

Investigation of energy audit of the administrative complex of Benue state polytechnic, Ugbokolo

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World Journal of Advanced Research and Reviews, 2022, 16(01), 449–556

Publication history: Received on 08 September 2022; revised on 14 October 2022; accepted on 16 October 2022

Article DOI: <https://doi.org/10.30574/wjarr.2022.16.1.1036>

Abstract

In this research, the importance of energy auditing and the process of energy auditing was discussed extensively. The study covers an energy audit. The calculations cover the amount of energy consumed in the administrative complex of Benue State Polytechnic Ugbokolo and the estimation of the consumed Energy per hour, day(s), week and month were presented. Identification of areas of energy wastage and estimation of energy saving potential in the complex were identified, and all sections and units' facilities have been made by walk-through energy Audit. Also, a detailed analysis of the data collected was done by suggesting cost-effective measures for energy use efficiency. The results and other vital information generated through these activities were documented. The Energy Auditing for a day is the index of the consumption which normalizes the situation of energy crisis by providing conservation schemes. The Polytechnic administrative building needs a maximum of 20530.95kW of electricity per hour which cost a total of ₦1,113,598.728 for running all these appliances. The cost of running them for the minimum of 4 hours supply that those within B and E should enjoy per day and in a year amounted to ₦53,452,738.944. The research proclaimed an alternative source of supply in order to reduce excessive costs.

Keywords: Energy Audit; Energy Flow; Electricity Bills; Energy Conservation; Energy Consumption and rationalization

1 Introduction

An energy audit is an inspection survey and an analysis of energy flows (usage) for energy conservation in a building. Energy plays an important role in the development of any country's economy; therefore, its usage has to be minimal in order not to avoid unnecessary costs. It is obvious that the demand for energy will continue to increase provided our cost of living does not stay down [1]. Apart from that, energy is needed to run industries, residences, institutions and utility applications but the supply is the major problem. Today developing countries are faced with challenges in energy supply because the resources required to produce large megawatts of electricity are scares. An energy audit as one of the tools to verify, control, monitor and plan on how this scarce energy is used is the key to ascertaining if the institution is running at a gain or loss [2]. The energy audit is essential to reduce electrical billing and decrease energy wastage. Governments must ensure that energy audits are carried out compulsorily in any institution or organization at certain frequencies in order to avoid waste of resources [3]. The author in [4] recommended that private and government parastatals will always require electrical energy to run their organization. An energy audit is used as a tool to evaluate the energy consumption of a building and helps to obtain an accurate method to manage it. It may include a process or system to reduce the amount of energy input into the system without negatively affecting the output. In commercial and industrial homes, an energy audit is the first step in identifying opportunities to reduce energy expenses and carbon footprint [5]. In Nigeria, the entire field of education and other fields have suffered greatly due to inconsistent and

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epileptics power supply. Sani [6] study showed that energy consumption in Kaduna State Polytechnic is at its peak during the dry season due to significant air-conditioning requirements, the author's work revealed that the annual electrical use per student per annum was found to be 216.97KWh with a yearly estimated saving of 37% of the total annual consumption. Abubakar [7] studied how energy is consumed in the Federal College of Education, Katsina, over a period of four years (2006-2009); the author report showed that about 41.2% of energy is consumed, followed by electrical appliances with a rate of 32.22% and lighting points of 26.50%. Oyedepo *et al.* [8] in their study at Covenant University, Ota, Nigeria showed again that the cooling systems in the academic building consumed 49% of electricity, followed by the lighting systems in the staff quarters which consumed 39% while the cooling of the space and the lighting points on the work ways consumed 29% each. The cost of minimizing the waste was presented. In the authors' presentation, the traditional Fluorescent Tube Light (FTL) and incandescent bulbs can be replaced with Compact Fluorescent Lamps (CFLs) at a cost of ₦4.8million (\$30,000) and 64MWh, ₦7.9million equivalent to (\$49.375) respectively. But Modu *et al.* [9] in their study of student hostels in Ahmad Bello University Zaria, reported that the lighting energy consumption per year was 58% which is equivalent to 47,888kWh/yr. before retrofitting but after retrofitting, it was shown to reduce to 19,165.40kWh/yr. saving energy of 8,213.8kWh/yr. equivalent to 60%. But today, we are marching towards the desirable status of a developed nation with fast strides. It is our belief that the development should be a sustained one. For achieving such an interminable development, energy management is very important. As far as the electricity crisis is concerned, staff are regularly faced with lack of electricity during office hours. So, institutional management is taking design regarding the production of electricity and saving the cost of electricity. The Energy requirement of Nigeria is growing rapidly. The country has a motivated strategy to enlarge its renewable energy resources and a policy to establish Energy consumption. Energy conservation means a reduction in energy consumption without making any sacrifice to quantity or quality. A successful energy management program begins with energy conservation; it will lead to the adequate rating of the equipment, using high-efficiency equipment and a change of habits which causes enormous waste of energy.

