table 5.1) is a comparative analysis of the green strategies discussed in the previous chapter, and assessing of each strategy to be applied in Egypt.

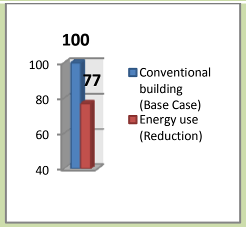
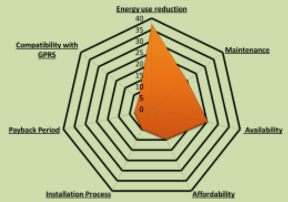
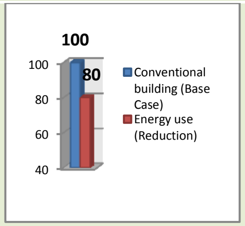
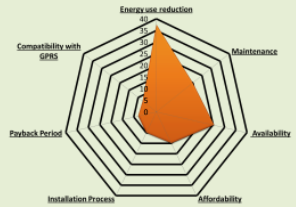
Table 5.1 Comparative Analysis of green strategies to be applied in Egypt
Source : The Researcher

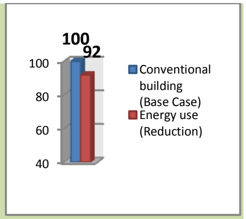
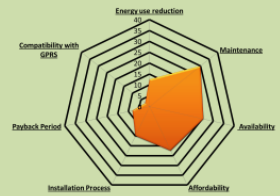
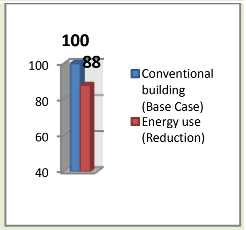
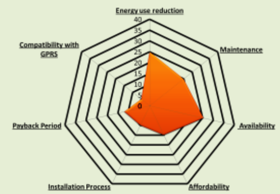
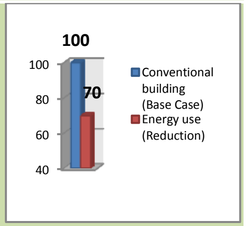
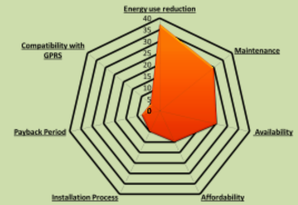
		The Strategy	Example Applied the Strategy	Motivation	Affordability	Payback Period	Availability	Maintenance	Installation process	Energy use reduction Compared to Base case (Static)		Compatibility with GPRS		Implementation in Egypt	Notes
					1.5	0.8	1.7	2.0	1.0	2.5		0.5			
Demand Side Management Strategies (DSM)	Heating and Cooling Demand Reduction	Windows Retrofits (fenestration)	 **Wipro Technologies Development center**	Acquiring LEED certification	⦿	⦿	●	○	○		○	**1 Credit Point:** Category 1.1.4 compatibility with national development plan . **1 Credit Point:** Category 2.1Energy Efficiency Improvement 5-10% reduction. **1 Credit Point:** Category 2.2 Passive External Heat Gain\loss Reduction 5-10% reduction **1 Credit Point:** Category 4.1 Regionally procured materials (to reduce the environmental impact of transportation)	⦿	111 	-
			 **Argonne National Laboratory**	Acquiring LEED certification, Energy use reduction	⦿	⦿	○	○	○		⦿	**1 Credit Point:** Category 1.1.4 compatibility with national development plan. **3 Credit Point:** Category 2.1Energy Efficiency Improvement 16-20% reduction. **2 Credit Point:** Category 2.2 Passive External Heat Gain\loss Reduction 11-20% reduction	●	109 	-
			 **Senior citizens' apartments building**	Smart technology use, Energy use reduction	○	●	○	●	⦿		⦿	**1 Credit Point:** Category 1.1.4 compatibility with national development plan. **2 Credit Point:** Category 2.1Energy Efficiency Improvement 11-15% reduction. **3 Credit Point:** Category 2.2 Passive External Heat Gain\loss Reduction 21-30% reduction	●	72.5 	This technology has a high cost, and short life cycle.

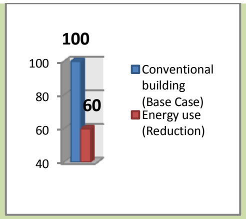
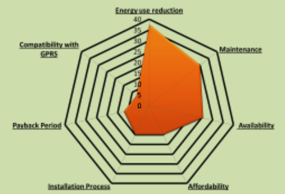
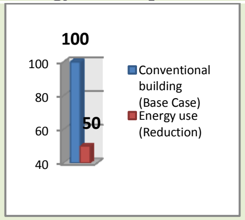
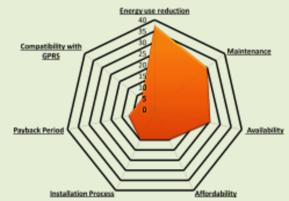
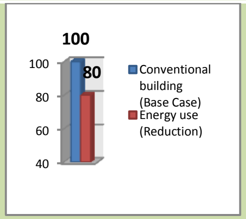
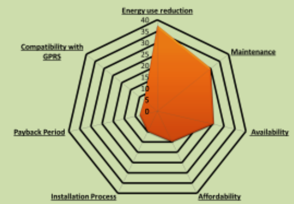
The Strategy	Example Applied the Strategy	Motivation	Affordability	Payback Period	Availability	Maintenance	Installation process	Energy use reduction Compared to Base case (Static)		Compatibility with GPRS		Implementation in Egypt	Notes
Exterior Shading Louvers	 **Trafalgar House office building**	Acquiring BREEAM certification, Energy use reduction.	●	○	●	○	○	 	○	**1 Credit Point:** Category 1.1.4 compatibility with national development plan. **1 Credit Point:** Category 2.1Energy Efficiency Improvement 5-10% reduction. **1 Credit Point:** Category 2.2 Passive External Heat Gain\loss Reduction 5-10% reduction	⊙	122.5  	shading devices can reduce the cooling load of building by 23% - 89%[1] reduces solar heat gain up to 45%.
	 **Xceed Headquarters**	Aesthetic, Energy use reduction	●	○	●	○	○	 	○	**1 Credit Point:** Category 1.1.4 compatibility with national development plan. **1 Credit Point:** Category 2.1Energy Efficiency Improvement 5-10% reduction. **1 Credit Point:** Category 2.2 Passive External Heat Gain\loss Reduction 5-10% reduction	⊙	 	
Interior window blinds	 **EPA Region 8 Headquarters**	Energy use reduction, Acquiring LEED certification, Glare reduction	●	○	●	○	○	 	○	**1 Credit Point:** Category 1.1.4 compatibility with national development plan. **1 Credit Point:** Category 2.1Energy Efficiency Improvement 5-10% reduction. **1 Credit Point:** Category 2.2 Passive External Heat Gain\loss Reduction 5-10% reduction **1 Credit Point:** Category 4.1 Regionally procured materials (to reduce the environmental impact of transportation)	⊙	 	

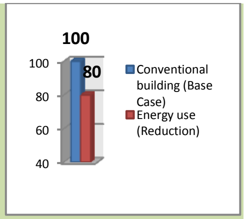
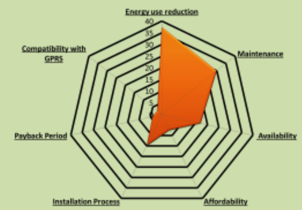
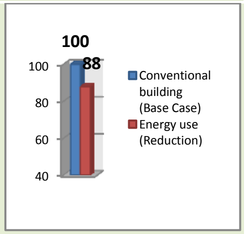
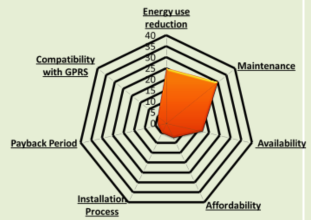
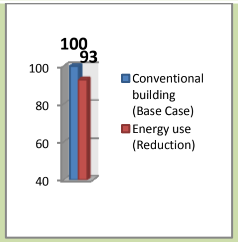
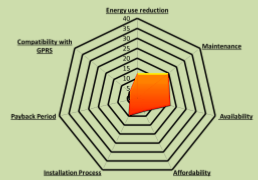
[1] Moeck, M., Yoon, Y., Bahnfleth, B. and Mistrick, M.: " How Much Energy Do Sidelighting Strategies Save", The Pennsylvania State University, Department of Architectural Engineering, USA. URL: http://www.lrc.rpi.edu/programs/daylighting/pdf/sidelighting.pdf, accessed May 20, 2013.

