Reducing the Cost of Home Lighting in Remote or Rural Community in Developing Nations

Ajibodu F. A

Ojo B. A

Electrical Department Federal Polytechnic Ilaro

DOI: 10.29322/IJSRP.9.04.2019.p8888
http://dx.doi.org/10.29322/IJSRP.9.04.2019.p8888

Abstract: *Home lighting is required to provide illumination when the environment is dark. Incandescent bulb has been a common device used to provide illumination, but needs to be powered by an alternating current (AC). This paper compares the benefit of using direct current (DC) devices to provide illumination than AC devices and hence reduces the cost of home lightning. A model was developed based on basic home lighting need in a developing community in Nigeria Ilaro. The study shows that using DC devices like LED light will reduce the cost, lower power requirement and also present a greater life span for the lightning devices and this can also by extension be used to reduce cost of lightning in urban settings.*

Keywords: *Alternating current (AC), Direct Current (DC), Lighting devices Light emitting Diode (LED).*

Introduction

Home lighting system is the illumination of the home using a source of light such as incandescent bulb or other source of lightning [1]. Typical, in rural area setting or remote location availability to electricity source is inadequate or not accessible [11]. The use of renewable source then suffix as the best alternative in this settings [12]. Sometimes when electricity supply is available its tariff is too expensive to make it accessible [13]. A lightning bulb operate by the heating of a filament to produce light been enclosed in a transparent glass, each of the bulb requires electricity to be energized. [2], The higher the wattage the higher the illumination and heat generated by the bulb and also higher power requirement [3]. A Light source is required at home or office to provide Illumination to a building as required in the day or night. This type of bulb uses alternating current (a.c) for its form of power. [4], as energy is neither created nor destroy some of this energy will be converted to light while other will be converted to heat. Currently, Light Emitting Diode (LED) is used in array to provide illumination, the array of LED is powered using direct current (d.c) [5]. As shown in Plate 1. [6]. The LED light generates lesser heat and provide better illumination, [7]. Due to the fact that the energy conversion is more efficient. [8]. A battery can be used as a power source, which in turn, can be charged using a solar panel and by extension can be used in the rural area setting. To this end in this paper a model was develop using the combination of a solar panel, charge controller and an accumulator (Battery)., To provide illumination for a typical Home requirement [9]., as shown in Table 1 and 2.

Plate 1: d.c 5W bulb

Table 1: typical Home Load Analysis d.c Load

S/N	ITEMS	Power	QUANTITY
1	Light Bulb	5W	18
2	12V d.c Fan	5W	2
3	12v project with TV option	7W	1
4.	Phone charging port		1
Total		107 Watt	

Table 2: A.c Load Equivalent

S/N	ITEMS	Power	QUANTITY
1	Light Bulb	15w	18
2	Ceiling Fan	80W	2
3	50 inches Flat screen TV	100W	1
4.	Phone charger	7w	1
Total		202 Watt	

The total wattage for the basic home load on d.c is 107W and 202W for a.c load equivalent as shown in Table 2

DESIGN AND METHODOLOGY

A model was developed as shown in Figure 1

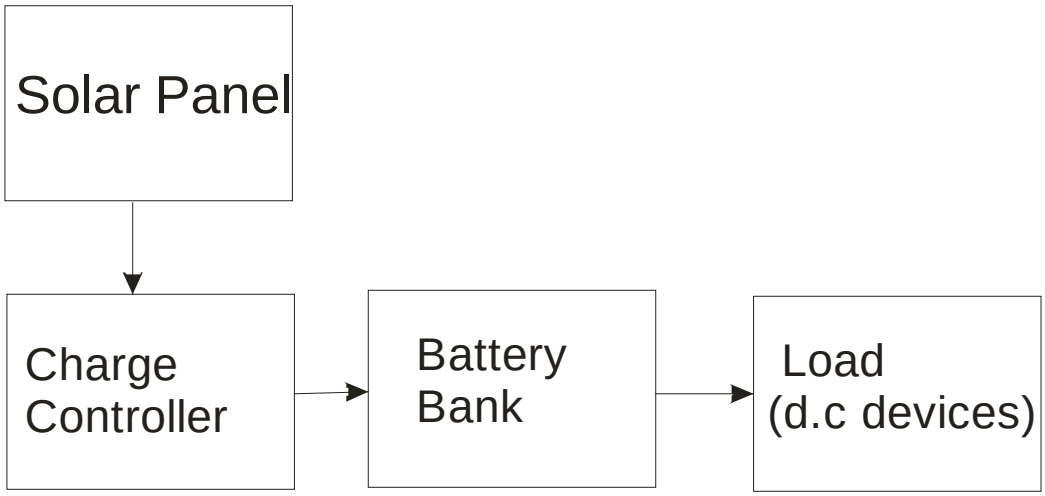

Figure 1: D.C Power system

1. **Solar Panel**:

The solar panel provide d.c power by converting the light ray from the sun to d.c power which in turn is used to charge a battery bank [10].

2. **Charge controller**:

This device compares the voltage on the battery under charge and prevent over charging of the battery.