In Nigeria, a lot of energy is wasted because households, public and private offices, as well as industries use more energy than is actually necessary to fulfil their needs. One of the reasons is that; they use outdated and inefficient equipment and production processes therefore, the need for energy is exceeding its supply in view of these circumstances. Primary energy conservation, rationalization, and efficient use, therefore, become the immediate needs. This paper will address the need why the administrative complex spends more on electricity bills and procure an alternative on how to reduce electricity costs.

2 Material and methods

Data collection for the energy audit of the Administrative building of Benue State Polytechnic Ugbokolo campus was conceded by the team for the period of 1 October 2020 to 30 November 2021. This audit aimed at showing a healthy and safe procedure to drop energy utilization and to proffer a simpler method of energy management. This audit helped to recognize the mainly energy-proficient appliances. Besides, each day processes concerning common appliances have been provided which facilitate sinking the energy expenditure. All data were collected from each unit, section and room of the administrative complex. The work was completed by considering, how many tubes, fans, A.Cs, electronic instruments, etc. in each room; how much was the participation of each component in total electricity consumption? Policies were instituted to explore other energy means. Nigeria, with one of the largest economies on the African continent, has a substantial installed generation capacity of more than 13.5 GW compared to the Country's peak demand of 8.25 GW, it is important that the government should be able to adequately address the national demand. But yet in 2019 the available capacity only amounted to 3.7 GW. According to the World Bank collection of development indicators, only 55.4% of the Nigerian population has access to electricity and the supply is still not consistent as of 2022. In this research, the polytechnic electricity audit has been conducted considering the administrative building of the polytechnic. The study of the total budget of the Polytechnic, the total economic investment of the Polytechnic on electricity and the total generation of electricity from the solar and other electricity generation units were also looked into. Also, the total saving on electricity was studied which showed the exact contribution of bulbs, fans, computers and other instruments to the total requirement of electricity. The wattages of all of this equipment were collected from the survey. The summary of the research methodology in the building complex was captured in the flow chart shown in Figure 1.0.

