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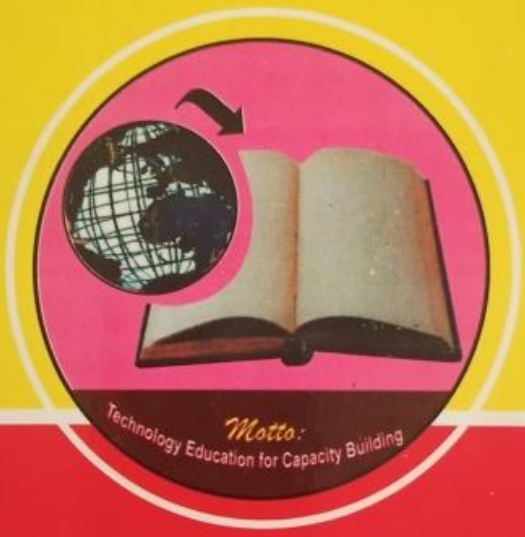
Website: www.futminna.edu.ng
Email: jiest@futminna.edu.ng
Tel: +2348033174958, +2348036276378



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A MODEL PREDICTING ELECTRICAL ENERGY MANAGEMENT PRACTICES AMONG RESIDENTS IN NIGER STATE, NIGERIA.

[1]Saba, T. M. , [2]Adamu, M. J., [1]Yisa, S. N. & [3]Daniel B. C.
[1]Department of Industrial and Technology Education
Federal University of Technology, Minna, Niger State, Nigeria
[2]Department of Electrical and Electronics Technology Education
Niger State College of Education Minna
[3]Department of Technical Education
Nuhu Bamalli Polytechnic, Zaria, Kaduna State, Nigeria.
E-mail: mosessaba@futminna.edu.ng **Phone:** 08036324657.

Abstract
The study predicted electrical energy management practices among residents, using regression model. Two research questions and a hypothesis were formulated to guide the study. Three variables used were (Income levels, Age groups and Educational levels) of electrical energy users. The study adopted a cross sectional survey research design. The population of the study was made up of 191,416 heads of households in residential buildings connected to the distribution network in 25 Local Governments of Niger State. The sample for the study consisted of 1,290 heads of households drawn through multistage sampling techniques. Out of 1,290 numbers of questionnaires administered to residents, 987 were returned representing 76.5% return rate. The instrument used for data collection was a structured questionnaire. Multiple Mean and standard deviation (SD) were used to analyzed research questions. Correlation and multiple regression analysis were used to analyzed hypothesis which determined the no relationship at (P · .05) level of significance on the practices of residents on electrical energy management in residential buildings in Niger State and to show the variable that has effect and the degree of the effect on the electrical energy management practices. The model developed is $Y = 1.868 + 0.07X_1 - 0.062X_2 + 0.097X_3$, *this shows that person income level, age group and educational level were significant in predicting practices on electrical energy management with significance values of 0.02, 0.00 and 0.00 less than the* $\alpha - value$ *of P · .05. Furthermore, age groups have a negative impact on electrical energy management practices in contrast to the income levels and educational qualifications. This is indicated by the values of their coefficient of +0.07, -0.062 and 0.097 respectively. The model significantly predicts electrical energy management practices. It is strengthen by the significant value of 0.00 less than the* $\alpha - value$ *of P · 0.05. The public awareness should be specifically designed for electricity users at different levels of age, education and income group. As these sociodemographic variables predicts electricity energy usage.*

Keywords: *Model, Predicting, Electrical Energy, Management, Practices , Residents.*

Introduction

Residential building uses electrical energy to operate equipment and appliances such as electrical heater, cooker, lighting bulbs, washing machines, refrigerator and other items. These equipment and appliances consume significant amount of energy. The quality of household energy usage has been increasing significantly and the trend will continue to increase. Household electrical energy usage is measured in kilowatt-hours (kWh). In Nigeria and specifically in Niger State, there is a large percentage of electrical energy usage in residential buildings (Saba, Usman, Adamu, & Daniel, 2018). Electrical energy management plays an important role in energy usage in residential buildings. Its proper management reduces costs of electricity and environmental degradation. The concept of electrical energy management practices as it relates to this study, therefore, can be defined as the conservative and efficient ways of managing electricity to save energy and offer a practical means of achieving economic competitiveness, environmental quality and energy security.