3. **Battery Bank**

This is an accumulator or set of battery used to store charges during the day when sunlight is available.

4. **Load:**

This is all the load or d.c devices connected to the d.c source.

Table 3: Parameter of Variables

S/N	ITEMS	DESCRIPTION	QUANTITY
1	Solar Panel	24V,200W	1
2	Charge Controller	12/24V 30A	1
3	Battery Bank	12V,200AH	2

Table 3 shows the parameter used in this model to provide illumination to the load described in Table 1. In conjunction with this a distribution box was used to isolate the system from the a.c equivalent circuit and to provide protection in case of short circuit fault or any other fault.

RESULT AND ANALYSIS

Items in table 1 above are the load powered by the electrical output generated by the system. The system can provide continuous power to the unit for 24hrs continuously, for the sake of analysis only the cost for the night duration when there is no sunlight that is 15Hrs will be used. The cost of power to items in table 1 can be evaluated by PHCN rating or the utility company rate. The equivalent load will be considered a.c load and also the d.c equivalent which will focus on the lighting point, according to Table 1., 18unit of 5w d.c bulb is been used to provide illumination for the 15hrs night duration from 6pm to 9am., and considering the cost if a.c equivalent powered bulb is been used to provide illumination over same period, using supply from the utility company or PHCN.

18 unit of 5W bulb will be equal to 90W per hour, hence

Watt consumed by 18 unit of d.c bulb

18 x 5= 90W

Per an hour

For 15 hours;

90W x 15hrs = 1350Watt-hour

In Kilowatt-Hour

1350/1000= 1.3KWh

For a month the total cost of lighting will be

1.3KWh x 30 = 40.5KWh per month

Table 3: Energy charge by utility company (PHCN} per month for domestic lighting Load.

Unit consumed (KWH) = 40.5 per month
Tariff rate (as at June. 2018 by Electricity company) =N=24.97
Hence, energy charge will be (Unit consumed x Tariff rate)
=N=1,011.285

Using the 15hrs duration, Table 3., shows 40.5 units would be used throughout the month by the same lighting load. From the result obtained it can be inferred that system will cost =N=1,011.285 if the utility tariff is used to provide light for domestic use at home or office.

Considering the a.c equivalent of 18 unit of incandescent light bulb or low energy bulb for this calculation.

Let consider a 15W low energy bulb, hence

18unit of 15W bulb will be equal to 270W per hour, hence

Watt consumed by 18 unit of low energy bulb

18 x 15 = 270W Per an hour

For 15 hours;

270W x 15hrs = 4050 Watt-hour

In Kilowatt-Hour;

4050/1000= 4.05KWh

For a month the total cost of lighting will be

4.05KWh x 30 =121.5KWh per month

Table 4: Energy charge by PHCN per month for domestic a.c equivalent lighting Load.

Unit consumed (KWH) = 121.5 per month
Tariff rate (as at June. 2018 by PHCN) =N=24.97
Hence, energy charge will be (Unit consumed x Tariff rate)
=N=3,033.855

Using the 15hrs duration, Table 4., shows 121.5 units would be used throughout the month by the same lighting load, with a cost of =N=3,033.855

From the result obtained it can be inferred that the d.c system has reduced the cost of energy charged paid to PHCN. That is =N=1,011.285 is saved by using the d.c model to provide light for domestic use at home or office, when compared with the a.c equivalent that will cause at minimum wattage of 15W =N=3,033.855

Consider Figure 2, which shows the amount saved by using d.c load in providing lighting for the duration of 15Hrs.

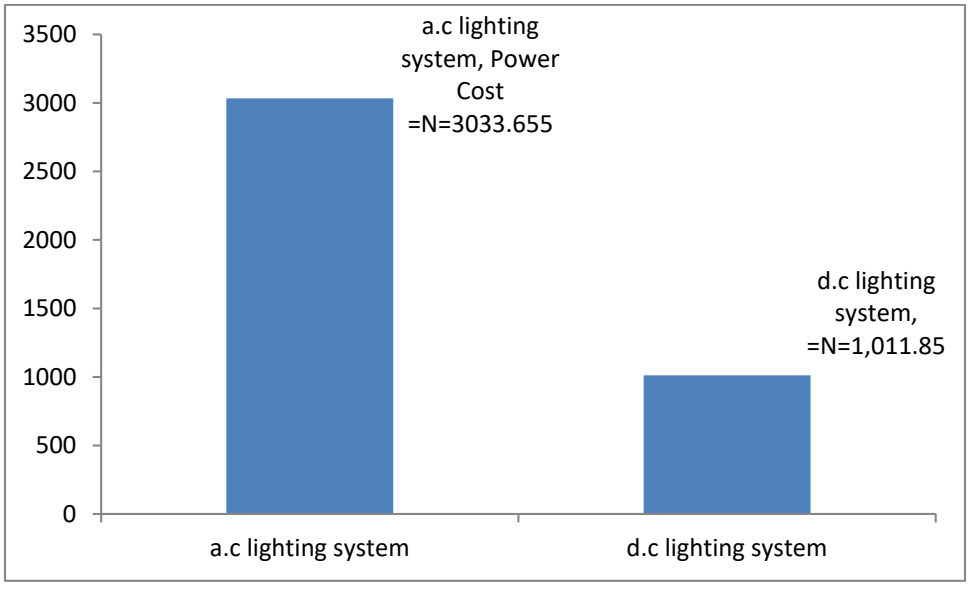

Figure 2: a.c lighting versus d.c lighting cost

From figure 3 we can also infer that 75% savings is achieved when d.c lighting system is used.

