



ENERGY CONSERVATION POTENTIALS IN UNIVERSITY OF MAIDUGURI: CASE STUDY OF SHETTIMA ALI MONGUNO HOSTEL

A. M. Malut^{1,2*}, A. M. El-Jumma¹ and A. B. Muhammad¹

¹Department of Mechanical Engineering, University of Maiduguri, Maiduguri, Borno State, Nigeria

²Department of Mechanical Engineering, Federal Polytechnic Monguno, Borno State, Nigeria.

*Corresponding author's email address: amsa4malut@gmail.com

ARTICLE INFORMATION ABSTRACT

Submitted 15 October, 2021

Revised 16 January, 2024

Accepted 20 January, 2024

Keywords:

Energy Conservation

Energy Audit

Cost Savings

Energy waste

Energy savings

This paper presents the result of investigating the energy conservation potentials conducted at Shettima Ali Monguno (SAM) Students' Hostel of University of Maiduguri. The aim of the study was to ascertain the energy consumption pattern and the amount of energy consumed, spot areas of waste and find measures to curb such waste. A walk-through audit and investigation through questionnaire and oral interviews were used to gather required data. Microsoft Excel software were used to analyse the data. The results show that fan element ranked top in energy consuming loads having 86 %, followed by lighting 73 %, resistant coil 25%, pressing iron 18% and electric hot plate 13%. And the aspect of cooking kerosene ranked up to the most used energy followed by charcoal. The annual energy and cost savings for replacement of conventional resistance electric regulator fans with electronic regulator fans is about 17MWh and N 1.1Million and that one for replacing incandescent light bulb is 13MWh and N0.9Million. The study recommends that Energy audit should be conducted for other parts of the institution, awareness on energy saving habits and their benefits should be created.

1.0 Introduction

Globally, energy is very vital in driving the growth and development of any economy as it is an important input to a nation's growth and development. Energy equally plays a major role in increasing the competitiveness of any nation among the committee of nations (Alege, 2014). The conservation of energy is one of the issues which need to be addressed with utmost importance in today's world. Today, energy is paramount across all domains. The energy conservation is essential to the improvement of energy efficiency in the present industrial world (Alege, 2014). In spite of the increasing number of power plants which mainly depends on conventional fossil fuels to meet the present energy demands, to address the energy crisis, adopting energy conservation measures is imperative. Effective planning of energy management programme requires sound understanding of energy utilization patterns, determinants of energy use and associated energy behaviours of the households needed.

Energy audit is the basic and most important step for implementation of any effective energy management program. It tries to answer how, where and how much energy is used in the system. It provides an opportunity to look into energy use pattern and suggests way and means of eliminating losses and improving the efficiency of the system. The immediate advantages obtained through energy audit are improved maintainability, reliability features coupled with reduction losses (Unachukwu, 2010). Long term energy saving can be through the use of energy efficient equipment. Generation of electricity is less as compare to the energy consumption in

Nigeria. This is the cause of load shedding due to which most of the sectors and industries are facing issues (McIntosh, 2013). So, the need of today is to save and conserve. A lot of energy is wasted in Nigeria because households, public and private offices and industries use more energy than is actually necessary to fulfil their needs (CREDC, 2009). Most Nigerians are unconscious of the energy they waste. Often, many people use wrong appliance for carrying out certain activities (Unachukwu, 2010).

Large institutions such as Universities, consume a large amount of energy on a daily basis (Oyedepo *et al.*, 2016). Improving the energy practices in these institutions can directly decrease the environmental impact associated with energy use, and equally act as an example for a change of people's attitude in the use of energy across the country. Therefore, energy availability, optimization, consumption and its attending costs in public buildings often constitute a major challenge to administrators and top management of public buildings (Oyedepo *et al.*, 2016). Much can, therefore, be achieved towards improving energy availability, if energy is conserved in public buildings with a significant level of occupancy such as the University students' hostel. Adetunji (2005) posited that energy conservation aims at the reduction in the consumption of non-renewable resources. Typically, University campus consumes a large amount of energy in providing essential services such as lighting, water supply, ventilation, and air conditioning (Oyedepo *et al.*, 2016).

