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## Energy Waste in Public Universities: A Study on Alternative Energy and Best Practices

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### **Abstract:**

*A 2013 EC report suggests that buildings are big energy consumers in current society. Characterized by steady infrastructure growth and staff strength, the University of Education, Winneba, has witnessed an overall increase in its energy load. As part of global measures for energy efficiency and tackling global warming, it is of the essence that states institutions like public universities champion efforts for reduced energy consumption; this is essential for meeting sustainable development goals. Utilizing both quantitative and qualitative approaches, this research is a longitudinal study that investigates energy waste at the University of Education, Winneba. The study establishes the existence of energy waste in public universities which has seen very little research, and explores the alternative approaches to mitigating energy waste on campus to reduce the financial burden created by an increase in expenditure on (utility) electricity bills in the university.*

**Keywords:** Energy waste, occupant behaviour, alternative energy, best practices

### **1. Introduction**

Between 2015 and 2016, media houses across Ghana carried what could be termed as the trending news of government's inability to meet payments of utility bills (water and electricity) of Ghanaian public universities. Unsettled arrears of utility bills led to a disconnection exercise executed by a team from the Electricity Company of Ghana (ECG), to which the University of Education, Winneba fell prey. Unpaid utility bills accrued by public universities increased over time in arrears with the government's inability to meet payments of utility bills on time. The subject of how to pay utility bills for public universities and polytechnics became an indispensable topic for discussions in Ghana during the 2015 – 2016 period.

In most jurisdictions, funding pressures have resulted in overall budget cuts or the introduction and increase of tuition fees. In Ghana, however, there is a different controversy. It has been estimated that public tertiary institutions currently owe well over Gh¢1 billion (US\$254 million) in unpaid utility bills, and it is not uncommon for the Electricity Company of Ghana to threaten to suspend the provision of electricity (Noumi & Stephenson, 2016).

Presently government no longer pays utility bills for public universities. In view of this, public universities rely on internally generated funds (IGF), which have been capped-rated by the government since 2017. Prior to the government's decision to stop paying utility bills for public universities, all utility bills that the universities received were immediately transferred to the government for payment, and the institution (universities) did not have a direct managerial role in terms of the financial aspects because the government was in full control of such payments.

In a number of studies carried out in the past several decades, the high importance of the occupants' role, defined as occupant behaviour, cannot be overemphasised in spending made by institutions (IEA, 2013). In view of this, occupant behaviour must be considered while retrofitting/refurbishing buildings since the absence of this may cause an inappropriate selection of energy-efficient measures (Ben, H. and K. Steemers, 2014; Wei, S. et al., 2015).

The University of Education, Winneba, has nearly all office spaces fitted with air-conditioning units. Mohamed, A.M.A., et al., (2015) and Guerra, (2015) opine that energy-efficient buildings require adequate consideration of occupant behaviour: since improper building use may result in a waste of energy. Regarding the opinions from these various schools of thought, it is inarguable that an occupant's behaviour has led to the increases in energy consumption that the university has witnessed in these past years and present. In summary, an occupant-involved building control system can significantly reduce the building's energy demand, (Yang, R. and L. Wang 2013; Gulbinas, R., R.K. Jain, and J.E. Taylor, BizWatts 2014). This clearly indicates that an occupant's behaviour indeed is a major contributor to the increase in energy usage and, thereof, energy waste.

In the University of Education, Winneba, the internally generated funds (IGF) are used for financing academic user fees, residential user fees, and payment of utility bills. A greater portion of IGF is spent on utility (electricity bills) and thus burdens the institution's spending. In view of this, it has become imperative to consider revisiting policies that guide how energy is used on campus to avert foreseeable challenges in the future since this has been identified as a major hurdle that,

