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Opportunities of energy saving in lighting systems for public buildings

Ayman Abd El-khalek, Kamelia Youssef and Ibrahim Yassin
Improving EnergyEfficiency of Lighting & Building Appliances Project
ayman.mohamed@eepegypt.org,
k_energystorm@yahoo.com,
ibrahim.yassin.mahmoud@gmail.com

Abstract - The lighting system provides many options for cost-effective energy saving with low or no inconvenience. Lighting improvements are excellent investments in most public buildings, it is usually cost-effective to address because lighting improvements are often easier to make than many process upgrades.
For public buildings, the easy no and low cost options to help save money and improve the energy performance are:

- Understand energy use.
- Identify options
- Prioritize actions

Make the changes and measure the savings.
Continue managing energy efficiency.
The challenge is to retrofit traditional lamps with LED lamps of good quality. The benefits of LED light bulbs are long-lasting, durable, cool, mercury free, more efficient, and cost effective.

The light Emitting Diode (LED) bulb uses a semiconductor as its light source, and is currently one of the most energy efficient and quickly developing types of bulbs for lighting. LEDs increasingly are being purchased to replace traditional bulbs. LEDs are relatively more expensive than other types of bulbs, but are very cost-effective because they use only a fraction of electricity of traditional lighting methods nd can last for longer.

Benchmarking guides decision makers to policies aimed at the energy sector through better understanding of energy consumption trends nationwide, e.g.: energy price, moderating, peak demand, and encouraging sectors, low energy expansions.

The “Improving Energy Efficiency Project of Lighting and Appliances” carried out energy audits and implemented opportunities of energy saving in lighting for different type of public buildings.

To rationalize the use of energy by giving guidelines to consumers, the IEEL&A project prepared some brochures.

This paper leads with the results of case studies as energy audits, opportunities in lighting systems, energy saving and CO2 reduction.

I. INTRODUCTION

Improving Energy Efficiency of Lighting and Building Appliances (IEEL&A) project was initiated by the Global Environmental Facility and the United Nations Developmental Program (GEF-UNDP), in conjunction with the Ministry of Electricity and Renewable Energy (MOERE), intends to publish the use of energy efficient lighting by making energy audits for public buildings and increase the awareness on the benefits of using new lighting technologies as LED.

Lighting consumes a considerable share of the total electricity consumption in Egypt, and it was identified as one of the main factors of the system peak consumption. In response, the Egyptian Ministry of Electricity and Renewable Energy (MOERE) has encouraged the use of LED on the domestic, commercial and industrial levels, as energy saving lamps, to reduce lighting consumption. LEDs are energy efficient as they consume 85% less electricity than the incandescent lamps, which are widely used in Egypt.

Lighting systems provide many options for cost-effective energy saving with no or low inconvenience.

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Lighting improvements are excellent investments in most of public buildings which make very good savings in electricity consumption.

The challenge is to retrofit traditional lamps with LED lamps of good quality.

II. LED LIGHTING

The Light-Emitting Diode (LED) is one of today's most energy-efficient and rapidly developing lighting technologies. Quality LED light bulbs last longer, are more durable and offer comparable or better light quality than other types of lighting, also LEDs are safe on environment as they don't contain mercury in its components.

The Light-Emitting Diode (LED) is an electronic component made from semiconductors and emits light without lost energy in heat. It is a highly energy efficient lighting technology, as it uses at least 75% less energy than traditional lamps, and lasts 25 times longer than incandescent lighting lamps. It is very different from other lighting sources such as incandescent bulbs and Compact Fluorescent Lamps (CFLs), because of many key differences include the following:

- Long lifetime - LED s' can last up to 50,000 hours.
- Rugged – LED's are also called (Solid State Lighting "SSL") as they are made of solid material with no filament or tube or bulb to break.
- No warm-up period - LED's light instantly – in nanoseconds.
- Directional – with LED's you can direct the light where you want, thus no light is wasted.
- Excellent Color Rendering - LED's do not wash out colors like other light sources such as fluorescents, making them perfect for displays and retail applications.
- Environmentally friendly - LED's contain no mercury or other hazardous substances.
- Controllable - LED's can be controlled for brightness and color using dimmers.

Table (1): Summarizes features for LEDs, incandescent and CFL lamps.

Table (2): Represents wattage comparison between LEDs, incandescent and CFL lamps.

Table (3): Represents the comparison between LEDs, incandescent and CFL lamps for efficiency and Color Rendering Index (CRI).

Table 1. Features for different types of lamps

Feature	Light Emitting Diodes (LEDs)	Incandescent Light Bulbs	Compact Fluorescents (CFLs)
Life Span (Hours)	Typically above 50,000	1,000 – 2,000	8,000 – 10,000
Wattage (equivalent to 60 W Incandescent bulb)	6 – 8 W	60 W	13 – 15 W
Temperature Sensitivity	None	Yes, Somewhat	Yes
Sensitive to humidity	No	Yes, Somewhat	Yes
Switching On/Off Quickly	No Effect	Yes, Somewhat	Yes – lifespan can reduce drastically
Turns on instantly	Yes	Yes	No – takes time to warm up
Durability	Durable – can handle jarring and bumping	Glass or filament are fragile	Glass can break easily
Toxic Mercury	No	No	Yes

Table 2. Wattage comparison between incandescent, CFL and LED lamps

Incandescent / Halogen	**CFLs**	**LEDs**
40-60	12-15	5-8
60-75	15-18	7-10
75-100	18-23	10-15
100-150	23-35	15-20
150-200	35-45	20-25
200-250	45-60	25-30

Table 3. Comparison between incandescent/Halogen, CFL and LED lamps in regards to efficacy and CRI

Incandescent / Halogen	**CFLs**	**LEDs**
Efficacy: 15-25 Lm/W	Efficacy: 40-70 Lm/W	Efficacy: 60-140 Lm/W
CRI: 98-100	CRI: 60-90	70-95

A. DISADVANTAGES OF LED

LED's are currently more expensive on the initial capital cost basis than other conventional lighting technologies.

