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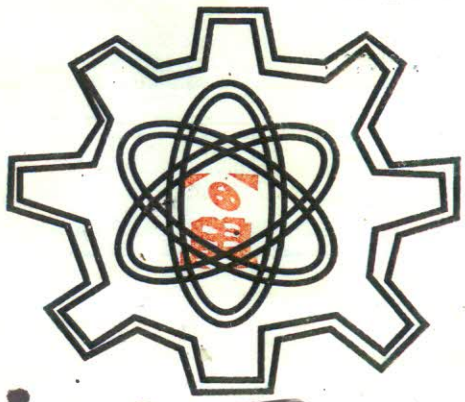

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EVALUATION OF ELECTRICAL ENERGY WASTAGE IN SECONDARY SCHOOLS IN NIGERIA: A CASE STUDY OF GOVERNMENT SECONDARY SCHOOL, MINNA, NIGER STATE,NIGERIA

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ABSTRACT
Energy is an essential factor in production and socio-economics growth, and its availability in sufficient quantity is central to all developmental activities. As a result of this, there is need for prudent management of available electrical power. This paper looks at various ways by which electrical energy is being wasted and the cost implication as a result of this wastage is estimated. Suggestions on how to minimize wastage are provided thus reducing unnecessary expenses. The research conducted at Government Secondary School Minna Compound shows that the average energy wasted per month is 5272.5Kwh or 10.17% of the total energy supplied to the school is wasted. This is roughly 9.58% of the average monthly bill for the energy consumed i.e. ₦ 44, 814.125. This quantity of energy will go a long way to improve the socio-economic standard of life of some families by providing lightning to homes and small industries that require moderate amount of energy.

Keywords: appliances, electrical, energy, wastage, cost

INTRODUCTION
Electrical energy is the most mobile and versatile form of energy. It is directly needed to run our home and industrial appliances and machinery, light, heat and cool our living and work spaces, and for our telecommunications. Other forms of energy sources (coal, oil and gas) are also needed to provide the electricity in the first instance, to run our transportation industry and to directly provide heating wherever needed as well. Their collective good quality and quantity are absolutely essential for national economic and technological development. Until and unless we get all their demand, generation, transmission and distribution/marketing matrix right - all of which should be part of a comprehensive energy policy for the nation - no amount of effort in attracting foreign direct investment into the country will yield the kind of positive results that we want (Aluko, 2004).

The magnitude of the standard of living in any society, the growth and development of any economy and its ability to affect the events is a function of the extent to which its energy resources are developed and utilized (Chifu and Fai, 2007). It is a known fact that one of the greatest problems in Nigeria today is the energy crisis. It has caused ripples in the country's economy and is a major setback in the nation's growth. The fact that the present power generation cannot meet the national demand is not doubt (Ahmed and Oghenejivwe, 2003).This calls for prudent management of the available electrical power. Nigerians should therefore imbibe the culture of energy conservation as being practiced in other parts of the world so that the electricity being generated can be

well managed to serve both residential areas and firms (Makoju, 2008). All electricity appliances should be switched off when not in use (Ukpabio, 2006 and Makoju 2008). The average temperature of Minna is about 36^0 C (Meteorological centre daily report). Therefore the use of air conditioners, fans, refrigerators and other cooling appliances in classroom, hostels, offices and laboratories is necessary. Library, classrooms, and need adequate illumination. As a result of this, Power Holding Company of Nigeria (PHCN) supplied the school with the electricity.

Nigeria's public power company-Power Holding Company of Nigeria has an installed generating capacity of about 6GW but actual available output is less than 2.5GW. Power black-out is frequent. New generation capacity-build-up under the National Integrated Power Project (NIPP) would result in more than 10GW by 2010. Available public capacity is supplemented by private captive generation serving industrial clusters and specific companies in the Cement, Steel and Oil & Gas sectors of the economy. A set of newly licensed independent power producers (IPP) would add more than 10GW if all come on stream before 2010-12. http/;//allafrica.com/stories.