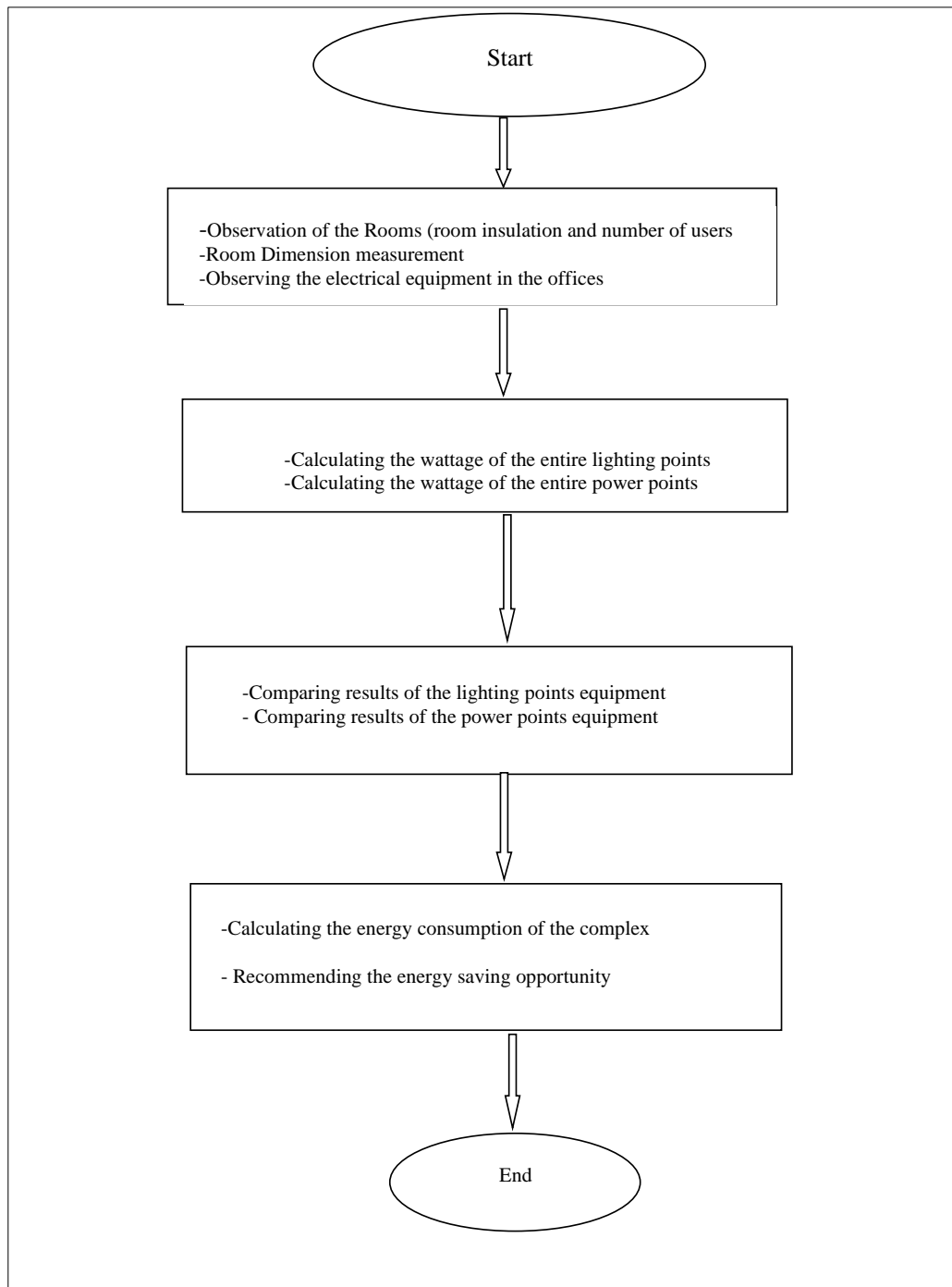


Figure 1 Flow chart of research methodology

3 Results

3.1 Data collection

Table 1.0 to Table 4.0 show the results of all the required data that were collected by the research team from the Electrical Engineering and Physics section of the Science Laboratory Technology department Benue State Polytechnic Ugbokolo and the total Wattage consumed by each block.

Table 1 Power requirement of various equipment within the Bursary and Dean Student affairs section

Office/ Instrument	Fan	LED light	Tube	A.C	Fridge	Computer	Printer	TV
Bursar's office	4	9		4	1	1	1	2
Bursary office 1	1	4		2		1	1	
2		2		1		1		
3		3		2		1		
4	1	2		1		1		
5		2						
6		2			1	1		
7	1	2		2		1		
8		2		1				
9	2			1				
Auditor's office	1	2		1	1	1	2	1
Office 1	1	2		1				
2	1	2		1				
3	2	3		1	1			
4	1	2		1				
5	1	2		1				
6	1	2		1				
7	7	2		1		1	2	
8	1	2		1				
9	1	2		1				
Dean student's affair	2	6		3	1	1	1	1
Conference hall	2	4		2				
Office 1	1	2		1				
2	1	2		1				
3	1	3		1				
4	1	2		1				
Rest room inside	2	4						
Rest room outside		6						
Total	30	77		33	5	10	7	4