The task of meeting the demands for energy comes at a significant cost to Universities play a role in reducing natural resource consumption. It is therefore, important that energy conservation practices be identified and promoted in Universities students' hostels. Energy conservation practices result in low energy consumption in buildings, such practices should include determination of energy cost savings and payback time (Stewart *et al.*, 2016).

In order to quantify and assess the rate and nature of energy supply and consumption in Nigerian tertiary institutions, different scholars have carried out researches on energy audits, energy efficiency, consumption and utilization patterns in many tertiary institutions in Nigeria. (Babangida *et al.* (2015) conducted study on energy auditing and management in student Hostel of Ahmadu Bello University Zaria. Maina *et al.* (2015) studied the electricity use characteristics of Ramat Polytechnic Maiduguri, Borno State; and Unachukwu (2010) investigated the energy savings opportunities at the University of Nigeria, Nsukka. Despite numerous researches done in the area of assessment of energy supply, consumption and utilization patterns in Nigerian tertiary institutions, there appears not to be enough information on the mode of energy utilization pattern and conservation potentials in the University of Maiduguri that can be Universities play a pivotal role in actively contributing to the reduction of natural resource consumption through various initiatives, research endeavors, and educational programs. Now to assess the current energy utilization pattern through energy audit, to identify the facilities used as energy consumption appliances that results in energy waste and to apply the data collected in order to raise awareness among students and also develop the potentials for savings in order to curb the possibility of energy wastage.

2. Methodology

2.1. Study Area

Shettima Ali Monguno Students Hostel is situated in University of Maiduguri, Borno State, Nigeria. The University was established in 1975 by the Federal Government of Nigeria (FGN),

which is situated at 11.8024°N, 13.1931°E of Maiduguri, Borno State, Northeastern part of Nigeria. Although, there exist privately arranged off-campus accommodations due to increased population and demand, the University is also residential for both Staff and Students. The hostel consists of two parts: an undergraduate section, which has a total of 80 rooms with 4 to 6 individuals occupying each room and a postgraduate section consisting of four blocks (A, B, C and D), with ten rooms in each block. In addition to the two sections, the hostel also has a kitchen, laundry and two common rooms.

2.2 Data Collection

An energy audit was conducted by walking through the hostel to collect information on the power ratings of electrical equipment and appliances that were in use, and the energy used for cooking. The power ratings were then compared to the nameplates on the equipment. The total energy consumption of each device was calculated by multiplying its power rating by the total number of hours it was in use. However, the actual energy consumed might be less than what was indicated by the manufacturer's power rating, which could be up to 50-70% lower, as reported by (Joseph et al., 2004). The hostel uses electricity for lighting, water heating for comfortable bathing, fan cooling, ironing, and supplementary cooking with hotplates they also use charcoal and kerosene stove for cooking.

2.3 Energy Audit Techniques

The following are the two - step techniques adopted for this audit:

- i. **Physical Inspection:** Data was gathered by manually counting the number of lighting and fan points, charcoal and kerosene stove, gas cookers and other appliances in seventy rooms across all the blocks of the hostel.
- ii. **Questionnaire structuring and administration:** The questionnaire was designed to address various aspects of energy utilization in the hostel, such as the respondents' awareness of energy conservation and its benefits, the patterns of energy consumption in the hostel, and the usage of energy-saving habits by the respondents. To administer the questionnaires, simple random sampling was used. The population was divided into two main groups: undergraduate and postgraduate. The questionnaire was randomly distributed to each group using simple random sampling (Olken, 1986). A total of one hundred and sixty-one More than half of the hostel population participated by completing the distributed questionnaires.
- iii. **Energy Consumption:** the following procedures were used according to (Oyedepo et al., 2016)

1. Survey Instrument Development: A questionnaire was designed to collect data on energy usage habits among students residing in the hostel. The questionnaire included sections addressing the use of resistant coils, pressing irons, electric hotplates, and other electrical appliances commonly used for daily activities.