Electrical energy management practices can be grouped in terms of technology and management/behaviour. Technology approach have been identified as one of the approach of electrical energy efficiency as electrical energy efficiency is the way technology is being used to reduce energy usage. It is the process whereby technology appliances are being replaced with more efficient technology and the use of energy control technologies such as dimmer switches, thermostat, occupancy sensors and others appliances to reduce the energy consumption, but most of this devices require high capital investment. It includes starting a new way or installation high energy reduction devices such as automation system, heat recovery system in new building design, buildings envelop system and inverters. If all incandescent lamps worldwide were to be replaced by Compact Fluoresce Lamps (CFL), an additional 728 Kilowatts/hour of electricity would be saved per annum and global light energy demand would be lowered by 27% (Hatem, Imad, and Eyad, 2012). They further said that, the high efficacy CFLs compared to incandescent lamps means that they will consume one-quarter to one-fifth of the energy while providing the same light quality. About 25% of energy consumed by CFLs is converted

to visible light, compared with just 5% for a incandescent lamp. Management/behavioural approach to energy management practices deals with lifestyle. Since human beings are the users of electrical energy, it is equally very important and necessary to put into consideration the human behaviour aspect of energy conservation. However, any attempt to ignore the human dimension of energy management may not achieve proper energy saving. One of the self-contradictory aspects of the technological approach to energy efficiency is that people tent to use appliances or equipment more often when labeled energy efficiency (Saba, Tsado, Bukar, & Bello, 2015). Zahirah, Nurul, Nazirah, and Sandeeka, (2019) argued that savings of up to 21% can be achieved through occupants' energy-saving behaviour alone at no additional costs. They further confirm that occupants' energy consumption behaviour can significantly affect a building's energy performance despite the use of energy-saving technology. Thus, even though the use of technology aims to achieve energy efficiency, changes in the occupants' energy-saving behaviour is important to avoid technical efficiency gains being overtaken by consumption growth. Electrical energy conservation is the way of reducing the quantity of electricity used, through human behaviour. The services needed to help a housing unit largely depend on the location of residential buildings and other factors that is occupant-related, like income, education attainment and age.

Eluwa and Siong (2013) said structural variables like socio–demographic influence behaviour and intention. The factors such as educational level, income, age group of electrical energy user may affect behavioural choices, because they determine to the extent how individuals are able to practice the act of saving energy. This is supported by Mutua and Kimuyu (2015), they noted that electrical energy usage in residential buildings is strongly related to socio-demographic factors such as the education level, income, household size and age of household heads. The extent to which occupants of a household save electrical energy may likely depend on variables that serve as opportunities or hindrances for conserving electrical energy, such variables are; income, age and education of energy users (Abrahamse'& Steg, 2011).

Poortinga, Steg, Vlek and Wiersma, (2003) argued that the uses of efficient technologies are likely to be imbibed by respondents that have a high income and with measures of behaviour which may be the least acceptable for high income earners. The low income earners may not be stable financially and may lack the money to invest in residential electrical energy efficient improvement technologies. Age is generally referred as a predictor variable for electrical energy conservation. The choice and use of energy-consuming appliances was also found to be influenced by the age of the head of the household; younger households' occupants preferred recent technology appliances and equipment that is often more efficient, while older households occupants accept their old appliances and replace them more seldom (Carlsson-Kanyama, Linden & Eriksson, 2005). The number of household appliances and equipment owned by consumers can be directly linked to the educational level of heads of households; this trend may likely be as a result of the positive correlation between income and education. It is also believes that the level of education of consumers may certainly have a significant effect on the behaviour they exhibited in electrical energy usage in residential buildings (Abrahams & Steg, 2011). The theory of planned behavior developed by Ajzen in 1985, measure how human actions are directed. It is introduced in the study to understand significant challenges and drives underlying intentional and behavioural change in electrical energy management practices.