Table 2 Power Requirement of various Equipment within Rectory section

Office/ Instrument	Fan	LED Tube light	A.C	Fridge	Computer	Printer	TV	Water Dispenser	Scanner
Rector's Office	4	10	5	2	4	2	3	1	1
Deputy's office	3	7	3	2	2	2	2	1	1
S.A Office	2	5	2	1	1	1	1		
P.R.O Office	2	6	2	2	2	2	1		
Rector's Hall	4	6	4		1	1			
Internal Audit	1	3	1		1	1			
Printing	2	6	1	1	1	1			
CIWES	1	4	1	1	1	1		1	
TET Fund	1	3	1	1	1	1			
Rectory Office 1	1	2	1						
2		2	1						
3		2	1						
4		2	1						
5		2	1						
6	1	3	1		1				
7	1	2	1						
8	1	2	1						
9		2	1						
10		2	1						
11	1	2	1						
Titrone room	2	4	2	1					
Academic reserved	1	3	1						
Walk way Upstairs		53							
Walk way Downstairs		53							
Outside		40							
Total Quantity	28	226	34	11	15	12	7	3	2

Table 3 Power Requirement of various Equipment within Registry section

OFFICE/ INSTRUMENT	Fan	LED Tubelight	AC	Fridge	Computer	Printer	TV
Entrepreneurship Office 1	1	3	1				
2	1	2	1				
3	1	2	1				
4	1	2	1				
5	1	2	1				
6	1	2	1				
Admission Office	1	2	1	1	1	1	
Exam & Record Office 1	1	2	1				
2	1	2	1			2	
3		2	1	1	1		
4		2	1		1		
5	1	2	1	1		1	
6	1	2	1	1	1		
Academic Office 1	2	4	1				
2	1	2	1		1	1	
3	1	2	1		1		
Registrar Office	3	10	4	2	2	2	2
Registry Office 1	1	2	1		1	1	
2	1	2	1				
3	2	2	1				
4	1	2	1	1			
5	1	2	1				
6	1	2		1	2	1	
7	1	2	1				
Total Quantity	26	59	26	8	11	10	2

Table 4 Total Power Requirement for various Equipment

Office/ Instrument	Fan	LED Tube light	AC	Fridge	Computer	Printer	TV	Water Dispenser	Scanner
Total from Table 1	30	77	33	5	10	7	4		
Total from Table 2	28	226	34	11	15	12	7	3	2
Total from Table 3	26	59	26	8	11	10	2		
Overall Total Quantity	84	362	93	24	36	29	13	3	2
Total consumed power in 1hr (Watt)	85	20	1440	565	200	230	50	700	25
Total power consumed in 5hrs (Watt)	35700	36200	669600	67800	36000	33350	3250	10500	250
Monthly consumption (Watt)	821100	832600	154008 00	1559400	828000	767050	74750	241500	5750

Total Monthly Power Requirement of all the instruments = 20530.95KW

4 Discussion

Table 4 shows the aggregate amount of energy consumed by each section of the administrative block in a month. The results displaced the appliances with the highest energy consumption. The data were collected considering the LED light, fan, computer, printer, A.C and other instruments. It is obvious from the table that, the AC and the refrigerators consumed the most. The total required energy is 20530.95KW. Energy Consumption through all devices is 20530.95 Units /Month from the data generated and their analysis. On the scale of ₦54.24 per kWh for E2 – MD BAND E electricity tariff classification, this increased tariff led to the classification of end users into Bands, the Benue State Polytechnic Ugbokolo is under band E which by implication are made to enjoy less than 8 hours of power supply per day. Based on this, the total amount of running all these appliances is ₦1,113,598.728. In the course of this research, a detailed analysis of the current energy situation of the administrative building of Benue State Polytechnic Ugbokolo is presented and the ways of reducing energy consumption without altering the comfort with which work can be done effectively are proposed. The condition of the energy balance which is the condition of heat exchange between the building and its surrounding is also analyzed. Data generated during the research work for the energy audit are useful for understanding the energy distribution and utilization of the polytechnic. The Polytechnic needs a maximum of 20530.95KW of electricity just for its administrative block. In other words, the Polytechnic administrative building needs 20530.95 units/month and there are no other means of energy generation devices other than fuel and diesel generators which contribute largely to air and noise pollution.

