

ESTIMATION OF LIGHTING COST AND ENERGY SAVED FROM LED (LIGHT EMMITING DIODE) BULBS

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ABSTRACT

This study presents the calculation and evaluation of the cost and energy saved when we switch from other forms of lamps (Incandescent bulbs and Compact Fluorescent Lamps) to LED (Light Emitting Diode) bulbs. The result and conclusion is based on observations and calculations from six buildings in Akanu Ibiam Federal Polytechnic Unwana, Afikpo, Ebonyi State. Among the buildings investigated are: (i) Old Lecture Theater (ii) Complex building (iii) Engineering Hall (iv) IBB Block B (v) IBB Block E (vi) IBB Block F. The initial cost of purchasing the incandescent bulbs in each of the building is about 15% the cost of purchasing light emitting diode bulbs. This initial cost is one off and cost effective as the estimated run hour for the incandescent bulb is about 1200hours against 25000hours for the light emitting diodes.

1. INTRODUCTION

Energy is essential to all human activities and critical to social and economic development. It is one of the many important inputs for production, conversion, processing and commercialization in all sectors.

Lighting or illumination is the deliberate use of light to achieve a practical or aesthetic effect. In general, lighting is a notable global energy consumer, and as such, the measures for reducing the cost and energy consumption of lighting are effective and appropriate. It is generally recognized that energy, including electricity, plays a significant role in the economic development of a country and enhances the productivity of the nation when inputs such as capital and labor are considered.

2. BACKGROUND OF THE STUDY

In the world today, electricity is the most widely used and desirable form of energy (Oyedepo, 2012). It is the bedrock, indispensable driving force and essential ingredient as well as a basic requirement for socio-economic growth and development (Oyedepo, 2012; Onakoya *et al.*, 2014; Oyedepo *et al.*, 2015).

There is hardly any aspect of modern life that does not have the imprint of electricity input. Be it entertainment, recreation, agriculture, commerce, industry, transport, education, communication, health, architecture and many others (Unachukwu *etal.*, 2015). However, high electricity consumption is a key issue facing all sectors of any economy worldwide and Nigeria is not exempted from the issue of high electricity demand (Ubani, 2013).

Nwachukwu *et al.* (2014) and Abimbola *et al.*, (2015) pointed out that the persistent electricity problems in Nigeria is not caused only by low generating capacity, but attributable mostly to the inability of energy planners to accurately forecast the determinants of the dynamics of electricity consumption in Nigeria. They noted that, without a doubt, the challenges of

electricity affordability, security and the sustenance of available electricity resources in Nigeria require more accurate estimates of key electricity demand parameters. In addition, knowing how much electricity is used and data on electricity consumption characteristics in various sectors of Nigeria economy are the way forward (Oyedepo, 2012a, 2012b, 2014; Unachukwu *et al.*, 2015).

Residential buildings consume about 41% of energy more than other broad sectors. About 70% of energy usage in residential buildings is in the form of electricity.

In Nigeria, most homes still make use of incandescent bulbs which are less efficient (about 90% of the energy goes to heat with only 10% towards light). This is a disaster when compared to more developed countries like the United States of America who as a result of a federal rule since 2014 no longer manufactures or import incandescent bulbs.

A LED (Light Emitting Diode) lamp is an electric light or light bulb for use in light fixtures that produces light using light-emitting diodes (LEDs). LED lamps have a lifespan and electrical efficiency which are several times greater than incandescent lamps, and are significantly more efficient than most fluorescent lamps (Greenamerica, 2016). Energy-efficient bulbs (LED Bulbs) cost more than incandescent bulbs and compact fluorescent lamps but last much longer and save energy costs in the long-term.

3. METHODOLOGY

The basis of this study is to estimate how much cost and energy we can save in the country if we phase out the importation of other forms of lighting sources (e.g., Incandescent light bulbs and compact fluorescent lamps (CFLs)) and replace them with cost effective and energy saving LED bulbs. The implications of global warming are also another aspect of consideration for replacing the other lighting sources with the more environment friendly LED lamps.

The survey was carried out at Akanu Ibiam Federal Polytechnic Unwana, Afikpo in Ebonyi State. General buildings within the school with mostly incandescent light bulbs and compact fluorescent lamps (CFLs) were selected.

The total number of light points in each building was counted, the energy consumed per hour for each lighting source type was estimated and the cost of energy consumed in running the different lighting sources were estimated.