Ajzen, emphasized that behaviour is gotten by coming together motive and ability which behaviour is control. Theory assumes that intention can be used to foreseen the behaviour (Grizzell, 2007). Attitude is an organized set of feelings about situation or subject, which has power to influence an individual's behaviour. Attitude towards the behaviour can be viewed as personal feelings which can be negative or positive about the act of doing the behaviour. Kano (2013) believed that behaviour which has desirable results makes attitudes that are favourable and in other way behaviour that are believed to have result that is not favourable, usually form attitudes that are unfovourable. On the other hand, the individual judgement on electrical energy management whether favourable, good or bad is a reflection of an attitude towards the behaviour. The issue of good electrical energy behaviour in this study may not occur unless householders view the behaviour from positive view. Okubo and Tsuchiya (2009), observed that good attitude towards the use of energy and behaviour may have constituted important condition for good energy related behaviour. There is a strong indication that people may misuse rather than create scarcity of resources, which might be the cause of the energy crisis. Energy attitude of person has significant effect on behaviour via the beliefs but conservation of energy provides direct personal benefits while consequences of the act performed develop social norms on energy saving. The paper considers the connection between occupants' habits and energy-saving behaviour, and noted that social-demographic variables are factors that can be used to predict the behaviour of household towards electrical energy management.

Problem Statement

Appropriate usage of electrical energy management practices in residential buildings is necessary for effective utilization of available electrical energy. Researches carried out in the area of electrical energy usage shows that socio-demographic factors such as age, educational qualification, sex and gender can be greatly influence residential energy usage. There are some rivalry factors that influence electrical energy usage, as there is no conclusion over the fact that the socio-demographic influences energy usage (Abrahamse and Steg, 2009). Abrahamse and Steg (2011) and Eluwa and Siong (2013) argued that, act to reduce electrical energy consumption continue to be more highly related to psychological factors, this might be the fact that act to lower electrical energy are intentional in nature and may be less hindered by certain contextual factors. The study ascertained how socio-demographic variables predicts electrical energy usage in among households in Niger State.

Research Questions

The following research questions were formulated to guide the study:

1. What is the extent of usage of technological devices among residents for improving electrical energy efficiency in in Niger State, Nigeria?
2. What is the attitude of residents towards conserving electrical energy in Niger State, Nigeria?

Hypothesis

The following null hypothesis was formulated to guide the study and was tested at 0.05 level of significance:

H_{o1}: There is no relationship among the mean responses of electrical energy users (Income groups, Age groups and Educational qualifications of household occupants) predicting electrical energy management practices adopted in residential buildings in Niger State, Nigeria (P• .05).

Research Methodology

This study adopted a cross sectional survey research design. This design enables the researchers to describe the attitudes, opinions, behaviours or characteristic of the population based on data collected from a sample of the users of electricity in residents on their practices of electrical energy management. The study was carried out in Niger State, Nigeria, The state lies on longitude of 03˚ 30 to 07˚ 40 East and latitude of 80˚ to 11˚ : 30 North. The state is bordered to the West by Kebbi State, North by Zamfara State, South-West by Kwara State, South-South by Kogi State, South-East by FCT, North East by Kaduna State and the state has international boundary with the Republic of Benin to the North West.

The population of the study was made up of 191,416 household heads of in residential buildings connected to the distribution network in 25 Local Governments of Niger State. The sample for the study consisted of 1,290 household heads in residential buildings drawn through Multistage Sampling Techniques. The instrument used for data collection is a structured questionnaire. The questionnaire was designed to generate data for answering the research questions of the study. The questionnaires were collected after some days and in some cases a space of one week was given to respondents and the questionnaires were returned through the research assistants. This method adopted, certainly help to avoid loss of the instrument and improve on the return rate of the questionnaires. Despite the adoption of the above strategy for effective collection, quite a few numbers of questionnaires were not returned. Out of 1,290 numbers of questionnaires administered to residents, 987 were returned representing 76.5% return rate. The data collected for the study was organized and analyzed on the basis of the research hypothesis. SPSS version 23 was used for the analysis. Decisions on the research questions were based on the resulting means score interpreted relative to the concept of real lower and upper limits of numbers as shown in Table 1. T

he standard deviation was used to decide on the closeness or otherwise of the respondents to the mean in their responses. Any item with standard deviation of less than 1.96 indicated that the respondents were not too far from the mean or from one another in their responses and any item having standard deviation equal or above stated value signified that respondents were too far from the mean. Correlation and multiple regression analysis were used to analyzed hypothesis to determine the no relationship at (P • .05) level of significance on the practices of electrical energy management in residential buildings in Niger State and to show the variable that has effect on the electrical energy management practices and also the degree of the effect on the electrical energy management practices. The demographic categories are Income Status Monthly: Low Income, < ₦25,000; Medium Income from ₦25,000 - ₦50,000; High Income, greater than ₦51,000. Age Group: 18 -39 years Young; 40 – 65 years Medium; > 65years Old. Educational Qualification: Below Primary Education; Primary/Secondary Education; Diploma/NCE; First Degree; Postgraduate.