The Strategy	Example Applied the Strategy	Motivation	Affordability	Payback Period	Availability	Maintenance	Installation process	Energy use reduction Compared to Base case (Static)		Compatibility with GPRS		Implementation in Egypt	Notes
Ventilated Double-skin Facades	 **SUVA Insurance Company**	Energy use reduction, improve building's thermal performance	○	⊙	⊙	●	⊙		⊙	**1 Credit Point:** Category 1.1.4 compatibility with national development plan **1 Credit Point:** Category 2.1Energy Efficiency Improvement 5-10% reduction. **1 Credit Point:** Category 4.6 Use of lightweight materials. **1 Credit Point:** Category 4.8 Use of prefabricated elements **1 Credit Point:** Category 5.1 Optimized Ventilation	⊙	**112.5** 	percentage and ways for improved performance differ according to location
Whole Envelope Replacement	 **First Bank Building**	Safety precautions Acquiring a LEED EBOM certification Aesthetical	○	○	●	⊙	●		⊙	**1 Credit Point:** Category 1.1.4 compatibility with national development plan. **1 Credit Point:** Category 2.1Energy Efficiency Improvement 5-10% reduction. **1 Credit Point:** Category 2.2 Passive External Heat Gain\loss Reduction 5-10% reduction **1 Credit Point:** Category 4.1 Regionally procured materials (to reduce the environmental impact of transportation) **1 Credit Point:** Category 4.6 Use of lightweight materials. **1 Credit Point:** Category 4.8 Use of prefabricated elements	●	**102.5** 	Lifespan of the glass: 100 years. Energy reduction will be great if other strategies were applied during recladding.

The Strategy	Example Applied the Strategy	Motivation	Affordability	Payback Period	Availability	Maintenance	Installation process	Energy use reduction Compared to Base case (Static)		Compatibility with GPRS		Implementation in Egypt	Notes
Green Wall	 **Aquaquest, the Marilyn Blusson Learning Centre**	Acquiring LEED certification, aesthetic	⦿	⦿	●	⦿	⦿		●	**1 Credit Point:** Category 1.1.4 compatibility with national development plan. **1 Credit Point:** Category 1.3.1 Protection of habitat. **3 Credit Point:** Category 2.1Energy Efficiency Improvement 16-20% reduction. **1 Credit Point:** Category 2.2 Passive External Heat Gain\loss Reduction 5-10% reduction **1 Credit Point:** Category 4.1 Regionally procured materials (to reduce the environmental impact of transportation)	●	**123.5** 	
Green Roof	 **Hulsey CenterUniv. of Alabama**	Energy use reduction	⦿	⦿	●	⦿	⦿		●	**1 Credit Point:** Category 1.1.4 compatibility with national development plan. **1 Credit Point:** Category 1.3.1 Protection of habitat. **3 Credit Point:** Category 2.1Energy Efficiency Improvement 16-20% reduction. **1 Credit Point:** Category 2.2 Passive External Heat Gain\loss Reduction 5-10% reduction **1 Credit Point:** Category 4.1 Regionally procured materials (to reduce the environmental impact of transportation)	●		

		The Strategy	Example Applied the Strategy	Motivation	Affordability	Payback Period	Availability	Maintenance	Installation process	Energy use reduction Compared to Base case (Static)		Compatibility with GPRS		Implementation in Egypt	Notes
		Cool Roof	 **Scottsdale Insurance Company**	Energy use reduction	●	⊙	●	○	○		○	**1 Credit Point:** Category 1.1.4 compatibility with national development plan. **1 Credit Point:** Category 2.1Energy Efficiency Improvement 5-10% reduction. **1 Credit Point:** Category 2.2 Passive External Heat Gain\loss Reduction 5-10% reduction	○	**116** 	
		Air Leakage control	 **21-storey apartment tower**	Energy use reduction, Improving building HVAC performance	⊙	○	●	⊙	⊙		⊙	**2 Credit Point:** Category 1.1.4 compatibility with national development plan. **2 Credit Point:** Category 2.1Energy Efficiency Improvement 11-15% reduction. **1 Credit Point:** Category 4.1 Regionally procured materials (to reduce the environmental impact of transportation)	⊙	**112.5** 	Annual Cost Savings $9,650. Retrofit Cost [1990 $] $54,800
		Day Lighting	 **Host Street building**	Maximizing day lighting in office parts, Minimizing energy use of artificial lighting equipment.	⊙	⊙	●	○	⊙	 **Reduction in lighting energy consumption**	●	**1 Credit Point:** Category 1.1.4 compatibility with national development plan. **3 Credit Point:** Category 2.1Energy Efficiency Improvement 16-20% reduction. **1 Credit Point:** Category 7.3 Innovation.	⊙	 **131**	

		The Strategy	Example Applied the Strategy	Motivation	Affordability	Payback Period	Availability	Maintenance	Installation process	Energy use reduction Compared to Base case (Static)		Compatibility with GPRS		Implementation in Egypt	Notes
		Lighting System upgrade	 **Alliance Center**	Acquiring LEED certification	⊙	○	●	○	○	 **Reduction in lighting energy consumption**	●	**1 Credit Point:** Category 1.1.4 compatibility with national development plan. **4 Credit Point:** Category 2.1Energy Efficiency Improvement 21-25% reduction. **1 Credit Point:** Category 2.3 Energy Efficienr appliances. **1 Credit Point:** Caregory 5.4 Visual comfort.	●	**142.5** 	
		Lighting System upgrade	 **United Nations Headquarters Nairobi**	Energy use reduction , a goal to build a green, energy neutral building.	⊙	○	●	○	○	 **Reduction in lighting energy consumption**	●	**1 Credit Point:** Category 1.1.4 compatibility with national development plan. **4 Credit Point:** Category 2.1Energy Efficiency Improvement 21-25% reduction. **1 Credit Point:** Category 2.3 Energy Efficienr appliances. **1 Credit Point:** Caregory 5.4 Visual comfort.	●		
		Mirror duct for natural light	 **Toyota Motor Corporation Head Office**	Acquiring CASBEE certification, Energy use reduction	⊙	⊙	●	○	⊙	 **Reduction in lighting energy consumption**	●	**1 Credit Point:** Category 1.1.4 compatibility with national development plan. **3 Credit Point:** Category 2.1Energy Efficiency Improvement 16-20% reduction. **1 Credit Point:** Category 4.1 Regionally procured materials (to reduce the environmental impact of transportation) **1 Credit Point:** Category 7.3 Innovation.	●	**133.5** 	

		The Strategy	**Example Applied the Strategy**	**Motivation**	**Affordability**	**Payback Period**	**Availability**	**Maintenance**	**Installation process**	**Energy use reduction Compared to Base case (Static)**		**Compatibility with GPRS**		**Implementation in Egypt**	**Notes**
		Solar PV installation on roof	 **Econcern Headquarter Köln**	Acquiring DGNB Label, energy neutralization	○	●	⊙	○	○	 In Heating/Cooling Energy	●	**1 Credit Point:** Category 1.1.4 compatibility with national development plan. **2 Credit Point:** Category 2.6 Renewable Energy Sources	○	113.5 	
		Solar power system integrated with building materials	 **Yokohama Dia Buiiding**	Acquiring CASBEE label, Energy generation.	○	●	⊙	○	⊙		⊙	**1 Credit Point:** Category 1.1.4 compatibility with national development plan. **2 Credit Point:** Category 2.6 Renewable Energy Sources **1 Credit Point:** Category 4.7 Use of higher durability materials **1 Credit Point:** Category 4.8 Use of prefabricated elements	⊙	93.5 	
		Wind turbines tower	 **San Francisco Public Utilities Commission Headquarters**	LEED Platinum certification	○	●	⊙	⊙	⊙		○	**1 Credit Point:** Category 1.1.4 compatibility with national development plan. **2 Credit Point:** Category 2.6 Renewable Energy Sources **1 Credit Point:** Category 4.8 Use of prefabricated elements	⊙	76 	Wind turbine will help to produce up to 7 % of the building power.

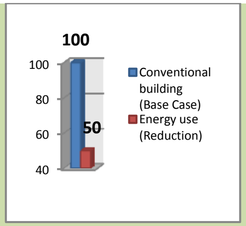
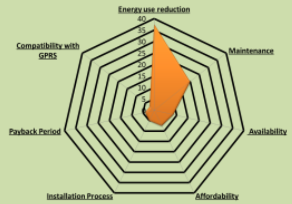
		The Strategy	Example Applied the Strategy	Motivation	Affordability	Payback Period	Availability	Maintenance	Installation process	Energy use reduction Compared to Base case (Static)		Compatibility with GPRS		Implementation in Egypt	Notes
		Geothermal energy system	 **Clock Shadow Building**	Build an environmentally sustainable building, Generating geothermal energy	○	○	○	⊙	●		●	**1 Credit Point:** Category 1.1.4 compatibility with national development plan. **2 Credit Point:** Category 2.6 Renewable Energy Sources	○	85 	

Table 5.2 Key Table
Source: The Resercher

	High	Medium	Low
Symbol	●	⊙	○
Notes	The symbols in the payback, maintenance, and installation columns are reflected in strengths, i.e. Maintenance ○ means need low maintenance thus great strength. Application in Egypt: the more the shaded part the more the strategy is applicable in Egypt		

From the previous table we conclude the following:

- From (Table 5.1), it is noticed that the highest range of application is 150 and the lowest is 50; thus the following applicability measure is concluded, see (Figure 5.15).