LED performance largely depends on correctly engineering the fixture to manage the heat generated

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by the LED. Over-driving the LED or not engineering the product to manage heat in high temperatures may result in overheating of the LED package, eventually leading to device failure. Heat sinking is required to maintain long life.

III. ENERGY AUDIT

The energy audit is the first and fundamental step for any organization, irrespective of type (Public Administration, Private company), size (SME, large organization) and sectors (commercial, industrial, residential), striving to reduce energy consumption and improve its energy efficiency. The implementation of the actions identified in the energy audit will generate values to the Customer (cost saving) and related environmental benefits. Fig (1) Describes the steps of an energy audit process.

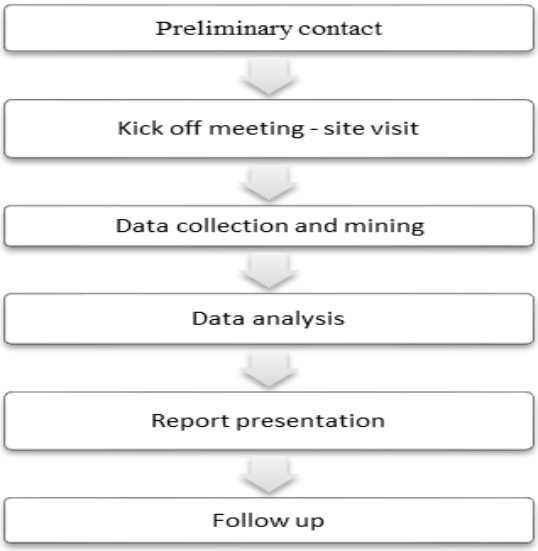

Fig .1. STEPS OF ENERGY AUDIT PROCESS

1. Final Report of energy audits:

The final report of the energy audit has to include all the key elements of the energy audit as below:

- Executive summary.
- Aim, scope and boundaries of the audited object.
- Baseline energy flow and adjustment factors.
- Criteria for ranking the improving energy efficiency opportunities.
- Assumptions made
- Proposed recommendations and action plan.
- Expected benefits.
- Technical, economic and financial analysis.
- The measurement and verification method.

2. BENCHMARKING AS THE BELOW IMPORTANT FACTORS

- Building Energy Index (BEI) (in Kwh/m2/year)
- Load factor
- Power factor
- Lighting Power Density (LPD) (in W/m2)

Depending on the values of those factors, the energy conservation potential is determined

IV. CASE STUDY

“Improving Energy Efficiency Project” has intended to provide technical aid as energy audits by qualified electrical engineers for more than 60 project and financial participation of replacing all the lighting systems for 17 buildings to the LED lighting technology systems.

Due to the success of those projects and the savings were recorded and notable, there are more cooperation with other parties to implement a set of pilot projects in different sectors and below is a detailed table of pilot projects that have been already implemented by the project:

Table 3. RESULTS OF CASE STUDIES

Places have been totally changed to LED	Number of LED lamps	Initial investment (EGP)	Yearly energy saving (kwh)	Lighting energy saving (%)	Yearly energy saving (EGP)	Payback period (year)
Public Building (1)	1,740	183,460	158,755	75%	57,946	3.2
Public Building (2)	1,018	91,351	109,433	75%	40,052	2.3
Public Building (3)	2,540	133,215	116,312	75%	42,570	3.1
Hotel (1)	8,312	942,181	1,804,998	81%	828,609	1.2
Hotel (2)	24,304	3,378,948	4,769,556	80%	2,527,865	1.3
Public Building (4)	1,753	346,000	229,520	90%	119,307	3
Public Building (5)	3,600	213,905	231,922	77%	70,672	3.4
Public Building (6)	2,295	134,930	128,824	66%	47,149	3
Public Building (7)	474	31,224	27,358	80%	10,013	2.2
Public Building (8)	9,477	528,011	364,984	65%	195,432	3
Public Building (9)	3,328	252,446	325,339	80%	119,074	2
Bank (1)	5,280	231,792	73,333	82%	627,216	0.4
Bank (2)	1,601	235,251	312,136	77%	206,010	1.1
Commercial Store	3,940	289,322	396,617	72%	187,698	1.5
Public Building (10)	100	275,220	48,904	76%	26,897	3
Public Building (11)	2,991	328,669	693,636	80%	457,800	0.7
Public Building (1)	3,290	781,631	635,543	75%	400,681	2
Total	76,043	8,377,556	10,427,170		5,964,991	

V. CONCLUSION

The Egyptian market is shifting toward energy-saving lighting projects and many pilot projects were implemented by "Improving Energy Efficiency Project" and supported by the Ministry of Electricity and Renewable Energy. The project intended to provide technical aid as energy audits by qualified electrical engineers for more than 60 project and financial participation of replacing all the lighting systems for 17 buildings to the LED lighting technology systems with a total number of 76,043 changed bulbs of different types and capabilities to the LED bulbs with a total investment 8.3 million Egyptian Pounds worth of energy savings of 10 million Kilowatt hours per year with a value of saving about 5 million pounds per year.

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