Despite the inadequacy in generation one area people hardly considered is the percentage of this total generation that is being wasted. We are all familiar with the 60-Watt incandescent electric bulb, but for the moment, let us look on the brighter side and consider the 100 Watt bulb, and assume that ten of those (that could light up 5 standard-size living or bedrooms/areas) are turned on 24 hours a day/7 days a week. That will require a 1,000 Watt generating power – or 1 kW or 1 KVA power-generating plant running 24/7, assuming no power losses from the generation point through the transmission line to the delivery site of the bulbs. 10,000 of those 100-Watt bulbs will therefore require a 1 MW power plant. [1 MW = 1,000 kW = 1,000,000 W; 1 W = 1 V x 1 A; V stands for Voltage and A stands for Ampere (a current strength measure). Watts and megawatts are units of power, which, if deployed in time as electricity, produce energy to do electric work. The relevant unit of such energy here is the watt-hr (a watt of power deployed over one hour) or the kWh or the MWh as the case may be.
[1 MWh = 1,000 kWh = 1,000,000 Wh]

1 MW of a power station running 24/7 (assuming 100% efficiency) produces roughly 0.01 billion kWh in one year (calculated from 1000 kW x 24 hrs per day * 365 days per year). That means that a 100 MW power plant – a good standard for sizing such plants - produces about 1 billion kWh (or 1 terawatt-hour) annually. [1 billion = 1,000 Million.] We can now appreciate the damage done when those ten bulbs are left to burn from seven pm to seven am when they are not actually required

METHODOLOGY

All devices that make use of electrical energy in the school were identified, some of these are lightning system (incandescent bulb and florescent tubes), air conditioners, electric fan, and heating devices such as boiling ring/electric kettles and electrical cookers especially students hostels. The ON and OFF periods of lighting systems in classrooms, staffrooms as well as security were monitored at regular intervals between hours of 7 pm and 8 am for a period of 24 months (January 2003 to December 2004). The electricity bill and total electrical energy consumed for the same period were obtained. The use of all electrical appliances in offices, classrooms and hostels was monitored.

Electrical equipment and machines used for practical in the laboratories and workshops were excluded; these include Chemistry, Computer, Physics and Introductory workshop because they are normally used as at when due. Staff quarters are excluded as each occupant pay their bills and responsible for the control of their electrical appliances. The power ratings of all electrical appliances were noted. The term wastage is used to describe the total consumed by electrical appliances which left ON when they were supposed to be put OFF. Attention was focused on common appliances that are easily misused thereby wasting electrical energy (mainly lighting system, fans and air conditioners).

The following assumptions were made to calculate electrical energy wastage

(1) Most of the offices and classrooms do not require additional lighting between hours of 8am and 4pm and between 10pm and 8am(18hours),
(2) Any appliances put ON within this period is regarded as electrical energy wastage, and
(3) Those electrical that appliances were OFF for a period of 10 days in a month as a result of power outage and/or occasional switch off by individual.

Considering the assumptions, energy wasted is calculated in Kilowatt as shown below (Anyakoha, 2007 and Nelkon and.Parker, 1991)

$$W = Pt \qquad (1)$$

Also $W = I^2R$

Where W is the energy consumed in joules (J), I is the current used in ampere, R is the resistance in Ohms, P is the power rating of the electrical appliance in watt (W) and t is the time used in second (s).

In this study P = 40W which is the power rating of the florescent tubes, t is the duration of use of the appliance in second per day which equals 24x60x60 seconds.
Therefore consumption per day is given as in (1), which in a month translate to

$$E_m = ED/1000 \qquad (2),$$

where D is the number of days an appliance is used in a month which is 20 days in a month.
Considering N of such appliances (2), therefore becomes

$$E_N = E_m N \qquad (3)$$

Where N is the number of lighting appliances that were ON when they ought to be OFF.
The cost (C) of energy consumed in Naira is calculated from

$$C = E_N . X \qquad (4),$$

Where X is the cost of energy consumed per KWh. The electricity billing of the school during the period of this work was (₦8) eight naira per unit of electricity.

RESULTS AND DISCUSSION

Table 1 shows the daily average number of good, bad and ON fluorescent tubes at the time of collecting the data, while table 2 shows the actual electrical consumed monthly and bill for the same period of study. Using equations 3 and 4 above, the energy wasted

and corresponding cost were calculated as shown in table 3. The total energy wasted for the period of study is calculated to be 12873.6Kwh which translate to monthly average of 536.4Kwh, the corresponding cost wasted amount to ₦ 102, 988.8; which give an average of ₦ 4, 291.2 per month. Table 2 shows the total energy consumed and the corresponding cost. The energy consumed is 126534Kwh and corresponding cost is ₦1075539. The waste arrived at is of great significance despite several assumptions made.

