ENERGY EFFICIENCY AWARENESS AND PREPAREDNESS AMONG STUDENTS

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Abstract: **This paper presents the results of a survey conducted to determine the extent of students' awareness of energy conservation measures in the use of various electrical appliances as well as their preparedness to support efforts towards reducing energy wastage in institutions. The survey was carried out through the administration of questionnaires. Nine hundred and seventy questionnaires were administered to resident students of the Kwame Nkrumah University of Science and Technology, Kumasi. The results of the survey point to appreciable levels of energy efficiency awareness in the use of various consumer loads. Additionally, a significant number of students were willing to support efforts towards reducing energy wastage.**

Key words: **Demand side management, Energy conservation, Energy efficiency, Energy savings**

1. Introduction

The high level of electricity consumption in educational institutions with its attendant increase in energy bills put a lot of pressure on managers of educational institutions. High electricity use in educational institutions can be attributed, in part, to gross energy wastage due to inefficient electricity utilisation. A significant percentage of electrical energy used in educational institutions is wasted [1]. For example, it is common to find lamps switched on, and fans working in classrooms when there is no occupant. Additionally, air conditioners are left on in offices when there is no occupancy. There is therefore the need to develop and implement measures to reduce electricity consumption and hence the electricity bills of educational institutions. Reduction in energy consumption can be achieved through effective demand side management (DSM) practices [2], [3]. DSM is the implementation of policies and measures which serve to control, influence and generally reduce electricity demand [4].

Effective demand-side management in educational institutions can be realized through (i) raising awareness among faculty, staff and students, (ii) managing building operations, (iii) upgrading of equipment, and (iv) installation of energy management devices. The first two approaches are behaviour-based, work synergistically with each other, and can be implemented without capital investment. The first avenue is focused on shifting behaviour among all building occupants, while the second is concerned more specifically with shifting awareness among facilities and custodial staff who manage building operations. The third and fourth approaches require capital investments [1].

Behaviour-based strategies offer a rewarding pathway for energy conservation. These strategies are both accessible and relatively inexpensive for schools to implement, and yet they are capable of yielding significant results. A key focus is on raising awareness among faculty, staff and students about energy-saving opportunities. Studies conducted by researchers point to the fact that behavioural change towards energy efficiency is key to effective DSM in educational institutions [1], [5]-[12]. For example, it is reported in [1] that through behavior-based strategies, dramatic reductions in electricity use ranging from 20 to 37

percent were recorded in some schools. The savings were realized through collaborative efforts among faculty, staff and students working to promote the adoption of energy-conserving behaviours without the need of capital investment in equipment and devices. Behavioural changes in energy usage amongst students will eventually affect energy use in homes, offices and industries. Such rippling effects will result in wide scale benefits. The benefits are: enhancement of the sustainability of energy systems, economic development, social development, environmental sustainability and increasing prosperity [12].

This study aimed at assessing the extent to which students in tertiary educational institutions in Ghana are aware of energy efficiency measures, and also know their preparedness to support energy savings. The findings of the study will inform the behaviour-based strategies towards energy conservation to use in tertiary institutions in Ghana.

2. Methodology

The Kwame Nkrumah University of Science and Technology, Kumasi, Ghana was chosen as the case study institution. The choice of KNUST as the research location was informed by the high level of energy consumption on campus, the diversity of energy usage, and the diversity of people there. KNUST has students from diverse social, ethnic, cultural and economic backgrounds. Thus a study at this location gives a fair representation of what pertains in other educational institutions.

The research objective was realised through the conduct of a survey and subsequent analysis of it. The survey was conducted through the administration of questionnaires. The questionnaire centered on three broad issues namely, energy efficiency (EE) awareness in the use of various consumer loads, preparedness to engage in EE activities, and current engagement in EE activities. With regards to energy efficiency awareness in consumer loads, the questionnaire was designed to determine the knowledge of students with regards to energy efficiency in the use of the following consumer loads: refrigerators, electronic devices, heating appliances, and air-conditioners. As regards preparedness to support EE activities, the readiness of students to engage in some specific EE activities was determined. Some of the activities asked were putting off lamps when not required and not keeping electronic equipment on standby for long periods. With respect to current engagement in EE activities, specific EE activities were listed and students were asked to select from the list the activities which they engage in.

Population data of students who are resident on KNUST campus was obtained from the Quality Assurance and Planning Unit (QAPU) of the university. The population data was used to determine the appropriate sample size. The sample size was determined using (1) [13].

$$n_0 = \frac{\left(\frac{Z^2 pq}{e^2}\right)}{1+\left(\frac{\frac{Z^2 pq}{e^2}-1}{N}\right)} \qquad (1)$$

where n is the sample size, z is the z-score, p is the estimated proportion of an attribute that is present in the population, $q = 1 - p$, e is the margin of error or confidence interval and N is the population.