2. Survey Administration: The questionnaire was distributed to all students residing in the hostel. Efforts were made to achieve a high response rate to ensure the reliability of the data collected. The survey was conducted over a defined period to capture variations in energy consumption patterns.

3. Data Collection and Analysis: Responses from the completed questionnaires were compiled and analyzed to determine the average duration of usage for each electrical appliance. Statistical techniques were applied to calculate the overall energy consumption attributable to resistant coils, pressing irons, and electric hotplates

2.4 Data Analysis

Microsoft Excel application from Microsoft Office Software was used in analysing the data obtained from the students in the hostel. Data input where related data was inserted into the excel, then excel function for energy efficiency and cost analysis was employed. Finally, chart will be used to show energy trends and distribution

3. Results and Discussion

3.1 The Energy Consumption Survey for the Students Hostel

The amount of energy utilization in SAM hostel depends on many factors; these factors include the population of the students, operational efficiency of the appliances, types of lamps and efficiency and maintenance mode of cooking. The student hostel has high power consumption due to large number of rooms. These rooms use power consuming appliances such as Pressing iron, hair driers, refrigerators, cooking (hot plate, charcoal and kerosene stove, and LPG) and similar equipment.

Table 1 shows the aspects of results of energy used for cooking in SAM. Also, Table 2 shows the aspects of results of energy used in SAM and Figure 1 shows Results of Percentage appliance uses by students in SAM. It shows that most of the students use kerosene for cooking.

Table 1: Energy use for respondents

S/N	Types of energy used	Number of respondents	Percentage (%)
1.	Electrical hotplate	42	8.00
2.	Charcoal stove	108	20.73
3.	LPG	0	0.00
4.	Kerosene	366	70.24
5.	Solar Cooker	5	1.00

3.2 Analysis of the Energy Consumption

To assess the possibility of energy saving through lighting in the hostel, the total energy consumption by lighting was calculated, energy cost savings through replacement of existing light fixture (incandescent bulbs) with energy efficient lamps such as compact fluorescent lamps (CFL) in the hostel. 35.79% of the total number of students sampled use 60W incandescent bulbs in the room while 12.7% use 100W bulbs, also only 41.3% remember to turn off light, while 7.1% do not turn off the light.

1.0 For hot water usage, 26.1% of student population bath with hot water during the hot water, while 73.8% do not. The peak period for hot water demand is in the morning hours.

2.0 For hot water generation 17.4% of the students' population makes use of 1500W rated resistant coil while 13.0% use electric hot plate. Furthermore, 11.1% own pressing iron, 1.8% use blender and 1.8% use hair drier and 2% use refrigerator.

3.3 Estimation of energy savings potentials in the students' hostel

Using statistics from the energy use survey in the hostel, the potentials for energy savings in the hostel are estimated. For instance, the average number of students in the hostel is 322 and a power supply factor of 0.6, indicating a poor power factor from the national grid, electricity consumption by students is estimated below:

1. **Resistant Coil:** Tests with the resistant coils show that it takes about 20 minutes to raise the temperature of 10 litres of water from an ambient of 20°C to about 52°C. An average of 15 minutes is assumed to achieve a temperature level suitable for comfort bathing.
2. **Pressing Iron:** It is also assumed here that students iron their cloths for an average of 15 minutes per day.
3. **Electric hotplate:** Students use electric hot plates for cooking. According to the survey findings, approximately 13.0% of students utilize electric hot plates for cooking, with the assumption that using a hot plate for meal preparation typically consumes approximately forty-five (45) minutes.

Table 2: Appliances and their consumption

S/N	Appliances	Consumption (kW/yr)	Percentage (%)
1.	Lighting	3.2×10^5	0.58
2.	Fan	4.8×10^7	87
3.	Resistant Coil	1.4×10^3	0.01
4.	Electric Pressing Iron	2.1×10^6	3.82
5.	Electric Cooker	4.6×10^6	8.36

From the computations, the students' electricity consumption by use of these 5 energy consuming appliances is estimated to be 57837211.475KWh per annum. The percent share of each of the appliances is shown in Figure 3.1 As can be seen, two major areas present great opportunities for energy savings in the students' hostels. These are energy consumed in the use of incandescent light bulbs and that for Fan. For instance, 40% of the total energy consumed by students in the hostels is expended on fan.