in essence, depletes the university's resources. Going forward, there is an estimation of the institution's inability to raise resources (funds) to cater to other subdivisions of the institution's spending; the very same challenge that the government encountered in the past years, which led to its resolution to stop paying utility bills of public universities. The government decides how much public universities can charge as school fees which is cumulatively what the public universities rely on in meeting financial needs and obligations. With expenditure on utility taking a greater portion of IGF, school fees charged do not seem to be commensurate with expenditure in the wake of constant utility tariff adjustments by service providers resulting in disparity. Since 2017, there have been several tariff adjustments. However, there has been no increase in school fees charged. Currently, university students in Ghana already pay some of the highest tuition fees on the continent (Noumi & Stephenson, 2016). Hence, considering or pushing for an increase in how much school fees should be paid by students may not fundamentally be the most suitable approach to addressing this challenge. After careful examination of the ECG load system, constant tariff adjustments, and the growing cost of spending on paying electricity bills by the University of Education, Winneba, the institution needs to consider a different approach to the usage of energy in the institution by members within the university community.

### *1.1. Objectives*

This study was underpinned by the objectives enumerated below:

- To examine the expenditure on electricity by the University of Education, Winneba, at the Winneba campuses.
- To investigate what accounts for the rising cost of expenditure on electricity bills at the University of Education, Winneba.
- To examine strategies that may be employed in mitigating the high cost of expenditure on electricity bills at the University of Education, Winneba.

### *1.2. Research Questions*

The following questions served as a guide for this study:

- How much has the University spent in its expenditure on electricity bills?
- What accounts for the increase in the cost of electricity bills at the University of Education, Winneba?
- What practices can be employed to address the high expenditure on electricity bills at the University of Education, Winneba?

### *1.3. Purpose of the Study*

This study holistically examines energy usage at the University of Education, Winneba. It is limited to energy usage by staff members at various office spaces on campus, focusing on expenditure on electricity by the institution. It looks into the administrative cost of energy waste. Therefore, the purpose of this study is to investigate alternative approaches and best practices to help reduce the financial burden on the school by reducing its overall expenditure on electricity.

## **2. Materials and Methods**

### *2.1. Research Design*

This research is a longitudinal study characterized by tracing and accessing a situation within a period. This study employed the use of both quantitative and qualitative research approaches to address the research questions that guide the study.

### *2.2. Research Instruments*

This study utilised direct detailed observations, interviews, and review documents. Questionnaires were distributed to staff of the University of Education, Winneba, for data collection, following which the data gathered were analysed. These were done to help examine the present situation in consonance with practices and perceptions and derive solutions around the subject in perspective.

### *2.3. Data Analysis Plan*

Data were analysed for more than two weeks after collection. The data collected from the field were analysed and presented thematically and with quantitative statistics. This was strategic in interpreting the various aspects of the research topic. In answering research question one, data from the questionnaire were analysed using SPSS. Frequency counts and percentages were derived using Likert's 5-point psychometric scale of strongly agree (5), agree (4), neither agree nor disagree (3), disagree (2), and strongly disagree (1). Data for research questions two and three were obtained through review documents, interviews, and observations and were analysed thematically.

### *2.4. Population, Sample, and Technique*

The accessible population for this study comprised teaching and non-teaching staff members of the University of Education, Winneba. Considering the variables involved in this study, stratified probability sampling was used. The stratum was defined by the role each member played (either teaching or non-teaching). This was done to offer each category of staff member an equal chance of being selected for the study. In view of this, the broad category of potential respondents was grouped into teaching and non-teaching staff members.

Entry Number	Description	Number of Respondents
1	Non-Teaching Staff	50
2	Teaching Staff	50
	Total	100

*Table 1: Statistics of Respondents*  
*Source: Field Data 2022*

### 3. Findings and Discussion

The discussions and findings have been organised into sub-sections that represent the key variables from the research questions that guide the study with an introductory overview of physical structures at the University of Education, Winneba.

#### 3.1. Physical Structure of Office Buildings

This study was conducted at the University of Education Winneba, Winneba campus' mixed-mode office buildings, including:

- Akwasi Asabere-Ameyaw Building,
- Emmanuel Kwasi Ampene Building,
- Peku Building,
- IERIS Block,
- The South Campus Administration Block,
- ITECPD and CoDEL Block, and
- The Faculty Blocks, which are story buildings, and
- Other office blocks that are single-storey buildings at the Central, South, and North Campuses of the University

These office blocks are equipped with mixed-mode ventilation, which implies that the system in place encourages energy efficiency by providing both natural ventilation from operable windows and active cooling (air-conditioning units and ceiling fans). The following images illustrate some office buildings on the university campuses in Winneba, showing how well natural ventilation is catered for.