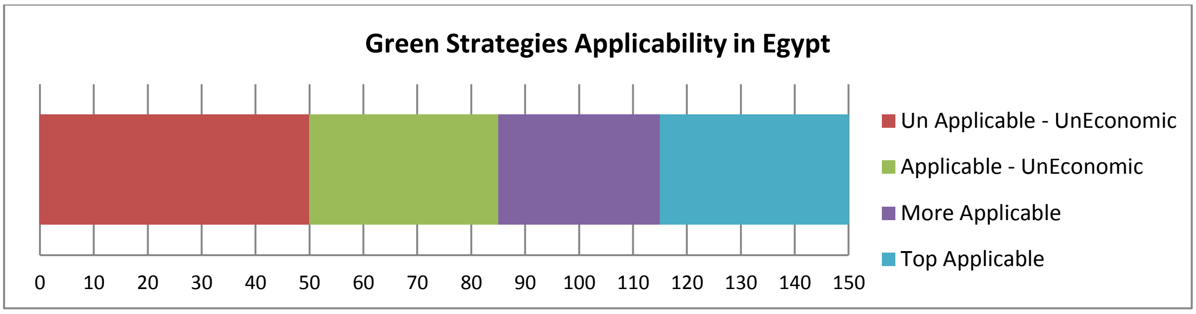


Figure 5.15 Applicability in Egypt.
Source: The Researcher

- The first motivation behind applying a green strategy for a building owner is acquiring a green certification to satisfy the tenant demand, secondly reduce the energy consumption, another motivation is an aesthetic one, which has a very low percentage compared to the other two. See (Figure 5.16).

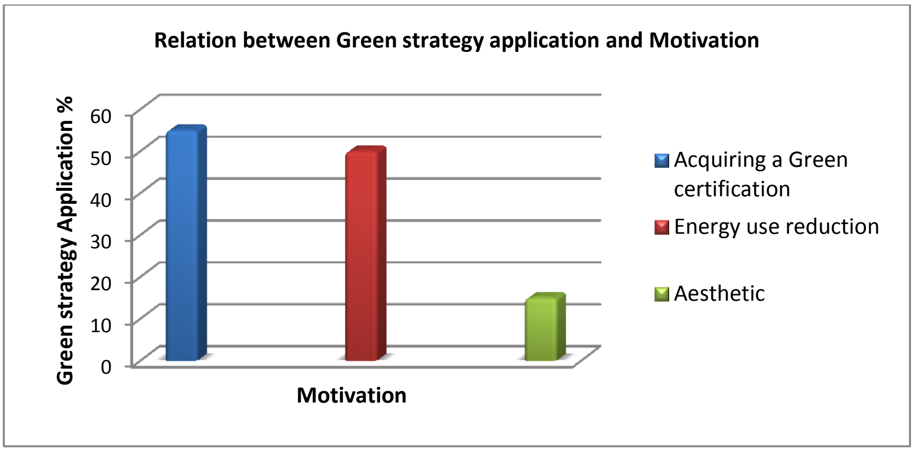


Figure 5.16 Motivation behind Green strategis application
Source: The Researcher

- The applicable green strategies or technologies in Egypt based on the mentioned factors and the methodology, (Figure 5.17) shows the strategies in descending order.

- Using the same methodology we can assess any green strategy either it is applicable in Egypt or not. The more the applicability in Egypt the more economic this strategy is.

The strategies applied in the Empire state building discussed in the previous chapter are assessed in (Table 5.3).

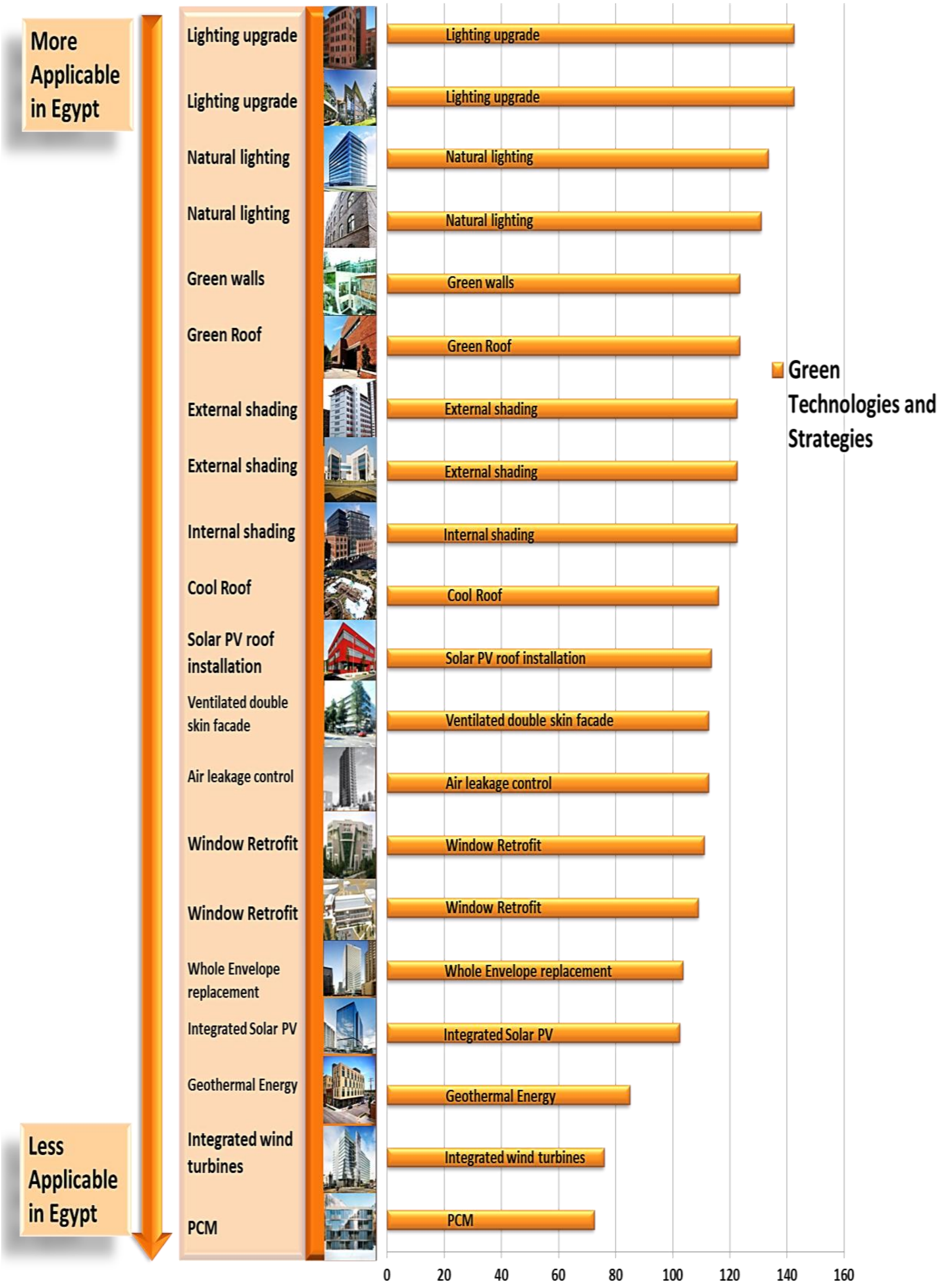
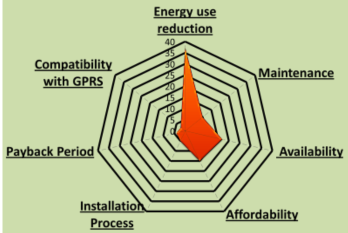
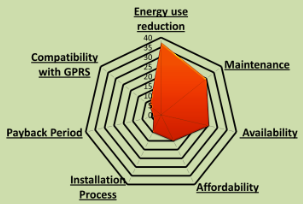
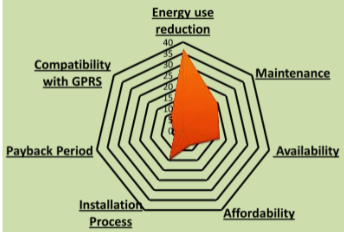
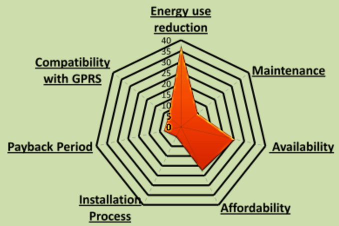
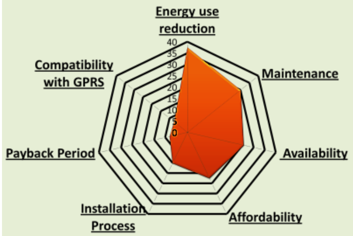
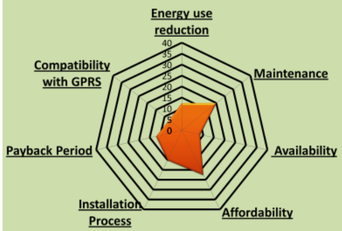
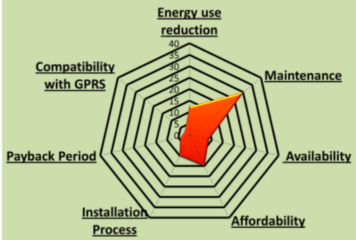


Figure 5.17 Applicable green strategies in Egypt (Descending order).
Source: The Researcher.