Table 1 Interpretation of Four Point Scale

S/N	Scale of R.Q 1	Scale of R.Q 2	Point
1	Very High Extent	Very Highly Adopted	3.50 – 4.00
2	High Extent	Highly Adopted	2.50 – 3.49
3	Medium Extent	Rarely Adopted	1.50 – 2.49
4	Low Extent	Not Adopted	0.50 – 1.49

Key: R.Q = Research Question

Results and Discussion

Descriptive Data

Demographic information for respondents is presented in Table 2, 3 and 4. The data were collected from a group of respondents by income group, age group and educational qualifications.

Table 2: Distribution of Respondents by Monthly Income Group

Category	Frequency	Percentage
Low Income	142	14.40
Medium Income	538	54.50
High Income	307	31.10
Total	987	100.00

Table 2 on the distribution of respondents by the monthly income group revealed that (538 or 54.9%) of the respondents were of the medium income group, while (307 or 31.1%) of the respondents were in the high income group and the low income group respondents were (142 or 14.4%).

Table 3: Distribution of Respondents by Age Group

Category	Frequency	Percentage
Young Age (18 to 39 years)	396	40.10
Medium Age (40 to 59 years)	494	50.10
Old Age (greater than 59 years)	97	9.80
Total	987	100.00

Respondents distributed according to age are in Table 3. Medium age (40 to 59 years) is the majority with the highest number of respondents (494 or 50.10%). Respondents from the youngest age group (18 to 39 years) were 396 representing 40.10%, while 97 or 9.80% of the respondents are from old age (greater than 59 years).

Table 4: Distribution of Respondents by Educational Level Attainment

Category	Frequency	Percentage
Below Primary Education	73	7.40
Primary/ Secondary	273	27.70
Diploma/ NCE	280	28.40
First Degree	303	30.70
Postgraduate Degree	58	5.90
Total	987	100.00

Table 4 on the distribution of respondents by highest educational level revealed that (303 or 30.70%) of respondents were holders of First degree; The holders of Diploma/ NCE as respondents were (280 or 28.40%); Respondents that hold Primary/ Secondary qualification were (273 or 27.7%). 73 or 7.4% of respondents belong to Below Primary education while the respondents that hold a Postgraduate degree were (58 or 5.90%).

Research Question One

What is the extent of usage of technological devices among residents for improving electrical energy efficiency in in Niger State, Nigeria?

Table 5: Residents Mean Opinions of the Extent of Usage of Technology Devices for Improving Electrical Energy Efficiency among household heads in Residential building in Niger State, Nigeria

S/N	ITEM	$\bar{X}$	SD	RK
1	Compact fluorescents lamps (CFLs)	2.51	0.34	HE
2	Light Emitting Diodes (LEDs)	1.18	0.27	LE
3	Fluorescent Lamp with electronic ballast	1.32	0.37	LE
4	Dimmer switches	1.44	0.17	LE
5	Task lighting	1.16	0.54	LE
6	Split air conditioners	1.45	0.08	LE
7	Occupancy sensors to cut off air- conditioner in unoccupied room.	1.37	0.09	LE
8	Energy efficient refrigerators	1.52	0.11	ME
9	Energy efficient washing machines	2.93	1.23	HE
	GRAND MEAN	**1.65**		**ME**

LE= Low Extent, ME= Medium Extent. HE= High Extent; RK = Remark

Table 5. shows that, respondents utilized the technology devices in items 1 and 9 to high extent for improving electrical energy efficiency with mean values ranging from 2.51 and 2.93. Items 2, 3, 4, 5, 6 and 7, with mean values ranges from 1.16 to 1.45 signify that the respondents utilized those technology devices to a low extent. The respondents use energy efficient refrigerators at medium extent. The total grand mean is 1.65 which mean these technology devices is been utilized at medium extent. The standard deviation of 9 items ranges from 0.08 - 1.23 each of these values was less than 1.96 indicating that the respondents were not too far in their mean responses. This adds value to the reliability of the mean.

Research Question Two

What is the attitude of residents towards conserving electrical energy in Niger State, Nigeria?