Table 1: Breakdown of questionnaires distributed

No.	College	No. of questionnaires
1	College of Agriculture and Natural Resources	150
2	College of Art and Built Environment	150
3	College of Engineering	150
4	College of Science	220
5	College of Humanities and Social Sciences	150
6	College of Health Sciences	150

The population of resident students was obtained to be 10,000. Using $z = 1.96$, $p = 0.5$, $e = 3\%$, the sample size was calculated to be 963. However, 970

questionnaires were administered. The questionnaires were distributed across the six colleges of the university. Only students in the colleges who were resident on campus were made to complete the questionnaire. Table 1 gives a breakdown of the number of questionnaires distributed.

3. Results and Analysis

At the end of the questionnaire administration period, 914 out of the 970 questionnaires distributed were returned. The response rate is thus 94.23%. However, not all the 914 questionnaires returned were fully completed; responses were not given to some of the questions asked. The questionnaires were analyzed using Microsoft excel. The results obtained are presented below.

A. *Energy efficiency awareness in the use of refrigerators*

Students were asked whether or not they knew that leaving fridge and freezer doors ajar, keeping refrigerators close to walls, not defrosting freezing compartments, and putting hot foods in refrigerators lead to higher consumption of energy. Fig. 1 shows the results obtained.

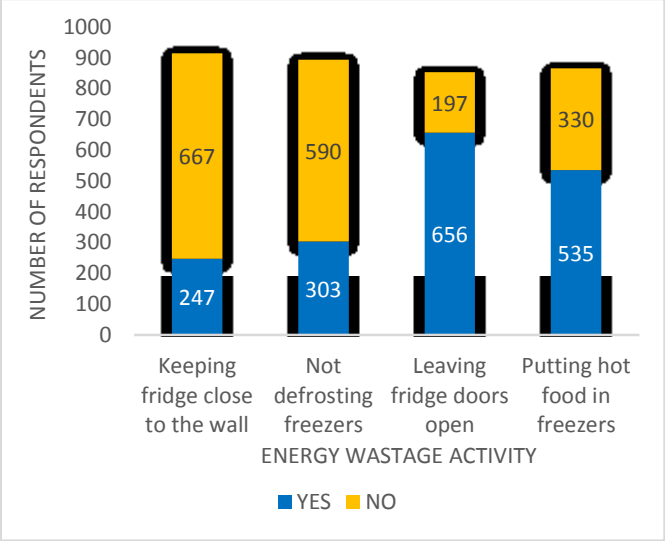

Fig. 1: Energy efficiency awareness in the use of refrigerators

Nine hundred and fourteen persons gave responses to the question as to whether they knew that keeping refrigerators close to walls lead to energy wastage. Over twenty-seven percent (27.02%) of this number responded in the affirmative, whereas 72.98% did not know of this. With regards to knowledge of energy wastage associated with not defrosting freezers, 893 persons gave responses. Close to thirty-four percent (33.93%) of this number indicated awareness of this fact while 66.07% were ignorant about it. Of the 853 persons that responded to the question as to whether or not leaving the door of refrigerators ajar or open amounted to energy wastage, 76.91% responded in the affirmative. Also, 61.85% of 865 respondents indicated that putting hot foods in freezers result in energy wastage.

B. *Energy efficiency awareness in the use of heating loads*

Heating loads like electric cookers and irons consume a lot of energy. They are commonly used by students. Ironing in bits instead of in bulk, covering of the lids of cooking utensils, and filling up kettles when only a small amount of water is required contribute to energy wastage. The responses given to the questions asked in this area are presented in Fig. 2. Six hundred and eighty-seven persons representing 80.44% of 854 respondents indicated knowledge of the fact that ironing in bits results in energy wastage. Eight hundred and fifty-four persons responded to the question as to whether filling up the kettle when only a small amount of water is required amounted to energy wastage. Here, 69.20% answered in the affirmative.