Table 5.3 Assessing applied strategies in the Empire Satae building to be applied in Egypt
Source: The Researcher

The Case Study that Applied Strategies	The Strategy	Affordability	Payback Period	Availability	Maintenance	Installation process	Energy use reduction Compared to Base case (Static)	Compatibility with GPRS		Implementation in Egypt	Notes
Empire State Building 	**Direct Digital Controls (DDC)**	⊙	●	⊙	●	●	●	1 Credit Point: Category 1.1.4 compatibility with national development plan . 1 Credit Point: Category 2.1Energy Efficiency Improvement 5-10% reduction. 1 Credit Point: Category 4.1 Regionally procured materials (to reduce the environmental impact of transportation)	○	**91** 	Direct controls do not have direct impact on energy use reduction but it guarantees the optimization of other strategies; thus it has a great effect.
	Tenant Day lighting/Plugs	⊙	●	●	○	⊙	●	1 Credit Point: Category 1.1.4 compatibility with national development plan. 3 Credit Point: Category 2.1Energy Efficiency Improvement 16-20% reduction. 1 Credit Point: Category 2.3 Energy Efficient appliances. 1 Credit Point: Category 5.4 Visual comfort.	●	**129.5** 	Dimmable ballasts
	VAV Air Handling Units	○	●	⊙	⊙	○	●	1 Credit Point: Category 1.1.4 compatibility with national development plan 3 Credit Point: Category 2.1Energy Efficiency Improvement 16-20% reduction. 1 Credit Point: Category 2.3 Energy Efficient appliances. 2 credit points: Category 5.3 Thermal comfort.	●	**108.5** 	Replacing existing constant volume units.

The Case Study that Applied Strategies	The Strategy	Affordability	Payback Period	Availability	Maintenance	Installation process	Energy use reduction Compared to Base case (Static)	Compatibility with GPRS		Implementation in Egypt	Notes
	**Chiller Plant Retrofit**	●	⦿	●	●	●	●	1 Credit Point: Category 1.1.4 compatibility with national development plan 3 Credit Point: Category 2.1Energy Efficiency Improvement 16-20% reduction. 1 Credit Point: Category 2.3 Energy Efficient appliances. 2 credit points: Category 5.3 Thermal comfort.	●	**116** 	
	Building Windows	●	⦿	●	○	○	⦿	1 Credit Point: Category 1.1.4 compatibility with national development plan 2 Credit Point: Category 2.1Energy Efficiency Improvement 11-15% reduction. 1 Credit Point: Category 2.2 Passive External Heat Gain\loss Reduction 5-10% reduction 1 Credit Point: Category 4.1 Regionally procured materials (to reduce the environmental impact of transportation) 1 Credit Point: Category 4.2 Materials fabricated on site 1 Credit Point: Category 7.3 Innovation.	●	**146** 	Glass units are remanufactured onsite..
	Tenant Energy Management	●	○	○	⦿	○	○	1 Credit Point: Category 1.1.4 compatibility with national development plan 1 Credit Point: Category 2.1Energy Efficiency Improvement 5-10% reduction. 3 Credit Point :Category6.3.1 Providing a Building User Guide 1 Credit Point: Category 7.3 Innovation.	●	**98** 	Comparison charts can encourage energy use reduction.

The Case Study that Applied Strategies	The Strategy	Affordability	Payback Period	Availability	Maintenance	Installation process	Energy use reduction Compared to Base case (Static)	Compatibility with GPRS		Implementation in Egypt	Notes
	**Radiative Barrier**	●	●	○	○	⦿	⦿	<u>1 Credit Point:</u> Category 1.1.4 compatibility with national development plan <u>1 Credit Point:</u> Category 2.1Energy Efficiency Improvement 5-10% reduction. <u>1 Credit Point:</u> Category 2.2 Passive External Heat Gain\loss Reduction 5-10% reduction	○	**102.5** 	
	Tenant Demand Control Ventilation (DCV)	⦿	●	○	○	⦿	○	<u>1 Credit Point:</u> Category 1.1.4 compatibility with national development plan <u>2 Credit Points:</u> Category 2.10 Energy and Carbon Inventories	○	**82.5** 	Helps in monitoring indoor air quality.

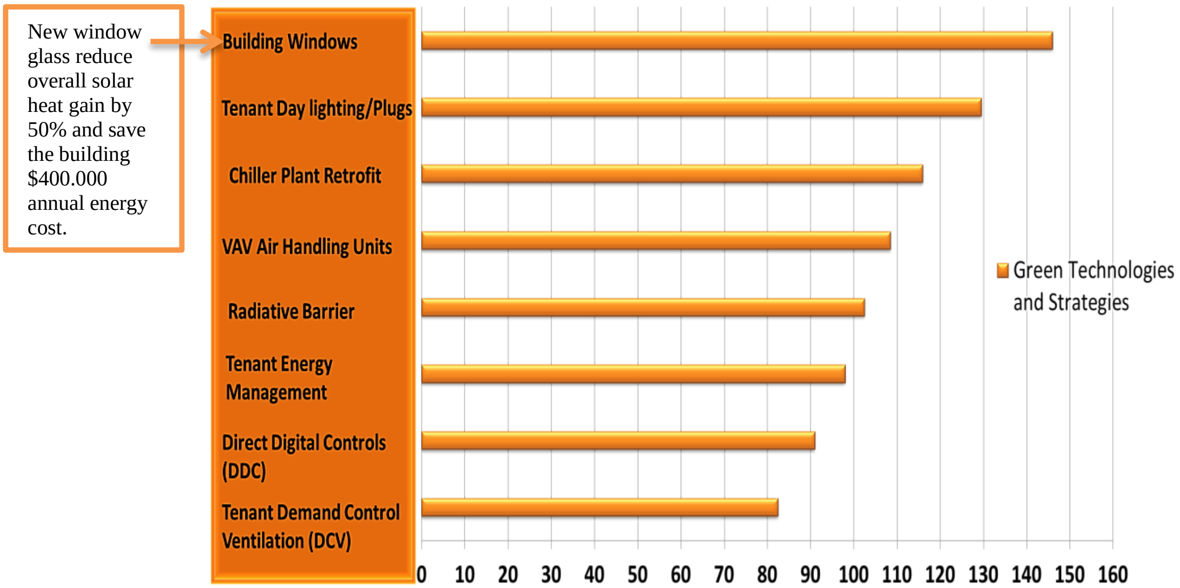


Figure 5.18 Application of green strategies of the Empire state building in Egypt
Source: The Researcher

(Figure 5.18) tells us the degree of applicability of the 8 green strategies implemented on the Empire State Building in Egypt, thus if we assume that the building had been located in Egypt, could these green strategies be applied or not! From (Figure 5.15) we can determine that 5 strategies are located in the more applicable part and 2 in the Top Applicable part; thus we conclude that these green strategies could be applied on the building if it had been located in Egypt, but it needs funding, awareness, and the most important thing is the lack of Energy Service Companies (ESCOs) to implement these strategies and perform the reporting.

5.9 Application in Egypt

The top rated strategies according to the methodology are applied to a building in Egypt; Vodafone headquarters in the smart village is selected to apply these strategies. The current condition of the building is discussed, then the assumed strategies to be applied on it.

5.9.1 Basics of selection

- Located in Egypt
- Existing occupied office building
- Non heritage building

5.10 Vodafone Headquarters (Smart Village) Egypt

Architect	Egyptian Consultant Group (ECG) [1]
Client	Vodafone Company
Founded in	2005
Location	Smart Village (Egypt)
Category	Office Building
Certifications and Awards	Not Certified
Motivation	Aesthetic, Energy use reduction
Existing Green Technologies	fixed sunscreens and sunshades were adopted in the office building's elevations
Orientation	North-East
Compactness	The building is long and narrow; permits an acceptable exposure to daylight.
Green technologies suggested to be applied	· Lighting fixtures upgrade · Green roof
Energy Efficiency Compared to Conventional building	· 40 % of lighting energy consumption reduction (lighting energy consumes about 30% of the building electrical energy). · Green roof is expected to save 10-15% of energy cooling loads.