PERCENTAGE USE

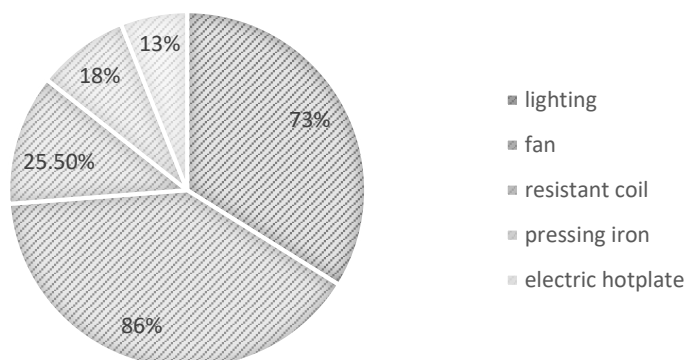


Figure 1: Percentage appliance uses by students.

The result obtained from the present study regarding energy consumption by resistant coils, pressing irons, and electric hotplates can be compared with the findings of Oyedepo et al. (2016) concerning space cooling and lighting.

While our study focuses on electrical appliances commonly used by students in the hostel, Oyedepo et al. (2016) investigated energy usage patterns related to space cooling and lighting. They reported a significant portion of energy consumption attributed to space cooling and lighting, specifically 29% of the total energy usage.

Interestingly, similarities can be drawn between the findings of both studies regarding energy conservation opportunities. In our study, feedback from questionnaires and audits revealed instances of inefficient lighting practices, such as external light bulbs remaining switched on during daylight hours and room lights being left on when students are not present for lectures. Similarly, Oyedepo et al. (2016) observed that external light bulbs were often left on during the daytime, contributing to unnecessary energy consumption.

Moreover, both studies suggest practical measures to reduce energy consumption. Oyedepo et al. (2016) proposed strategies such as turning off lighting and fans in unoccupied rooms and using external light bulbs exclusively during nighttime to reduce the total number of hours that light bulbs remain switched on, thereby achieving energy savings in both lighting and fan consumption. Similarly, our study identifies opportunities for energy conservation through the optimization of electrical appliance usage, such as reducing the duration of usage for resistant coils, pressing irons, and electric hotplates when not required.

Here, specific areas within the hostel where there is high energy consumption potential, namely, lighting and fans. The cost of electricity per unit in Nigeria's tariff stands at N69.43/kWh. The student hostel's energy and cost-saving potential can be realized by replacing the current lighting fixtures with energy-efficient bulbs. Table 3 and 4 are used to compute energy and cost savings for the replacement of 60 W incandescent bulbs with 12W CFL.

Table 3: Comparison between the existing lightning system and the recommended system

Existing System	Recommended System
Total number of rooms = 322	Total number of rooms = 322
Total number of bulbs in rooms = 266	Total number of bulbs in rooms = 266
Total watts consumed = $266 \times 60 = 15960W$	Total watts consumed = $266 \times 12 = 3192W$
Total usage time/day = 17 hours	Total usage time/day = 17 hours
Total usage time in a year = $17 \times 245 = 4165$	Total usage time in a year = $17 \times 245 = 4125$
Total watts in a year = $15960 \times 4125 = 65835000$	Total watts in a year = $3192 \times 4125 = 13167000$
Total units in a year = 65835.0	Total units in a year = 13167000
Cost of 1 unit = N69.43	Cost of 1 unit = N69.43
total cost in a year = $66473.4 \times 69 = N4,586,664$	Total cost in a year = $13166.7 \times 69 = N908,502.3$