Table 6: Attitudinal Mean Opinions of the residents towards conserving electrical energy in Niger State, Nigeria

S/N	ITEM	$\bar{X}_{av}$	S D	RK
1	Utilization of minimum wattage lamp for required light.	1.86	0.04	RA
2	Regular usage of natural day lighting.	1.62	0.82	RA
3	Replacing incandescent bulb with more efficient bulb.	1.49	0.19	RA
4	Switching off the lights when not in use	1.52	0.47	RA
5	Regular defrosting of freezing compartment.	2.10	0.90	RA
6	Allowing the hot items to cool down before refrigerating	1.74	0.18	RA
7	Covering of all food stored in the refrigeration.	1.57	0.33	RA
8	Selection of right temperature during ironing.	1.94	0.60	RA
9	Turning off the socket when electricity is interrupted.	1.29	0.38	RA
10	Reducing peeping at food inside oven.	1.66	0.25	RA
	GRAND MEAN	**1.68**		**RA**

Table 6 shows that, the respondents rarely adopted the all items as attitude for conserving electrical energy in residential buildings in Niger State. The mean values ranges from 1.49 to 1.94. The standard deviations ranged from a highest of 1.10 to a lowest of 0.62 which shows that the respondents mean responses do not differ significantly. The 10 items had their standard deviation less than 1.96 showing that the respondents were not too far from the mean and were close to one another in their responses. The closeness of the responses adds value to the reliability of the mean.

Hypothesis

There is no relationship among the mean responses of electrical energy users (Income groups, Age groups and Educational qualifications) predicting electrical energy management practices adopted in residential buildings in Niger State, Nigeria (P> .05).

Table 7: Multiple Correlation between Income Groups, Age Groups and Educational Level of Residences in Niger State Predicting Electrical Energy Management Practices

		Mean	Income Status	Age Group	Educational Qualification
Multiple Correlation	Income Status monthly	0.01	1.00	0.32	0.13
	Age Group	-0.08	0.32	1.00	0.05
	Educational Qualification	0.24	0.13	0.05	1.00
Significant	Income Status monthly	0.44	0.00	0.00	0.00
	Age Group	0.01	0.00	0.00	0.06
	Educational Qualification	0.00	0.00	0.06	0.00

From Table 7., it can be concluded that there is a very weak positive correlation of 0.01 between electrical energy management practices and monthly income status. Hence, indicating no significant correlation with the significant value of 0.44 greater than $\alpha - value$ of $P \cdot 0.05$. The correlation between electrical energy management practices and age group is very negative with value of -0.08 and significant value of 0.01 less than the $\alpha - value$ $P < 0.05$. The correlation between electrical energy management practices and educational level is positive with value of 0.24 and significant value of 0.00 less than the $\alpha - value$ $P \cdot 0.05$. A model of electrical energy management practices as related to Income group, Age groups and Educational qualifications of the consumers of electrical energy within the study area is developed in equation 1.

$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3$ .....(1)

Where; Y= Electrical Energy Management Practices, β_0 = Intercept, β_1, β_2 and β_3 are the slopes of the regression model, while X_1, X_2 and X_3 stand for income group, age group and education qualification.

Table 8: Regression Model Predicting Electrical Energy Management Practices by Relationship between Income Groups, Age Groups and Educational Qualifications of Residences in Niger State, Nigeria

Coefficients of regression and standard error

	B	Std. Error	T	Sig
(Constant)	1.87	0.06	32.37	0.00
Income Status	0.07	0.02	0.10	0.02
Age Group	-0.06	0.02	-2.97	0.00
Educational Level	0.097	0.01	7.99	0.00

From the statistical evaluation results as shown in Table 8., the model developed is shown in equation 2.

$Y = 1.868 + 0.07X_1 - 0.062X_2 + 0.097X_3$ .....(2)

From equation 2. shows that person income level, age group and educational level are significant in predicting ones practices on electrical energy management with sig values of 0.02, 0.00 and 0.00 less than the $\alpha - value$ of $P \cdot 0.05$. Furthermore, age groups have a negative impact on electrical energy management practices in contrast to the income groups and educational qualification. This is indicated by the values of their coefficient of + 0.07, -0.062 and 0.097 respectively. The regression measures the overall significant of the predictors variables, educational level, Age group and income status and conclusive, the equation 2 is a model that is a significant predictor of the electrical energy management practices. The conclusion is strengthen by the significant value of 0.00 less than the $\alpha - value$ of $P \cdot 0.05$.