5.10.1 Heating and Control Demand Reduction

5.10.1.1 Building Envelope

Curtain wall system, Stainless Steel, Granite and marble for the opaque parts.

5.10.1.1.1 Shading System

A careful study of the sun Paths & building orientation during the design developed the sunshades system shown in (Figure 5.19).

Solar shading helps to reduce heat gain; it is possible to reduce the total cooling load of the air conditioned buildings by approximately **7%** by employing an efficient shading strategy[2]

Figure 5.19 Three row of horizontal membranes stretched between steel posts stabilized by a net of vertical, horizontal and bracing cables.
Source: URL: http://www.ecgsa.com/vodafoneheadquarters , accessed April 8, 2013.

Interior shading system is used in the office space (Sun screen roll up- roll up black out) to provide shading.

[1] URL: www.elofoq.com/projects. Accessed April 8, 2013.
[2] M. Santamouris, A. Argiriou, E. Daskalaki, C. Balaras and A. Gaglia, "Energy Characteristics and Saving Potential in Office Building," Solar Energy, vol. 52, no.1, 1994, pp. 59-66.

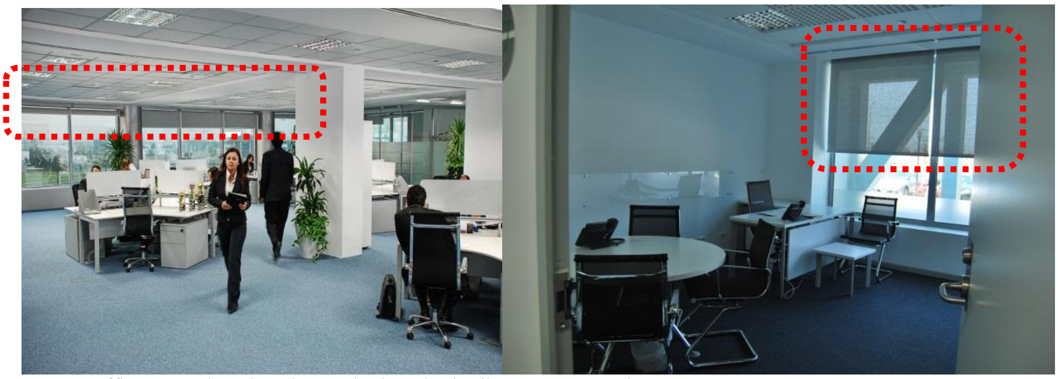


Figure 5.20 Office space interior shows the interir shading system used.
Source:URL: http://smartvillage.e-turn.net/docs/gallery.aspx?catId=9, accessed June 22, 2013.

5.10.1.1.2 Fenestration (Windows) System

Double Glazed windows (6mm, 6mm, 6mm), with low SHGC, Electrostatic coated Aluminum sections, Reflective blue glass for the fixed parts (Structural glazing). Openings represent 95% of the facades as shown in (Figure 5.21), all the opening are oriented towards East and West.

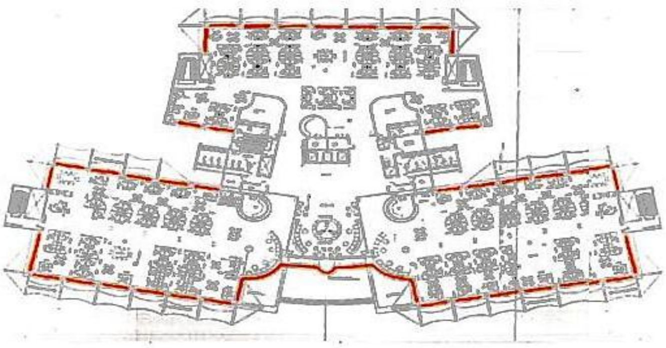


Figure 5.21 Openings of the building.
Source: Badr, M., (2010), "Intelligent Architecture" As an Approach for apply the Technological Development in the Environmental Control and Energy Efficiency in Buildings " An Analytical Study to assess the Environmental Performance of Intelligent Buildings", Master of science, Faculty of Engineering, Cairo university.

5.10.2 Energy Efficient Equipment and Low Energy Technologies

5.10.2.1 Lighting System (already fixed)

Recessed Mounted Luminaire fluorescent fixtures are used in the office space, while in corridors, circular halogen spot lights are use. (Figure 5.22)

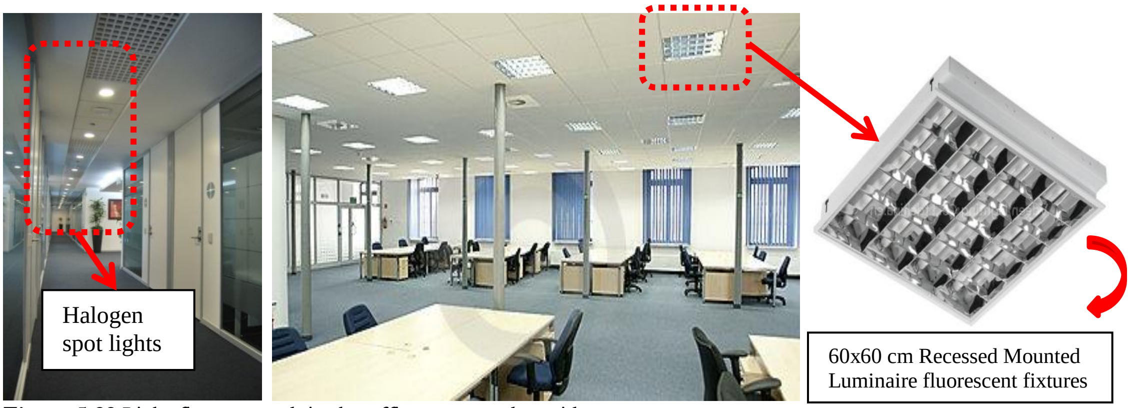


Figure 5.22 Light fixtures used in the office space and corridors.
Source: URL: http://www.smart-villages.com/en/brochure/page/179/type/2, accessed June 22, 2013.

5.10.3 Suggested green strategies to be applied

5.10.3.1 Lighting System Upgrade to LED lighting

- Switch to energy-efficient LED, contain no hazardous substances and because they last up to three times longer you save on maintenance too.
- Use lighting controls – for spaces that are only occupied occasionally, controls can switch lights off when no one is around. Controls automatically adjust lighting levels based on the amount of natural daylight in the space.
- Link lights and blinds – intelligent solutions that raise and lower blinds in response to changing daylight levels maximize comfort and minimize energy use for lighting and air conditioning. (Optional).

The suggested solutions are available in Egypt via Philips Company, and can save up to 40% of lighting energy consumption.

Corridors:

Areas in the office that are occupied the least can often waste energy, dimmable LuxSpace luminaires save energy and create ambience. Intelligent sensors like OccuSwitch turn the light off when it's not needed.

Figure 5.23 LED solutions for the corridors in the building.
Source: URL: www.philips.com/office-lighting , accessed August 20, 2013.

Open space offices

In combination with OccuSwitch DALI it enables you to maximize energy savings by automatically switching lights off when an area of the office is unoccupied or there is sufficient daylight present. So you can save energy at every opportunity.

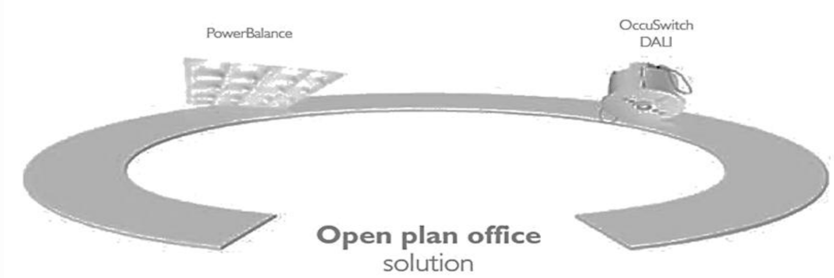


Figure 5.24 Open plan office LED solutions
Source: URL: www.philips.com/office-lighting , accessed August 20, 2013.

5.10.3.2 Green Roof

Another suggested green technology or strategy which takes a high rank in the application in Egypt is the green roof. It could be implemented in the Vodafone headquarters and is expected to save up to 10-15% of energy consumption. (Figure 5.25).

Figure 5.25 Green roof suggested as a green strategy to be implemented on the building.
Source: URL: http://www.panoramio.com/photo/16421180, accessed August 20, 2013.