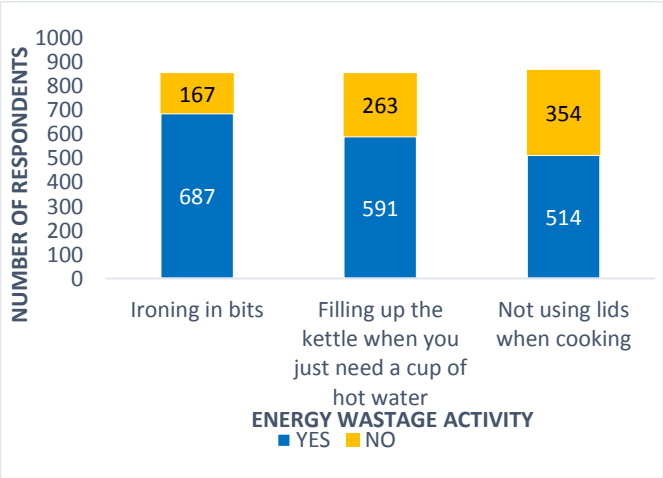

Fig. 2: Energy efficiency awareness in the use of heating loads

Of the 868 persons who responded to the question as to whether or not the absence of lids when cooking

amounted to wastage, 514 representing 59.22% indicated knowledge of the fact that not using lids during cooking resulted in energy wastage.

C. *Energy efficiency awareness in the use of ventilation and air conditioning appliances*

Air conditioners consume more energy when doors and windows are not properly closed or left open. Also, filters ought to be cleaned regularly since the build-up of dust causes air conditioners to consume more energy. Fig. 3 shows the responses given to questions relating to energy efficiency awareness in the use of ventilation and air conditioning appliances. Seventy nine percent of 898 respondents indicated knowledge of the fact that not cleaning air conditioning systems regularly result in wastage of energy. Regarding energy wastage due to leaving doors and windows not properly closed or open, 78.82% indicated knowledge of this fact.

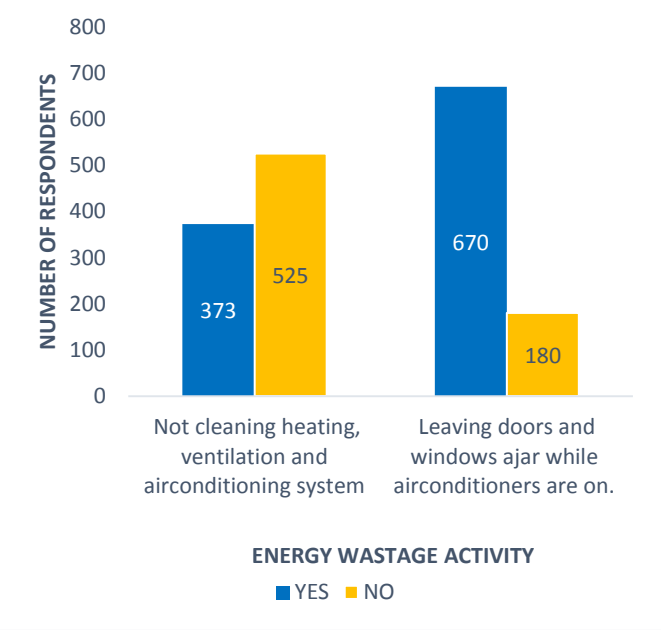

Fig. 3: Energy efficiency awareness in the use of ventilation and air-conditioning appliances

D. *Energy efficiency awareness in lighting*

The use of daylight during daytime instead of electric bulbs can result in significant energy savings. Here, students were asked whether or not they knew about this. The result obtained is presented in Fig. 4. Six hundred and fifty persons representing 76.56% of respondents indicated awareness of this, whereas 23.44% of this number did not know of this.

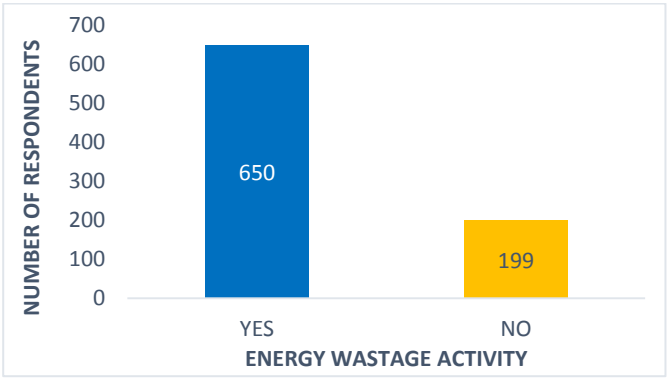

Fig. 4: Energy efficiency awareness in lighting

E. E*nergy efficiency awareness in the use of electronic devices*

Keeping electronic devices on standby result in energy wastage. Students were asked knowledge of this fact. Eight hundred and sixty-seven persons gave responses to this question. The responses given are presented in Fig. 5. Five hundred and ninety-one persons, representing 68% respondents knew about this fact. The remaining 32% did not know that.

