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Application of LED Type Lamps in Domestic and Public Utilities and Gain Capability to Run New Small Investments in Rwanda

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ABSTRACT

The Rwandan State-run Energy Water and Sanitation Authority Company (EWSA) is rapidly increasing the number of population having access to electrical power energy. 30% of electrical energy is used in lighting. The incandescent bulbs, compact fluorescent lamp bulbs as well as fluorescent tubes are mostly used to convert electrical energy into light. The said light sources have many disadvantages such as excessive power consumption leading to giant bills of electricity, short life span leading to continuous replacement of lamps, and emission of CO_2. Application of light-emitting diode (LED) lamps in lighting in long term suppresses the aforementioned problems resulting into saving of money that will be used for running new small investments.

Keywords: LEDs Lamps; Lighting Systems in Domestic and Public Utility Building; Small Investments

1. Introduction

The electrical energy is a pillar of development in all countries all over the world, thus Rwanda government is pressurizing the State-run Energy Water and Sanitation Authority (EWSA) to augment the power generation capacity and the number of population accessing electrical energy. At home and in public utilities, 30% electricity is used for lighting. The luminous intensity varies with areas to be lighted up and the work to be performed in the area. Therefore, the manufacturers have a task to design lamps in different shapes and wattages aiming at meeting the requirements from different users.

Due to different manufacturing technologies, some lamps are source of greenhouse gases emitted in the atmosphere. Incandescent lamps are mostly concerned by this issue as they contain mercury substance [1]. This leads to various diseases, problems of respiratory system of human being, etc.

Incandescent bulbs and fluorescent tubes consume too much power, leading to monthly huge bill of electricity. When the electricity customers are not able to pay the consumed electrical energy whereas they still need it for the next month, they pass by the electrical power-meter and steal the energy. If this case is not identified, there is a big loss in terms of money for electrical energy Distribution Company; if the case is identified, the customers using electrical energy in illegal way pay too much money for penalties.

Like Incandescent bulb and fluorescent tube, compact fluorescent lamp (CFL) has short life expectancy; as a consequence all these three types of light source acquire regular replacement due to short life span.

Giant monthly bill of electrical energy in combination with regular cost of regular replacement of lamps puts a curb on the new investments to all users of Incandescent lamps (IL); Compact Fluorescent Lamps (CFL) as well as fluorescent tubes (FT). Light Emitting Diode lamps (LED lamps) possess longer life span estimated at 50,000 hours and are free from greenhouse gas emission [1,2]. These new modern lamps are available on market in various shapes and wattages depending on the needs of users. LED lamps are very efficient, with the same electrical energy consumption as the lamps described in previous paragraph; the former lamps output the greater luminous power.

2. Techno-Economical Comparison between LEDs, CFLs and Incandescent Light Bulbs

In Rwanda, incandescent bulbs have been being used since 1959 with the arrival of electrical power generation

in Rwanda [3]. They relatively have low price compared to CFL and fluorescent tubes, but they consume too much electric power and generate heat. The light emitted by the incandescent lamps is not white, thus it can be harmful to human being eyes when they are installed in the reading rooms. For better white light close to day-sun-light, fluorescent lamps replace the incandescent lamps. The fluorescent lamps are dominant in public utilities. With evolution of light source technologies, compact fluorescent lamps (CFL) are the 3rd type of light sources used in Rwanda; nowadays is dominating the incandescent bulbs and fluorescent tubes in domestic houses. CFLs are considered as electrical energy saving lamps, their wattage ranges between 8 W and 40 W. As incandescent lamps, CFLs have limited life span leading to regular replacement of these lamps. The **Table 1** illustrates the difference between LEDs, CFL, Incandescent bulbs based on life expectance, input power and cost of one lamp of each type. CFL ranging between 11 W and 18 W, Philips brand is considered in this paper. It has a projected life span of 10,000 hours when it is used in domestic activities and costs 2500 Rwandan francs (Rwf) equivalent to 3.965 United states dollar (USD), calculated using data from the website of national bank of Rwanda, 1 USD = 630.602 Rwf [4].

The **Table 2** illustrates the energy consumed and compares electricity bill payment when incandescent; CFL and LED types are used over a period of 50,000 hours in electrical circuit containing only one lamp. The price of 1 kWh equals 0.25USD in low voltage net work [5].

Table 3 shows that the type of lamps with shorter life span needs regular replacement leading to a huge number of lamps for long term of use. **Table 4** shows the total expenses to running a lighting system of only one lamp for three different types over a period of 50,000 hours. **Table 5** shows the projected savings if and only if LED bulbs are used for lighting instead of using incandescent or CFL.

Table 1. LED, CFL and incandescent lamps comparison based on life expectancy, input power and price.

	LED	CFL	Incandescent
Lifespan	50,000 hours	10,000 hours	1200 hours
Watts/bulb for same luminous power output	10 W	14 W	60 W
Cost per bulb	35.95 USD	4.03 USD	1 USD

Table 2. Comparison based on energy consumption and electricity bill.

	LED	CFL	Incandescent lamp
Lifespan	50,000 hours	10,000 hours	1200 hours
Input power/bulb for same luminous power output	10 W	14 W	60 W
Electrical energy over 50,000 hours	500 kWh	700 kWh	3000 kWh
Electricity bill over 50,000 hours	127.5 USD	178.5 USD	765 USD
Extra money paid if LEDs are not used	0	51 USD	637.5 USD

Table 3. Comparison based on replacement of lamps and maintenance.