5.11 Conclusion

- The majority of architectural and engineering offices and companies in Egypt don't apply green strategies in their projects.
- The main motivation behind application of green strategies is energy use reduction according to the survey, but this motivation is enhanced when the building is seeking a green certification i.e. LEED.
- According to the survey, the most significant factor for architects and engineers when applying a green strategy in Egypt is the energy use reduction.
- The majority of survey participants wouldn't accept a pay-back period 5-10 years and may abandon the application of a certain green strategy, on the other hand this period is accepted abroad, thus owners and investors should accept this pay-back period to apply more green strategies.
- GPRS certification encourages the majority architects to apply green strategies, but it makes no difference to others.
- Some architects care about acquiring LEED certification than acquiring GPRS.
- The methodology of assessment discussed shows the most applicable green strategies in Egypt, the more the applicability in Egypt the more economic and efficient the green strategy.

Conclusions and Recommendations

Through the Theoretical and the Practical study of the research, the following conclusion points were reached.

6.1 Conclusions

- No one group of stakeholders can do everything, but everyone can, and must, do something. Recognizing the different conditions, in terms of climate, culture, tradition, economic systems, availability of materials, and so on, which apply to the Building Sector in different countries, it is obvious that there can be no universal solution or recommendation that can be given for reducing greenhouse gas emissions from buildings or greening the building that already have been built. However, there has never been a time when interest in addressing the issue of greening the buildings has been greater.
- With proven and commercially available technologies, the energy consumption in both new and existing buildings can be cut by an estimated 30 to 80 percent with potential net profit during the building life-span.
- Residential buildings as a whole consume more energy than commercial (office) buildings; office buildings consume nearly twice as much energy than residential buildings per square foot.
- The majority of the environmental impact and energy consumption takes place during operational phase (existing buildings).
- Building sector is a major part of the mitigation of GHG emissions strategies.
- Egyptian Green Pyramid is the first step to achieve the green concepts in Egypt.
- New building codes and certification systems are becoming stricter regarding buildings' CO_2 emissions, energy efficiency, and other environmental aspects.
- Driving forces for greening existing –office- buildings varies; there are economic, environmental, cultural/social, and political/governmental driving forces.
- Greening existing buildings has benefits to tenants, owners, investors, and managers.
- The most significant barrier to greening the existing buildings is first cost, high construction and implementation cost, and the lack of awareness.
- In Egypt, the electricity is cheap, which makes steps towards reducing energy consumption slow and ineffective, in contrast with the energy prices globally; the KWH reaches 0.41$ in Denmark, and 0.35$ in Germany[1].
- The incremental cost of greening the existing building is much more than the incremental cost in new buildings to achieve the same performance.
- In Egypt, there is a lack of coordination and consistency in government policies affecting buildings, i.e. the GPRS is not applied yet and the energy code is not easy applicable.
- There are initiatives regarding green architecture and energy efficiency in buildings, i.e. Egyptian Group for Energy in Buildings and Environmental Design Research, IBPSA-International Building Performance simulation Association, and Go Green Expo held this year (2013).

[1] IEA, EIA, National electricity boards, URL: **http://www.eia.gov/electricity/monthly/** , accessed November 30, 2013.

- There are no incentive programs in Egypt to encourage energy efficiency in building or greening the existing buildings, on the contrary, in the majority of the developed countries, there are many incentive programs i.e. tax incentives.
- Failure to encourage energy efficiency and low carbon when building new or retrofitting will lock Egypt into the disadvantages of poor performing buildings for decades; thus face an energy crisis.
- Deep retrofits require an integrated design approach, and team work (Figure 6.1).

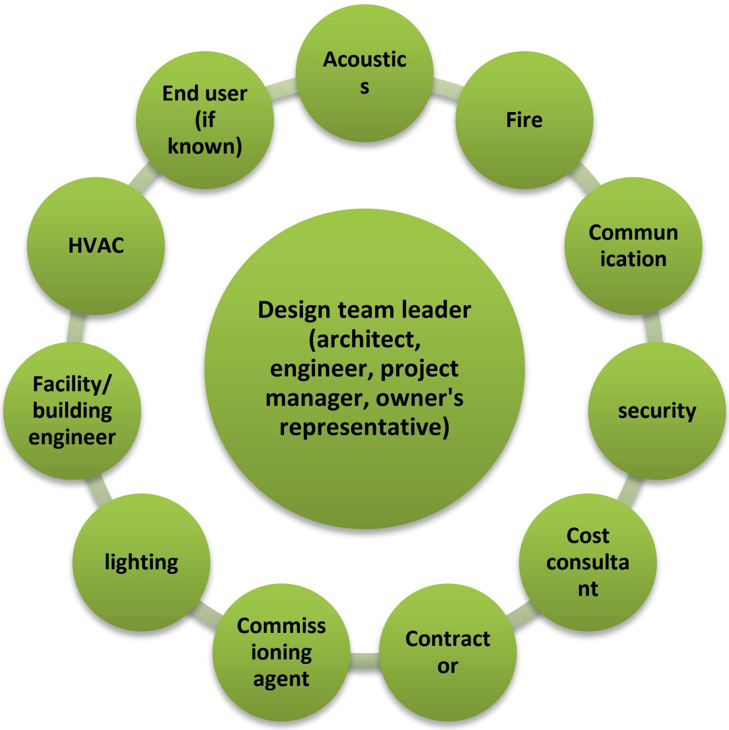


Figure 6.1 Integrated Project Design Team
Source: ASHRAE American Society of Heating, Refrigerating and Air-Conditioning Engineers, (2011).

- Corporate sustainability is reached through the following steps:

1- **Setting the Vision:** you have to set a goal to reach, i.e. do you want a carbon neutral building, energy reduction 20%.

2- **The task team:** once the vision is set, there is work to be done by an integrated design team.

3- **Examining Green Options:** Typically, there are three areas of consideration: new construction and major renovations; greening existing properties; and corporate operations.
should a company focus on green building certifications, on upgrading the energy performance of existing properties, tracking its carbon footprint, or some combination of all of these?, according to this green strategies are examined by the design team to reach optimum solution. Clients and customers must also be taken into account: what they are willing to pay for and what they will support in the years ahead?

4- **Internal Education and Training:** There must be a commitment to education and training. For example, studying to become a LEED Accredited Professional or some other certified sustainability professional.

For others, it’s training in how to apply BREEAM or LEED-EBOM to current design and construction projects.
For property management, it might be training in the LEED for Existing Buildings/Operations and Maintenance Program.

5- **Green Operations:** There is much to do on the property management side. Companies’ efforts may involve negotiating national waste recycling contracts, renegotiating janitorial and landscape maintenance contracts.

6- **Communications**: Effective communications is a requirement of every serious sustainability effort. Leadership should be tracking and reporting the company’s carbon footprint, issuing an annual or biennial sustainability report, having a green or sustainability web site, and other activities that tell both the internal and external stakeholders what the company is doing and where it expects to be in a year or two.

7- **Continuous Improvement:** Ongoing corporate sustainability is about continuous improvement, using environmental and energy metrics. Most of the buildings we build today will still be here 25 years from now; thus sustainable programs should be adopted to the buildings. (Figure 6.2).

- Tenants and building users should participate in the greening process.
- Egyptian architects and engineers wouldn't accept a Pay-back period that ranges 5-10 years, which make the implementation of deep renovation complicated.
- The derived methodology for assessing implementation of green strategies in Egypt is filled by the team leader or the architect after consulting the client, it helps in determining the most applicable green strategies in Egypt; thus suggesting the suitable green strategies to be applied on building.