5 Conclusion

In conclusion, the Polytechnic administrative building needs a maximum of 20530.95kW of electricity just for its administrative block. In other words, the Polytechnic administrative building needs 20530.95 units/month. On the scale of ₦54.24 per kWh for E2 – MD BAND E electricity tariff classification of which Benue State Polytechnic Ugbokolo is under by virtue of its location which by implication it made to enjoy less than 8 hours of power supply per day. Based on this the total amount of running all these appliances is ₦1,113,598.728. This indeed is a huge sum compared with the numerous appliances within the institution and the cost of running them for the minimum of 4 hours supply that those within Band E should enjoy per day and in a year the amount of money will be ₦53,452,738.944. The epileptic supply of electricity supply of the area has affected negatively the performances of both staff and students of the institution. The

said amount of money is enough to install a solar system technology that can supply the building with as much as needed energy to enhance optimum performances and discharge of duties.

Recommendations

Based on the results of this study, the following recommendations are made for the existing offices and buildings of the Benue State Polytechnic Ugbokolo. The management should provide a means of keeping an up-to-date record of the load demand of all existing appliances and the total monthly consumption. Prepaid meters should be installed in each building so that individual consumption can be determined and solar energy utilization should be greatly encouraged. The number of LED bulbs should be reduced since most of the administrative work is usually during the day to save more power. All the cathode-ray tube (CRT) monitors should be replaced with light-emitting diode (LED) or liquid crystal display (LCD) monitors. The fans and air-conditioner should not be used simultaneously, windows and doors should always be open while using the fan and should be properly closed when air condition is in use.

Compliance with ethical standards

Acknowledgments

The authors wish to thank the management of Benue State polytechnic Ugbokolo and Tertiary Education Trust Fund (TETFund) Abuja, Nigeria for their support in ensuring this work is a success.

Disclosure of conflict of interest

The authors have declared that no conflict of interest exist.

References

- [1] ECN (Energy Commission of Nigeria) (2003). National Energy Policy.
- [2] S.U. Kulkarni and Kalpana Patil. Energy Audit of an Industrial Unit: A Case Study. International Journal of Emerging Science and Engineering, 2013, (2):22-26.
- [3] H. S. M. Singh, G. Singh, "Energy audit: a case study to reduce lighting cost," Asian J. Comput. Sci. Inf. Technol. 2012; 2(5):119–122.
- [4] H. H. Sait, "Auditing and analysis of energy consumption of an educational building in hot and humid area," Energy Convers. Manag. 2013 Feb; 66:143-152.
- [5] CADDET Energy Efficiency (1997). Centre for the Analysis and Dissemination of Demonstrated Energy Technologies. Accessed from <http://www.caddet.ee.org>
- [6] Sani M. (2005). Energy Audit for an Institution: A case study of Kaduna State Polytechnic. An unpublished M.Eng. thesis Bayero University Kano, Nigeria.
- [7] Abubakar, (2012). Study of Electrical Energy Consumption Pattern of Federal College of Education, Katsina, an unpublished M. Eng. thesis, Bayero University Kano, Nigeria.
- [8] Oyedepo, S.O, Adekeye, T, Leramo, R.O. Kilanko, O. Babalola, O.P Balogun, A.O. and Akhibi, M.O. A Study on Energy Demand and Consumption in Convent University, Ota, Nigeria. International Conference in African Development Issues (CU-ICADI) 2015: Renewable Energy Trade
- [9] Modu B., Bukar A.L., Musa A. and Aliyu A.K. Energy Auditing and Management: A Case Study of Student Hostel, A.B.U Zaria, Nigeria. Journal of Multidisciplinary Engineering Science and Technology. 2015;2(7):231-237