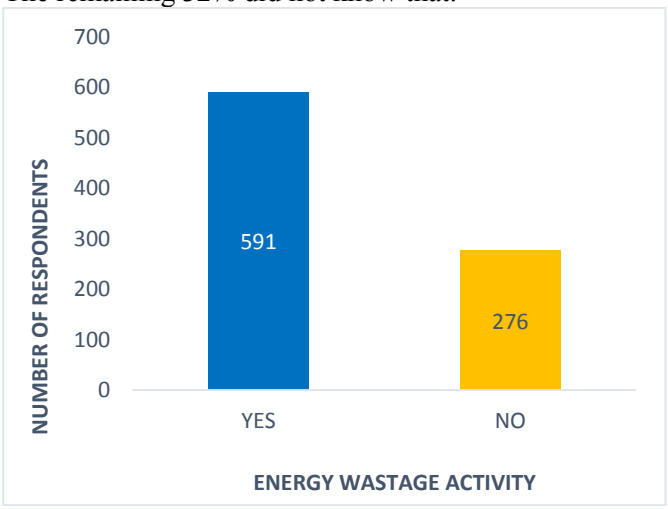

Fig. 5: Energy efficiency awareness in the use of electronic devices

F. *Engagement in energy saving activities*

Significant gains in energy savings can be made if students get actively involved in efforts towards the minimization of energy wastage. The number of students who are presently engaged in energy saving activities (ESA) was determined. The result obtained is presented in Fig. 6. Here, 887 students responded to this question. Out of this number, 63.02% indicated

that they were presently engaged in helping the university save energy. For those who indicated current involvement in ESA, a list of activities was provided and they were asked to select from the list, the specific activities they engage in. The result obtained is presented in Table 2. The activity that is mostly engaged in by students is the putting off of lights when leaving rooms. The activity that is least carried out is the putting off of rice cookers few minutes after switching to warm from cook.

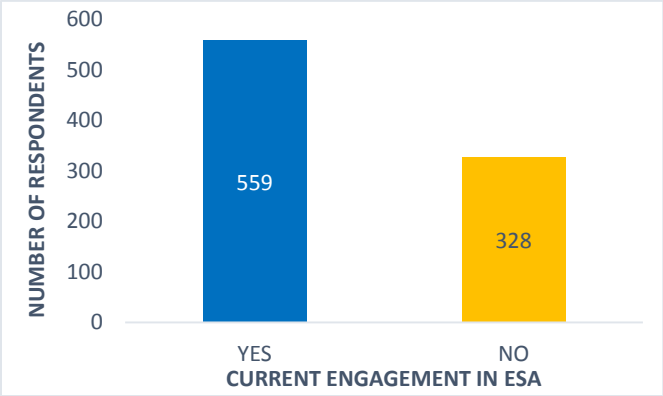

Fig. 6: Current engagement of students in energy saving activities

Students were also asked about their preparedness to support the University reduce energy wastage. Responses were obtained from 858 persons. Fig. 7 shows the results obtained. 75.52% of this number was willing to support efforts towards the reduction of energy wastage. This is encouraging. Those who indicated willingness to support in ESA were also asked to indicate the specific activities they were prepared to support; a list of activities was provided. Table 3 shows the results obtained.

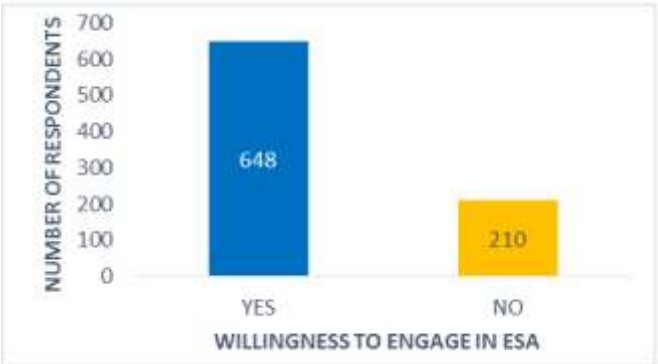

Fig. 7: Willingness of students to support energy saving activities

Table 2: Energy saving activities currently engaged in by students

Energy saving Activity	No. of resp.	No. engaged in ESA	%
Putting off rice cookers few minutes after switching to 'warm' from 'cook'	887	410	46.22
Switching off appliances such as microwaves, electric irons and kettles	887	531	59.86
Not keeping chargers and other electronic equipment on stand by	887	445	50.17
Putting off lights in room when there is sufficient day light	887	535	60.32
Putting lights off when leaving the room	887	562	63.36
Switching outdoor lamps off when not required	887	472	53.21
Switching off fans and air-conditioners when leaving the room	887	543	61.22
Putting computers off when not in use	887	481	54.23
Educating colleagues about energy efficient practices	887	323	36.41