4. DATA COLLECTION

5. Table I: Estimated cost of bulbs

BULB	ESTIMATED COST (NAIRA)	ESTIMATED DURATION(HOURS)	WATTAGE
LEDs	1000	25000	10
CFLs	350	8000	14
Incandescents	150	1200	60

Table 2: Cost of electricity within Enugu Disco

BUILDING TYPE	RATE PER KILOWATT HOUR (NAIRA)	AMOUNT OF 1000 UNITS (NAIRA)
Bungalow or flat with single phase	27.13	27130
Bungalow or flat with triple phase	27-13	27130
Mini bungalow or Estate with a 500kv transformer	45.40	45400
Large bungalow or Estate with dedicated transformer	43.19	43190

Table 3: Surveyed building showing estimated cost of lighting with different lamps

Name of Building	Total number of lamp points	Cost of purchasing bulbs (Naira)		
		Incandescent	CFL	LEDS
Old Lecture Theater	137	20550	47950	137000
Complex	178	26700	62300	178000
Engine Hall	113	16950	39550	113000
IBB Block B	149	22350	52150	149000
IBB Block E	67	10050	23450	67000
IBB Block F	77	11550	26950	77000

6. DATA ANALYSIS

Contrary to common belief, wattage isn't an indication of brightness, but a measurement of how much energy the bulb draws. European Union legislation in September 2010 came into force mandating that lighting equipment must be labeled primarily in terms of luminous flux (lm), instead of electric power (W) (NPL, 2010). The table below shows comparison of bulbs in wattage and lumens.

Light Output	LEDs	CFLs	Incandescents
Lumens	Watts		
450	4 – 5	8 – 12	40
500 – 900	6 – 8	13 – 18	60
1100 – 1300	9 – 13	18 – 22	75 – 100
1600 – 1800	16 – 20	23 – 30	100
2600 – 2800	25 – 38	30 – 35	150

Table 4: Comparison of Lamps by wattage

7. GENERAL WORKING HOUR RULES IN AKANU IBIAM FEDERAL POLYTECHNIC UNWANA

Offices in Akanu Ibiyam Federal Polytechnic, Unwana open 8am and closes 4pm (bulbs inside office are on for 8hrs/day, off during weekend amounting to 40hours/week and 160 hours/month).

Security lights are on between 6pm-7am (security lights are on for 13hrs/day including weekend which amounts to 390 hours/month).

Library, Classroom (complex), Engineering Hall and Corridor lights are on all day (24hrs including weekend which amounts to 720 hours/month).

8. ESTIMATED WATTAGE USED BY LIGHT BULBS

Incandescent Bulb

A typical incandescent bulb is 60W (0.06kW).

Office: $0.06\text{kW} \times 160\text{hrs} = 9.6\text{kWhr/month}$

Security Light: $0.06\text{kW} \times 390\text{hrs} = 23.4\text{kWhr/month}$

Corridor: $0.06\text{kW} \times 720\text{hrs} = 43.2\text{kWhr/month}$

CFL Bulb

A typical CFL with intensity equivalent to a 60W incandescent bulb is 13W (0.013kW).

Office: $0.013\text{kW} \times 160\text{hrs} = 2.08\text{kWhr/month}$

Security Light: $0.013\text{kW} \times 390\text{hrs} = 5.07\text{kWhr/month}$

Corridor: $0.013\text{kW} \times 720\text{hrs} = 9.36\text{kWhr/month}$

LED Bulb

A typical LED with intensity equivalent to a 60W incandescent bulb is 7W (0.007kW).

Office: $0.007\text{kW} \times 160\text{hrs} = 1.12\text{kWhr/month}$

Security Light: $0.007\text{kW} \times 390\text{hrs} = 2.73\text{kWhr/month}$

Corridor: $0.007\text{kW} \times 720\text{hrs} = 5.04\text{kWhr/month}$

Cost per kilowatt hour in Ebonyi State (Enugu Disco)

Rate per kilowatt hour (R4) = ₦43.19

Amount based on 1,000 units = ₦43,190

Incandescent Bulb = ₦2.59 per hour

CFL Bulb = ₦0.56 per hour

LED Bulb = ₦0.30 per hour

9. ESTIMATED COST OF LIGHTING EACH BUILDING IN A MONTH WITH DIFFERENT LAMPS

Old Lecture Theater

Rooms in Building	Number of bulbs	Duration each bulb is on (hours)	Total time bulbs are on(hours)	Cost of Running bulb		
				Incandescent bulb(₦)	CFL (₦)	LED (₦)
General Hall	89	160	14240	36881.60	7974.40	4272.00
Alumni Office	3	160	480	1243.20	283.20	144.00
Stores	6	160	960	2486.40	566.40	288.00
Corridor	5	720	3600	9324.00	2124.00	1080.00
Lobby	16	390	6240	16161.60	3681.60	1872.00
Security	16	390	6240	16161.60	3681.60	1872.00
Toilet	2	160	320	828.80	188.80	96.00
Total	137	2140	32080	83087.20	18500.00	9624.00