Table 4: Comparison between the existing fan system and the recommended system

Existing system	Recommended system
Total number of rooms = 322	Total number of rooms = 322
Total number of fans in rooms = 130	Total number of fans in rooms = 130
Total watts consumed = $130 \times 70 = 9100W$	Total watts consumed = $130 \times 45 = 5850W$
Total usage time/day = 17 hours	Total usage time/day = 17 hours
Total usage time in a year = $17 \times 245 = 4125hr$	Total usage time in a year = $17 \times 245 = 4125hr$
Total watts in a year = $9100 \times 17 \times 245 = 37537500$	Total watts in a year = $5850 \times 17 \times 245 = 17199000$
Total units in a year = 37537.5	Total units in a year = 17199.0
Cost of 1 unit = ₦69	Cost of 1 unit = ₦69
Total cost in a year = $37537.5 \times 69 = ₦2,590,087$	Total cost in a year = $17199 \times 69 = ₦1,186731$

4. Conclusion

The energy audit at SAM Student Hostel identified inefficiencies in various appliances and practices, offering insights for energy conservation. By implementing strategies like upgrading to energy-efficient lighting and optimizing appliances, substantial energy and cost savings are achievable. This approach targets behavioral changes, equipment upgrades, and operational optimizations to reduce energy waste effectively.

Analyzing data on energy waste and costs enabled the identification of consumption patterns and areas for improvement. Implementing energy-saving measures, such as upgrading appliances and promoting behavioral changes, aims to minimize wastage and lower expenses. By fostering an energy-conscious environment, the hostel can operate more sustainably and economically, benefiting both the environment and its financial sustainability.

The study recommends:

1. Conducting energy audits across the institution to identify areas for savings.
2. Establishing an energy audit committee in each hostel to promote energy-saving habits, utilizing existing staff.
3. Raising awareness of energy-saving practices through various channels.
4. Listing inefficient appliances in hostel regulations to discourage their use.
5. Implementing automatic controls for external lighting to minimize energy wastage.

References

- Adetunji, I. 2005 Sustainable Construction: A Web-Based Performance Assessment tool. Loughborough University. Loughborough, Leicestershire, UK.
- Alege, P. 2014. Energy Supply and Climate Change in Nigeria. *Journal of Environment and Earth Science*, 4(14): 47–60.
- Babangida, M., Abba, L., Abubakar, M. and Abubakar, K. 2015. Energy Auditing and Management A Case Study of Student Hostel, A. B. U ZARIA, Nigeria. *Journal of Multidisciplinary Engineering Science and Technology (JMEST)*, 2(7): 7-9

CREDC. 2009. Energy Efficiency Survey in Nigeria, Community Research Development Centre, Benin City.

Joseph, C., Ricky, Y., Tsang, C. and Danny, HL. 2004. Electricity use characteristics of purpose-built office buildings in subtropical climates. *Energy Conversion and Management*, 45: 829–844.

Maina, M., Ngala, G. and Muhammad, S. 2015. Electricity Use Characteristics of Tertiary Institutions in Nigeria: A Case Study of Ramat Polytechnic Maiduguri, Borno State. *International Journal of Engineering Research & Technology (IJERT)*, 4(12): 5-11

McIntosh, M. 2013. Report:24,000 bridges, 5,000 structurally deficient. Iowa: KCCI News.

Otegbulu, CA. 2011. Energy Efficient Practice: A Focus on Residential Management, University of Lagos, Lagos, Nigeria.

Oyedepo, SO., Adekeye, T., Leramo, RO., Kilanko, OO., Balogun, AO. and Akhibi, MO. 2015 A Study on Energy Demand and Consumption in Covenant University, Ota, Nigeria. In: 2nd Covenant University Conference on African Development Issues (CU-ICADI), 11th - 13th May, 2015, Africa Leadership Development Center, Covenant University, Ota, Nigeria, 203–211.

Oyedepo, S., Adekeye, T., Leramo, R., Kilanko, O., Babalola, O., Balogun, A. and Akhibi, M. 2016. Assessment of Energy Saving Potentials in Covenant University, Nigeria. *Energy Engineering*, 113(7): 45-67.

Stewart, N. and Sarpola, A. 2016. Energy innovation needs in public buildings. Sizing a Photovoltaic System for the University of Oulu Linanmaa Campus, Oulu., pp. 10–129.

Unachukwu, G. 2010. Energy savings opportunities at the University of Nigeria, Nsukka. *Journal of Energy in Southern Africa*, 21(3): 7-9