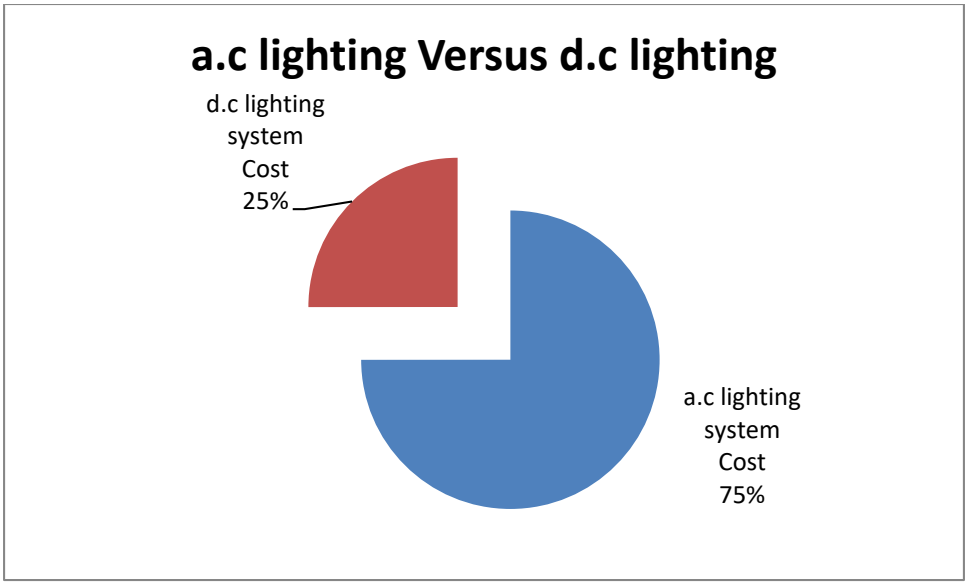

Figure 3: percentage saved by d.c lighting load 75%

Conclusion

The result shows that using DC devices like LED light as used in this study and also adopting the model developed, will reduce the cost, give better illumination, lower power requirement and also present a greater life span for the device.

References

[1] Ramachandran , S Anitha (2005), Sectoral demand of Electricity in Kerala, ISDA Journal, January-

[2] Bye, T. and E. Hope (2005), Deregulation of Electricity Markets – the Norwegian

[3] C.Gunaratne, K.Christensen, S.Suen, and B. Nordman, (2008) "Reducing the Power Consumption of Ethernet with an Adaptive Link Rate (ALR)," IEEE Transactions on Computers, Vol. 57, No. 4, pp.448-461, April 2008.

[4] Olaleye S.O. and Akinbode S.O(2012), “Analysis of Households’ Demand for Alternative Power Supply in Lagos State, Nigeria” Current Research Journal of Social Science 4(2): 121-127, 2012

[5] Gupta, Geetu and Sahu, Naresh Chandra (2009), Causality between Electricity Consumption and house, Journal of Chongqing University (English Edition) [ISSN 1671-8224 Vol. 11

[6] 1indianmart.com (2018). “5W LED Bulb” retrieve from: https://www.indiamart.com/proddetail/5w-led-bulb-15453386688.html

[7] Forster (2010); http://www.ssb.no/publikasjoner/DP/pdf/dp433.pdf

[8] Matsumoto Y, Yanabu, S. (2005) “A vision of an electric power architecture for the next generation”,Electrical Engineering in Japan Vol. 150, Issue 1 , pp. 18 – 25, January 2005.

[9] Vassileva (2012), Characterization of household energy consumption in Sweden Energy savings downloaded 18.08.2018.

[10] Gordon, K. (2008). Energy Efficiency of White LEDs. U.S. Department of Energy; Energy Efficiency and Renewable Energy. Retrieved July 25, 2018, from http://www.netl.doe.gov/ssl

[11] BBC (2018). India says all villages have electricity. Available at: http://www.bbc.com/news/world-asia-india-43946049, accessed on 30-04.-2018.

[12] Dawra,V. (2016). How solar power is turning rural India bright and shining. Available at: https://www.thehindubusinessline.com/specials/how-solar-power-is-turning-rural-india-bright-and-shining/article9277415.ece, accessed on 16-04-2018.

[13] LiveMint (2018).Electricity reached all Indian villages on Saturday. Available at: https://www.livemint.com/Industry/ORuZWrj6czTef21a2dIHGK/Electricity-reached-all-Indian-villages-on-Saturday.html, accessed on 29-04-2018.