Summary of the Findings

1. The household heads utilize technological devices for improving electrical energy efficiency at medium extent.
2. The household heads rarely adopted good attitude towards conserving electrical energy in Niger State, Nigeria.
3. There was a statistically significant difference ($P \cdot 0.05$) in the mean relationship of income group, age groups and educational qualifications of household heads in Niger State, Nigeria

Discussion of Findings

The findings revealed that the household heads utilize technological devices for improving electrical energy efficiency at medium extent. This implies that many of Nigerians were not able to purchase efficiency equipment/appliances which are sometimes more expensive than the less efficient ones. This is in consonance

with the study carried by Oyedepo (2012), that major factor working against the use of CFLs and other energy saving bulbs is the cost. Energy saving bulbs is costly at first installment compare to incandescent bulbs. The researcher found out that Nigeria markets is flooded with used refrigerators and compressors and are cheaper compared to new ones, so people of low income will prefer that, due to their income level. The findings also revealed that people used fluorescent lamp with electronic ballast, dimmer switches and occupancy sensors at a low extent. The findings were in harmony with the works of UNDP (2011) as they observed that efficient lighting and control systems are used at low extent in most of residents and commercial enterprises in Nigeria.

The household heads rarely adopted good attitude towards conserving electrical energy in Niger State, Nigeria. This implies that people rarely adopted right behavioural practices towards electrical energy management and that often lead to waste of electrical energy. There is a strong indication that people may misuse rather than creating scarcity of resources. This might be the cause of energy crisis witness in Nigeria. This is also in line with the study conducted by Sanyaolu (2013) and Omowunmi (2015), as they agreed that many Nigerians do not put off the outside light during the day, which is due to wrong behavioural practices adopted towards electrical energy usage. Loozen and Moosdijk (2001) observed that experiments have shown that through application and appropriate use of positive behaviour towards energy saving about 25–30 % of the energy can be saved, as many people fails to practice. They further added that the rarely adoption of minimum wattage for saving energy can be due to inadequate knowledge regarding the selection of minimum wattage and illumination standard of rooms.

The findings of hypothesis revealed that, there was a statistically significant difference (P• 0.05) in the mean relationship of income group, age groups and educational level attainment of people residing in Niger State. There is a very weak positive correlation between management practices towards electrical energy and income level, the correlation between electrical energy management practices and age groups is negative and the correlation between electrical energy management practices and educational qualification of residents is positive. The regression model indicated that age groups and education qualifications of household heads are significant in predicting ones' practices of electrical energy management. But the overall sign of the predictors variables; education, age and income groups are a significant predictor of the practices towards electrical energy management. The findings of this study is in consonance with the works of Poortinga *et al.* (2003) and Abrahamse and Steg (2011), which they explained that the person with higher levels of education may certainly have higher income which may move him or her to purchase efficient equipment and energy savings technology but may lack behaviour of switching off the light when not in use. The correlation between level of energy user's education, energy saving activities and the use of energy efficient technology is strong and positive. Other reason for positive correlation is that the levels of educational attainment reduce cost of information acquisition and low level of education may lead to careless attitude towards energy savings (Eluwa, & Siong, 2013).

Conclusion

Residents rarely adopted right attitude toward usage of electricity at home and utilization of technology devices for efficient use of electricity is at medium extent. Application of good behaviour and efficient electrical energy management help in reducing energy wastages in residential buildings. The variables such as income group, age group and educational qualification of household heads electrical energy users have significant effect on the way electrical energy is been managed in residential buildings. The regression model indicated that age groups and education level are significant in predicting ones' practices of electrical energy management.

Recommendations

Based on the findings of this study, the following recommendations were made:

1. Ministry of Power should advise government to retrofit homes by replacement incandescent bulbs with energy saving bulbs of low wattages. This will reduce electrical energy consumption drastically and it will assist government to postpone the building of electric power stations. which will in turn make the environment to be friendly.

2. Electricity management Board should organize public enlightenment campaigns for electricity users on behavioural related practices needed to enhance proper electrical energy management. This will go a long way to change people's behaviour positively towards electrical energy management and the use of the technological devices to reduce electrical energy wastages.

3. Electrical energy management programme should be integrated in schools' curriculum at all level of educational programmes. This will help broaden the knowledge of pupils and students at all level of educational systems.

4. The public awareness should be specifically designed for electricity users at different levels of age, education and income group. As these sociodemographic variables predicts electricity energy usage.

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