Table 3: Energy saving activities likely to receive students' support

Energy saving Activity	No. of resp.	No. of students willing to support	%
Putting off rice cookers few minutes after switching to 'warm' from 'cook'.	648	484	74.69
Switching off appliances such as microwaves, electric irons and kettles	648	503	77.62
Not keeping chargers and other electronic equipment on stand by	648	516	79.63
Putting off lights in room when there is sufficient day light	648	552	85.19
Putting lights off when leaving the room	648	529	81.64
Switching outdoor lights off when not required	648	511	78.86
Switching off fans and air-conditioners when leaving the room	648	524	80.86
Putting computers off when not in use	648	518	79.94
Educating colleagues about energy efficient practices	648	524	80.86

G. *Energy efficiency awareness campaign*

Education about energy efficiency is key to energy savings. Students were asked whether or not they would join an energy efficiency awareness campaign team. The results obtained are presented in Fig. 8. Forty eight percent were willing to join a campaign team. The remaining 52% were however unwilling to join. Although the majority of students are not interested in joining an energy efficiency campaign team, the number that expressed interest in joining is high and encouraging. The involvement of 48% of students in an energy efficiency campaign will most likely result in significant gains.

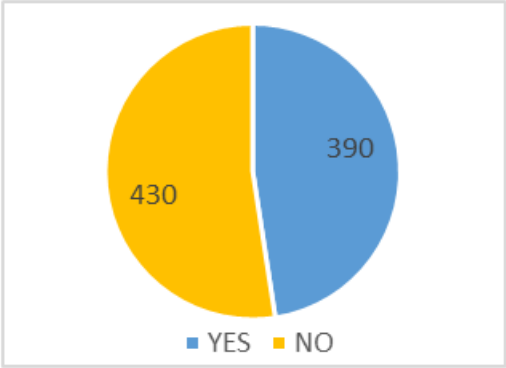

Fig. 8: Willingness to join an energy efficiency campaign team

Students were also asked about the need for the provision of incentives for engagement in ESA. The responses given are presented in Fig. 9. Eight hundred and seventy-two students responded to this question, of which 68.46% were of the view that incentives have to be provided to students for them to engage in ESA. However, 31.54% did not find the provision of incentives necessary. The results show that authorities may have to put in place some incentives to encourage students for them to get actively involved in efforts towards the minimization of energy wastage.

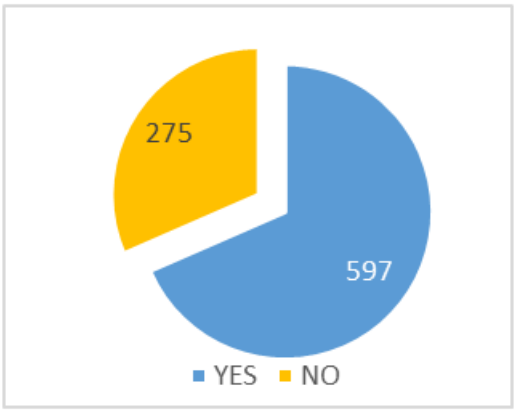

Fig. 9: Responses to the provision of incentives for energy savings

4. Conclusion

The result of a survey conducted to determine the level of energy efficiency awareness amongst students as well as their preparedness to support in efforts towards energy savings has been presented. Out of 970 questionnaires administered, 94.23% were returned albeit with varying levels of completion. Majority of students were ignorant of the fact that keeping refrigerators close to walls and not defrosting freezer compartments lead to energy wastage. Most of them however knew that keeping refrigerator doors open and putting hot foods in them result in energy wastage. Majority of students were aware of energy efficiency issues relating to the use of heating loads. With regards to ventilation and air conditioning systems, most of the students knew of the fact that keeping doors and windows open make air conditioners consume more energy. Most of them did not know that not cleaning air conditioners regularly make them consume more energy. Most students knew that that the continual use of bulbs when there is sufficient daylight constitutes energy wastage. Majority of students were aware of energy efficiency issues in the use of electronic devices. It was also realized that appreciable number of students are already engaged in at least one form of energy conservation and are also prepared to support efforts towards reducing energy wastage. A significant number were willing to join an energy efficiency campaign team. Majority of them were however of the view that incentives must be provided to encourage students to support energy saving activities.

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