	LED	CFL	Incandescent
Number of lamps used in period of 50,000 hours	1	5	42
Cost of lamps over 50,000 hours	35.95 USD	20	42

Table 4. Total expenses for running lighting system of one lamp over 50,000 hours.

	LED	CFL	Incandescent
Cost of lamps	35.95 USD	20 USD	42 USD
Cost of electricity over 50,000 hours	127.5 USD	178.5 USD	765 USD
Total expenses over 50,000 hours	163.45 USD	198.5 USD	907 USD

From **Table 5**, it is seen that the savings increase with the number of bulbs installed in domestic or public utility. Another factor that affects the saving is the time, longer period of time of using LED bulbs leads to important augmentation of savings.

The LED bulbs will replace the incandescent and CFL without changing the existent electrical installation and wiring, the brightness measured in lumen must remain unchanged. The **Table 6** illustrates the equivalence in lumen output from different bulbs and for different input power.

3. LED Tube Lights to Replace Conventional Fluorescent Tube

Designed to replace fluorescent tube, LED tubes are available in 8 and 23 watts, which replace conventional 25-watt and 40-watt T8/T10/T12 fluorescent tubes. T-8 LED Tubes are Ideal for Fluorescent replacement and have many advantages over Fluorescent Tubes. LED based light sources, are environmentally friendly and a much longer life than Fluorescent tube. In addition, T-8 LED Tube produces a wonderful pure white light, colors brighter and viewing is easier on the eyes than with conventional fluorescent tubes [6]. **Table 7** shows the advantages of T-8 LED tube compared to conventional fluorescent tube. **Table 8** illustrates the total saving over 25 years in domestic house and public utility containing more than one lamp.

4. Conclusion

LED lamps replace incandescent, CFL and fluorescent tube without changing the electrical installation [7]. If LED bulbs replace incandescent lamp for a period of 50,000 hours, there would be a saving of 743.35 USD. The replacement of CFL by LED lamps during a period of 50,000 hours, there would be a saving of 35.05 USD. When fluorescent tube is replaced by LED tube for a period of 40,000 hours, the saving is estimated at 61 USD. Domestic and public utilities have more than one luminaire; therefore, the saving is multiplied by the

Table 5. Savings when LED bulbs are used in lighting circuits.

	Expenses	**Saving if LED lamp is used in place of incandescent or CFL**
Incandescent lamp	907 USD	743.35 USD
CFL	198 USD	35.05 USD
LED	163.45 USD	

Table 6. Illumination equivalence of IL, CFL and LED bulbs [5].

Light output in Lumens	Electrical power input in watt (W)		
	LEDs	CFL	Incandescent lamps
450	4 - 5	8 - 12	40
300 - 900	6 - 8	13 - 18	60
1100 - 1300	9 - 13	18 - 22	75 - 100
1600 - 1800	16 - 20	23 - 30	100
2600 - 2800	25 - 28	30 - 55	150

Table 7. Comparison of LED and conventional fluorescent tubes.

	LED tube	Fluorescent tube
Energy consumption	18 W	40 W
Life expectancy	40,000 hours	8000 hours
Cost of tube	65 USD	6 USD
Cost of tube replacement over 40,000 hours	0 USD	3000 USD
Energy cost over 40,000 hours	92 USD	182,000 USD
Total expense over 40,000 hours	157 USD	218 USD

Table 8. Saving for a whole domestic or public utility.

	Type of lamp to be replaced by LED	Location	Number of lamps	Utilization period (hours/day)	Hours/years	Lifespan in years	Saving in 25 years (all lamps in use)	Saving per building in 25 years
Domestic	IL	Indoor	10	6	2190	22.8	8150.77 USD	13831.67 USD
		Outdoor	3	14	5100	9.8	5680.90 USD	
	CFL	Indoor	10	6	2190	22.8	384.32 USD	652.56 USD
		Outdoor	3	14	5100	9.8	268.24 USD	
Public utility	FT	Indoor	100	8	2920	13.7	11131.39 USD	16019.19 USD
		Outdoor	25	14	5100	7.8	4.887.8 USD	

number of luminaires installed in the concerned area. Another factor affecting the saving is time. At long period of using LED type lamps result in considerable saving that would be used for running new small investments.

REFERENCES

[1] D. Silverman, "Comparing CO_2 Pollution Using Heat from Incandescent Light Bulbs versus a Gas Heater," 2012. http://sites.uci.edu/energyobserver/2012/01/10/comparing-co2-pollution-using-heat-from-incandescent-light-bulbs-versus-a-gas-heater/

[2] M. Yamada and D. Chwastyk, "Adoption of Light-Emitting Diodes in Common Lighting Applications," Solid-State Lighting Program Building Technologies Office of Energy Efficiency and Renewable Energy, US Department of Energy, 2013, pp. 9-16.

[3] H. Hove and J.-E. Parry, "Maintenance of Hydropower Potential in Rwanda through Ecosystem Restoration," World Resources Report, Washington DC, 2010.

[4] National Bank of Rwanda, "Exchange Rates in Rwanda," 2013. http://41.74.165.238:8081/exchangerates.aspx

[5] Eartheasy Solutions for Sustainable living, "LED light bulbs: Comparison Chats," 2013. http://eartheasy.com/live_led_bulbs_comparison.html

[6] M. A. Myer, M. L. Paget and R. D. Lingard, "Performance of T12 and T8 Fluorescent Lamps and Troffers and LED Linear Replacement Lamps," Pacific Northwest National Laboratory Richland, Washington, 2009, pp. 2-7.

[7] ABS Consulting, "Report on the Trial of an LED Lighting Installation at the Sherfield Building for Imperial College London," 2010, pp. 4-7.