Complex Building

Rooms in Building	Number of bulbs	Duration each bulb is on (hours)	Total time bulbs are on(hours)	Cost of Running bulb		
				Incandescent bulb(₦)	CFL (₦)	LED (₦)
Complex A	15	720	10800	27972.00	6048.00	3240.00
Complex B	15	720	10800	27972.00	6048.00	3240.00
Complex C	14	720	10080	26107.20	5644.80	3024.00
Complex D	15	720	10800	27972.00	6048.00	3240.00
Complex E	15	720	10800	27972.00	6048.00	3240.00
Complex F	15	720	10800	27972.00	6048.00	3240.00
ComplexG	12	720	8640	22377.60	4838.40	2592.00
Complex H	14	720	10080	26107.20	5644.80	3024.00
Complex I	15	720	10800	27972.00	6048.00	3240.00
Complex J	15	720	10800	27972.00	6048.00	3240.00
Corridor	19	720	13680	35431.20	7660.80	4104.00
Security	3	390	1170	3030.30	655.20	351.00
Total	178	8640	109170	311421.60	61135.20	35775.00

Engineering Hall

Rooms in Building	Number of bulbs	Duration each bulb is on (hours)	Total time bulbs are on(hours)	Cost of Running bulb		
				Incandescent bulb(₦)	CFL (₦)	LED (₦)
Hall A	21	720	15120	39160.80	8467.20	4536.00
Hall B	36	720	25920	67132.80	14515.20	7776.00
Hall C	45	720	32400	83916.00	18144.00	9720.00
Corridor	11	720	7920	20512.80	4435.20	2376.00
Total	113	2880	81360	210722.40	45561.60	24408.00

IBB Block B

Rooms in Building	Number of bulbs	Duration each bulb is on (hours)	Total time bulbs are on(hours)	Cost of Running bulb		
				Incandescent bulb(₦)	CFL (₦)	LED (₦)
Office	57	160	9120	23620.80	5107.20	2736.00
Laboratory	56	160	8960	23206.40	5017.60	2688.00
Corridor	15	720	10800	27972.00	6048.00	3240.00
Store	12	160	1920	4972.80	1075.20	576.00
Security	9	390	3510	9090.90	1965.60	1053.00
Total	149	1590	34310	88862.90	19213.60	10293.00

IBB Block E

Rooms in Building	Number of bulbs	Duration each bulb is on (hours)	Total time bulbs are on(hours)	Cost of Running bulb		
				Incandescent bulb(₦)	CFL (₦)	LED (₦)
Library	4	720	2880	7459.20	1612.80	864.00
Office	23	160	3680	9531.20	2060.80	1104.00
Laboratory	18	160	2880	7459.20	1612.80	864.00
Measurement room	11	160	1760	4558.40	985.60	528.00
Store	2	160	320	828.80	179.20	96.00
Corridor	4	720	2880	7459.20	1612.80	864.00
Toilet	1	160	160	414.40	89.60	48.00
Security	4	390	1560	4040.40	873.60	468.00
Total	67	2630	16120	41750.80	9027.20	4836.00

IBB Block F

Rooms in Building	Number of bulbs	Duration each bulb is on (hours)	Total time bulbs are on(hours)	Cost of Running bulb		
				Incandescent bulb(₦)	CFL (₦)	LED (₦)
Office	26	160	4160	10774.40	2329.60	1248.00
Corridor	51	720	36720	95104.80	20563.20	11016.00
Total	77	880	40880	105879.20	22892.80	12264.00

10. RESULTS AND DISCUSSION

This study aimed to investigate the amount of energy that could be saved if households switch from incandescent bulbs and compact filament light bulbs to light emitting diode bulbs.

From the charts above, it is clearly observed that the cost of running all light points on light emitting diodes is much cheaper than the compact fluorescent and incandescent bulbs respectively. In most cases, it costs about 11.5% of the cost of running on incandescent bulbs to run on light emitting diodes.

However, the initial cost of purchasing the incandescent bulbs in each of the building is about 15% the cost of purchasing light emitting diode bulbs. This initial cost is one off and cost effective as the estimated run hour for the incandescent bulb is about 1200hours against 25000hours for the light emitting diodes.

What this implies is that about 21 incandescent bulbs will be required for a light point against 1 light emitting diode bulb. Hence, the cost of using incandescent bulbs for a light point is ₦3150 against ₦1050 for a light emitting diode bulb.

The analysis above clearly indicates that the light emitting diode bulbs are cost effective for long term use-which is clearly the need of the polytechnic

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