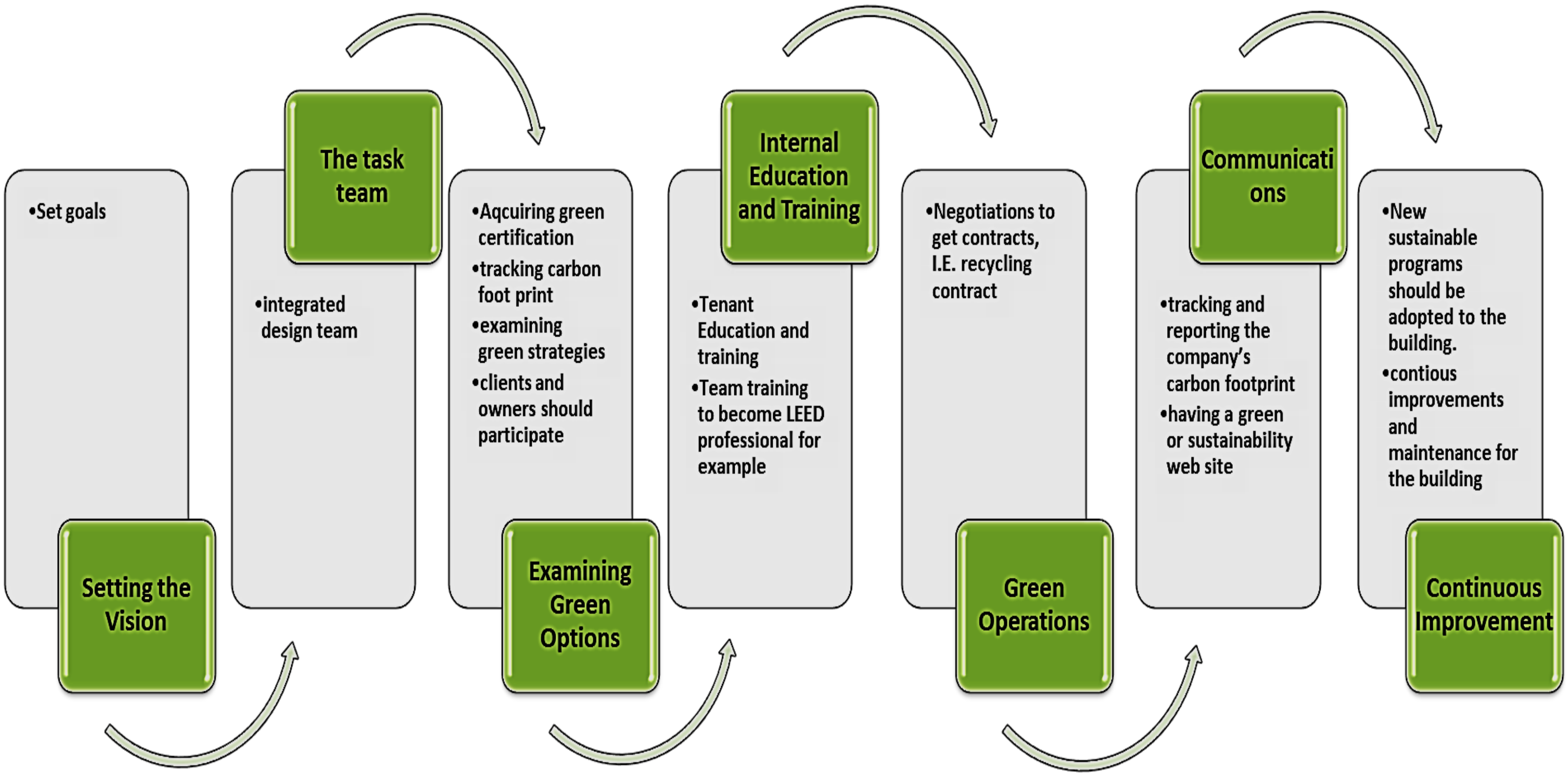


Figure 6.2 7 step program for corporate sustainability
Source: The Researcher

6.2 Recommendations

- Government has to create applicable policies that encourage energy efficient and low emission building activity ***(Incentive Programs).*** Significant co-benefits including employment will be created by these policies.
- In most cases, codes tend to regulate new buildings; governments have to amend their codes to cover renovations and refurbishments of existing buildings.
- Transfer to green behavior in buildings.
- Faculties have to foster environmental awareness, develop curriculum and tools for building energy efficiency and environmental responsibility.
- ***Procurement policies*** is an example how consumers can flex their market power, it can be introduced to both public and private sectors, whereby customers who procure large quantities of energy-using appliances and equipment cooperate in order to influence the market for more efficient products. The goal will be the commercial availability of new technologies for all buyers. The more availability of the product or technology the more its affordability.
- ***Establish an energy efficiency investment fund*** that can be used to promote initial investments and renovations for energy efficiency in buildings. Such a fund can be financed through taxation of energy use above the national average, thereby always providing additional incentives to high energy users to reduce their energy use. It can be also funded by redirecting investments in additional energy production that will be avoided by reduced energy demand in buildings. (High energy users are always huge firms and companies and will be able to implement a green strategy to avoid paying the taxes[1]).
- There should be awareness raising campaigns, mass media motivational campaigns, training of building professionals.
- (Table 6.1) summarizes the role of different actors and decision makers to promote greening existing office buildings.
- To enhance greening the existing office buildings in Egypt, the following components must be accomplished. (Figure 6.3)

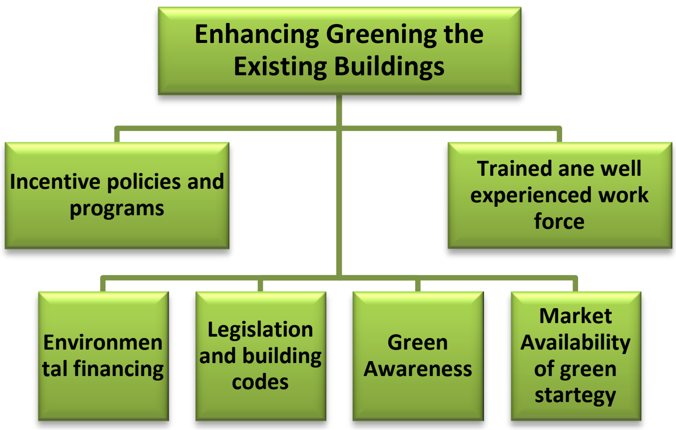


Figure 6.3 Enhancing Greening existing building in Egypt.
Source: The Researcher.

[1] Based on an interview with Assoc. Prof. Ahmed A. Medhat, inThe Housing and Building National Research Center, November, 2012.

Table 6.1 Different actors and decision makers role to enhance greening existing office buildings
Source: The Researcher

	Actors and Decision Makers				
	Government (Public Sector)	**Investors (Private Sector)**	**Architects and Engineers**	**Customers/Owners**	**Tenants**
Tasks	- Provide legislations and building codes to organize the refurbishments in existing buildings - Adopt financial incentives i.e tax deduction, loans ….ect. - Establish an energy efficiency investment fund - Provide training courses to architects and engineers to compensate the lack of experienced work force. - Funding researches related to green building practices - Cooperate with green building initiatives i.e IBSA. - Mass media awareness programs - Ministry of industry has to start manufacturing energy efficient appliances (i.e. LED Lamps) and do not import them.	- Awareness of green architecture benefits - Invest in green strategies due to its attractive ROI. - Invest in green buildings or turning existing buildings to green due to its improved marketability - Bear high initial cost, and payback period that range 5-10 or more. - Invest in energy efficient equipment during procurements.	- Awareness of green architecture principles - Awareness of retrofits importance - Have training to green certification programs - Advice building owners to invest in green strategies - Participate in the development of legislations and codes to ensure their application at all levels of review and design approvals.	- Concern about energy prices and future volatility - Owners with longer term perspective, should be concerned that their properties attractiveness might diminish - Involve workers in the design and implementation of new technologies or change programmes, so as to maximize acceptance. - Use the power of social pressure between groups of employees; thus giving a competitive edge to changing behavior. - Offer rewards or incentives to help incentivize individuals - Green buildings increase the productivity of employees; and increase profit. - Turn to green buildings due to its reputational issue; higher rental rates.	- Demand green building and healthier environment - Tenants have to adapt green behavior - Switch off equipment when not used - Participate in green competitions that could be held in offices.

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Appendix

A. On-line Survey

- **Assessing Green Strategies to be Applied in Egypt**

The following is provided as a general set of questions, for assessing green strategies and technologies to be applied on existing office buildings in Egypt.

1- Which of the following best describes your current occupation? *
- Architect
- Electrical engineer
- Operations Senior Manager
- Environmental engineer
- Urban & Landscape Designer
- Mechanical Engineer
- Green buildings Consultant
- Other, please specify (……………………………..).

2- Gender
- Male
- Female

3- Do you work at a
- Major Company in Egypt
- Small Company in Egypt
- Engineering Office
- Other, please specify (……………………………..).

4- Experience in the Architecture Field
- 1-5 Years
- 5-10 Years
- More than 10 years

5- **Does your company/office work with green technologies or strategies?**
- yes
- No

6- **If Yes, What are the Green Strategies Applied by your company/Office? ***
- Cooling/Heating Demand Reduction Strategies
- Using Energy Efficient Equipment and Low Energy Technologies
- Adding Renewable Energy Sources
- Other (please specify) (……………………………..).

7- As an architect, what comes to your mind if you are making an existing building green?

……………………………………………………………………………………
……………………………………………………………………………………

8- As an Architect, What Will Be Your Motivation (Incentive) when applying a Green Strategy to an existing Building?

- Energy Use Reduction
- Acquiring a Green Certificate (i.e. LEED or GPRS)
- Other (please specify) (……………………………..).

9- What are the most significant factors you take into considerations when applying a green strategy to an existing building in Egypt? *

- GPRS (Green Pyramid Rating System in Egypt)
- Affordability
- Payback Period
- Availability in the Egyptian market
- Maintenance
- Installation process
- Energy use reduction
- Compatibility with GPRS
- All the above
- Other (please specify) (……………………………..).

10- Arrange the following factors according to their importance if the strategy is to be applied in Egypt (From 1 to 7) *

(1 is the Top rank, 7 is the least.)