Electrical energy wastage also has a very great effect on the lifespan of appliance, since every appliance has its service lifespan, hence leaving them ON permanently will definitely reduce their lifespan. Table 1 maintains a steady increase in the number of bad bulbs every month despite constant replacement of the tubes, thus leading on unnecessary waste of fund in replace those appliances. Also any energy wasted by any consumer may deprive others of normal supply.

Table 1: Number of good and bad fluorescent tubes

	Total no of bulbs ON	Total no of good tubes	Total no of bad tubes	% (bad/good)
2003				
January	78	264	47	17.8
February	54	302	63	20.9
March	43	286	30	10.5
April	50	236	27	11.4
May	39	278	46	16.5
June	19	312	64	20.5
July	59	259	37	14.3
August	10	345	79	22.9
September	21	248	36	14.5
October	16	198	18	9.1
November	37	204	29	14.2
December	46	319	48	15.0
2004				
January	48	332	69	20.8
February	32	301	54	17.9
March	47	318	67	21.1
April	26	273	53	19.4
May	53	360	71	19.7
June	35	241	49	20.3
July	28	194	38	19.6
August	22	269	58	21.6
September	43	362	69	19.1
October	37	209	45	21.5
November	27	361	63	17.5
December	24	387	75	19.4
Total	894	6858	1235	
Mean	37	286	51	

Source: Survey data

Table 2: Actual energy consumed

Year/Months	Energy consumed (Kwh)	Cost in ₦
2003		
January	6711	57043.5
February	6153	52300.5
March	4211	35793.5
April	3975	33787.5
May	5404	45934
June	4631	39363.5
July	5438	46223
August	4704	39984
September	4871	41403.5
October	6086	51731
November	5994	50949
December	5410	45985
2004		
January	4154	35309
February	4672	39712
March	5014	42619
April	5321	45228.5
May	4754	40409
June	5623	47795.5
July	6743	57315.5
August	5972	50762
September	5487	46639.5
October	6496	55216
November	3978	33813
December	4732	40222
Total	126534	1075539
Mean	5272.25	44814.125

Source: PHCN Bill for the study years

Table 3: Calculated electrical energy wasted and cost

2003	Total number of bulbs	Energy wasted	Cost in Naira
January	78	1123.2	8985.6
February	54	777.6	6220.8
March	43	619.2	4953.6
April	50	720	5760
May	39	561.6	4492.8
June	19	273.6	2188.8
July	59	849.6	6796.8
August	10	144	1152
September	21	302.4	2419.2
October	16	230.4	1843.2
November	37	532.8	4262.4
December	46	662.4	5299.2
2004			

January	48	691.2	5529.6
February	32	460.8	3686.4
March	47	676.8	5414.4
April	26	374.4	2995.2
May	53	763.2	6105.6
June	35	504	4032
July	28	403.2	3225.6
August	22	316.8	2534.4
September	43	619.2	4953.6
October	37	532.8	4262.4
November	27	388.8	3110.4
December	24	345.6	2764.8
Total	894	12873.6	102988.8
Mean	37.25	536.4	4291.2

Source: Survey data

Conclusions and Recommendations

The average energy wasted per month in the study area is 5272.5Kwh and 10.17% of that is wasted, while the average monthly bill for the energy consumed is N44, 814.125 and 9.58% is wasted. This waste is unacceptable to the school considering the fact that the school source of income is limited and may increase the levy to pay by students. It is therefore recommended that:

- Both students and staff should be encouraged to always switch off electrical appliances when not needed
- The school authority should assign a junior staff to monitor and control the use of electrical appliances to enable the available go round
- The attention of government and school administrator is drawn to this preventable wastage in order to reduce the waste of this scarce resource.
- It would appear that the introduction of pre-payment methods will go a long way to solving these problems – but obviously not those of "blackouts, brownouts and heavily-fluctuating voltages," unless the increased revenue is appropriately re-directed!

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