	1	2	3	4	5	6	7	Weighting --	-	+	++
Affordability	○	○	○	○	○	○	○	○	○	○	○
Availability in the Egyptian market	○	○	○	○	○	○	○	○	○	○	○
Compatibility with GPRS	○	○	○	○	○	○	○	○	○	○	○
Energy use reduction	○	○	○	○	○	○	○	○	○	○	○
Installation process	○	○	○	○	○	○	○	○	○	○	○
Maintenance	○	○	○	○	○	○	○	○	○	○	○
Payback Period	○	○	○	○	○	○	○	○	○	○	○

11- From your own perspective, payback period for a certain strategy is long and makes you abandon the project, if it is *

- Less than 5 years
- 5-10 years
- More than 10 years

12- When applying a green strategy to a certain project in Egypt, the compatibility with GPRS

- Encourages you to apply this strategy
- Makes no difference
- Other (please specify) (……………………………..).

13- Would you recommend to your clients a major renovation (more than 2 strategies to be applied)?

- o Yes
- o No
- o It depends (……………………………..).

14- Notes

…………………………………………………………………………………………

………………………………………………………………………………………

Appendix

B. LEED Scorecard for the Empire State Building

SUSTAINABLE SITES		AWARDED: 6 / 12
SSc1	LEED certified design and construction	0 / 1
SSc2	Building exterior and hardscape Mgmt plan	1 / 1
SSc3	Integrated pest Mgmt, erosion control and landscape Mgmt plan	1 / 1
SSc4	Alternative commuting transportation	4 / 4
SSc5	Reduced site disturbance - protect or restore open space	0 / 1
SSc6	Stormwater Mgmt	0 / 1
SSc7.1	Heat island reduction - non-roof	0 / 1
SSc7.2	Heat island reduction - roof	0 / 1
SSc8	Light pollution reduction	0 / 1

WATER EFFICIENCY		AWARDED: 4 / 10
WEc1.1	Water performance measurement	0 / 1
WEc1.2	Water performance measurement	0 / 1
WEc2.1	Additional indoor plumbing fixture and fitting efficiency	1 / 1
WEc2.2	Additional indoor plumbing fixture and fitting efficiency	1 / 1
WEc2.3	Additional indoor plumbing fixture and fitting efficiency	1 / 1
WEc3.1	Water efficient landscaping	0 / 1
WEc3.2	Water efficient landscaping	0 / 1
WEc3.3	Water efficient landscaping	0 / 1
WEc4.1	Cooling tower water Mgmt	1 / 1
WEc4.2	Cooling tower water Mgmt	0 / 1

ENERGY & ATMOSPHERE		AWARDED: 25 / 30
EAc1	Optimize energy efficiency performance	12 / 15
EAc2.1	Existing building commissioning - investigation and analysis	2 / 2
EAc2.2	Existing building commissioning - implementation	2 / 2
EAc2.3	Existing building commissioning - ongoing commissioning	2 / 2
EAc3.1	Performance measurement - building automation system	0 / 1
EAc3.2	Performance measurement - system-level metering	1 / 1
EAc3.3	Performance measurement - system-level metering	1 / 1
EAc4.1	On-site and off-site renewable energy	1 / 1
EAc4.2	On-site and off-site renewable energy	1 / 1
EAc4.3	On-site and off-site renewable energy	1 / 1
EAc4.4	On-site and off-site renewable energy	1 / 1
EAc5	Refrigerant Mgmt	0 / 1
EAc6	Emissions reduction reporting	1 / 1

MATERIAL & RESOURCES		AWARDED: 7 / 14
MRc1.1	Sustainable purchasing - ongoing consumables	0 / 1
MRc1.2	Sustainable purchasing - ongoing consumables	0 / 1
MRc1.3	Sustainable purchasing - ongoing consumables	0 / 1
MRc2.1	Sustainable purchasing - durable goods	0 / 1
MRc2.2	Sustainable purchasing - durable goods	0 / 1
MRc3	Sustainable purchasing - facility alterations and additions	1 / 1
MRc4.1	Sustainable purchasing - reduced mercury in lamps	1 / 1
MRc4.2	Sustainable purchasing - reduced mercury in lamps	1 / 1
MRc5	Sustainable purchasing - food	0 / 1

Appendix

MATERIAL & RESOURCES		**CONTINUED**
MRc6	Solid waste Mgmt - waste stream audit	1 / 1
MRc7.1	Solid waste Mgmt - ongoing consumables	1 / 1
MRc7.2	Solid waste Mgmt - ongoing consumables	0 / 1
MRc8	Solid waste Mgmt - durable goods	1 / 1
MRc9	Solid waste Mgmt - facility alterations and additions	1 / 1
INDOOR ENVIRONMENTAL QUALITY		**AWARDED: 7 / 19**
EQc1.1	IAQ best Mgmt practices - IAQ Mgmt program	0 / 1
EQc1.2	IAQ best Mgmt practices - outdoor air delivery monitoring	0 / 1
EQc1.3	IAQ best Mgmt practices - increased ventilation	0 / 1
EQc1.4	IAQ best Mgmt practices - reduce particulates in air distribution	0 / 1
EQc1.5	IAQ best Mgmt practices - Mgmt for facility alterations and additions	0 / 1
EQc2.1	Occupant comfort - occupant survey	0 / 1
EQc2.2	Occupant comfort - occupant-controlled lighting	0 / 1
EQc2.3	Occupant comfort - thermal comfort monitoring	0 / 1
EQc2.4	Occupant comfort - daylight and views	0 / 1
EQc2.5	Occupant comfort - daylight and views	0 / 1
EQc3.1	Green cleaning - high-performance cleaning program	1 / 1
EQc3.2	Green cleaning - custodial effectiveness assessment	1 / 1
EQc3.3	Green cleaning - custodial effectiveness assessment	1 / 1
EQc3.4	Green cleaning - purchase of sustainable cleaning products and materials	1 / 1
EQc3.5	Green cleaning - purchase of sustainable cleaning products and materials	1 / 1
EQc3.6	Green cleaning - purchase of sustainable cleaning products and materials	0 / 1
EQc3.7	Green cleaning - sustainable cleaning equipment	1 / 1
EQc3.8	Green cleaning - entryway systems	1 / 1
EQc3.9	Green cleaning - indoor integrated pest Mgmt	0 / 1
INNOVATION		**AWARDED: 5 / 6**
IOc1	Innovation in operations	4 / 4
IOc2	LEED Accredited Professional	1 / 1
IOc3	Documenting sustainable building cost impacts	0 / 1
TOTAL		**54 / 91**

Figure B LEED scorecard for Existing Buildings: Operations & Maintenance (v2008)
Source: United States Green Building Council, USGBC,URL: http://www.usgbc.org/projects/empire-state-building , accessed June 30, 2013.

الملخص

قطاع المبانى لديه أعلى امكانيات توفير الطاقه و التخفيف من الغازات الدفيئه و استخدام الطاقات المتجدده. و الأهم أن المبانى لديها تلك القدره بتدابير منخفضه التكلفه او بدون تكلفه .

تستعرض هذه الدراسه التغير المناخى و قضايا استهلاك الطاقة, أسس العماره الخضراء, و نظم تقييمها محلياً فى مصر و عالمياً, و تركز على نظام التقييم الأكثر شيوعاً للمبانى القائمة. كما تستعرض أحدث تكنولوجيات البناء الأخضر التى يمكن تنفيذها فى مبنى قائم لتحسين أداء المبنى و لراحة المستأجرين.

و مناقشه المُحفزّات و العقبات التى تحول دون جعل المبانى القائمة خضراء, و الخطوات التى يجب إتخاذها للتغلب على هذه العقبات : مثل برامج التحفيز و زيادة الوعى.

و تهدف الرسالة إلى وضع مبادىء توجيهيه _برنامج_ يمكن أن يساعد فى هذا من خلال تحليل مبانى ناجحه من جميع أنحاء العالم, و وضع منهجيه لتقييم مدى إمكانية تطبيق التكنولوجيات و الإستراتيجيات الخضراء فى مصر.

الكلمات الدالّة	المبانى القائمه، التقنيات الخضراء، الإستراتيجيات الخضراء، الإستدامه، العماره الخضراء، مبانى المكاتب، مرحلة التشغيل، التغير المناخى، البرامج المُحفزّه، التطبيق فى مصـــر.

تحويل المبانى القائمه الى خضراء كأولويه لمعالجة التغيير المناخى و أزمة الطاقه

" تطوير منهجيه لتقييم مدى تطبيق التقنيات و الإستراتيجيات الخضراء فى مبانى المكاتب فى مصر"

اعداد

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رسالة مقدمة إلى كلية الهندسة - جامعة القاهرة
كجزء من متطلبات الحصول على درجة الماجستير
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الجيـزة - جمهوريـة مصـر العربيـة

٢٠١٣

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