*Figure 1: Physical Structures (Faculty Block)*  
*Source: Field Study 2022*



*Figure 2: Physical Structures (Students Centre)*  
*Source: Field Study 2022*

#### 3.2. Expenditure on Electricity

The following are presentations on expenditure on electricity at the University of Education, Winneba.

Campus/ Building	Location	Usage (kWh) May 2021	Usage (kWh) November 2021	Charges (GHS) May 2021	Charges (GHS) November 2021
Central Campus	Central Campus	12,538	27,584.39	16,094.16	35,407.15
Peku Building	North Campus	78,410	86,251.00	100,649.95	110,714.95
Faculty Block	North Campus	49,769	54,745.90	63,907.07	70,297.78
South Campus	South Campus	83,150	91,465.00	106,730.81	105,243.00
University Hall	North Campus	6,805	7,485.83	10,797.04	11,876.74
Student's Centre	North Campus	26,138	28,751.30	33,549.98	88,370.66
	Total	256,810	296,283.42	331,729.01	421,910.28
	Averages	42,802	177,234.03	55,288.17	281,260.12

*Table 2: Average Monthly Electricity Bills for UEW, Winneba Campus  
(May 2021 and Nov 2021 in Perspective)  
Source: UEW 2022 Field Study*

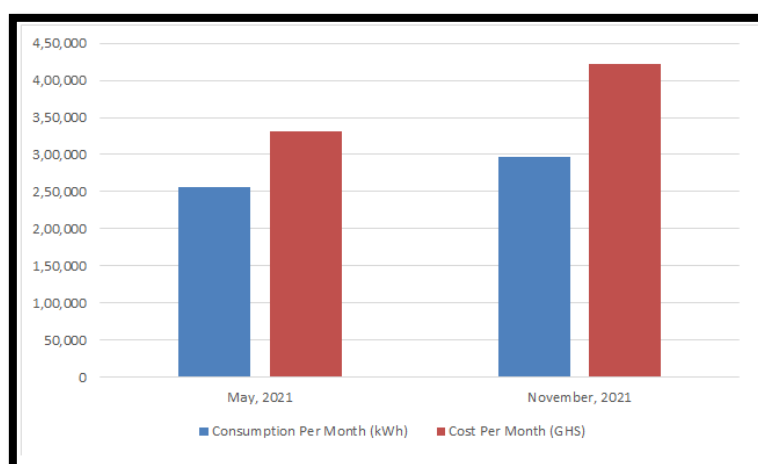
Table 2 above presents data gathered on the average monthly expenditure on electricity consumption at the South, Central, and North Campuses of the University of Education, Winneba. The data illustrates the surge in energy usage evident in the increases in the average kilowatts used in May 2021 and November 2021. The months of May and November were strategically selected for this study because the months represent periods when students were on break resulting in most staff members using the opportunity to embark on leave and when the university is usually fully represented, respectively.

Prior to May and November 2021, the study also gathered that significantly low charges were recorded in months like April and May 2020. This decrease was attributed to the Coronavirus (COVID-19) pandemic that saw the closure of the university from March 2020 through June 2020. The data presented in table 2 suggests the Central Campus doubled its energy usage between May and November 2021 by 220.006% increase, whereas other Winneba campuses of the university, like the Peku Building and the faculty block, recorded 10% increases each, respectively. The South Campus, University Hall, and Student's Centre also recorded an increase in energy usage. This was recorded as a 10% increase for South Campus, a 10.0048% increase for University Hall, and a 9.99809% increase for the Student's Centre building.

Year	Month	Consumption Per Month (kWh)	Cost Per Month (GHS)
2021	November	296,283.42	421,910.28
2021	May	256,810	331,729.01
TOTAL		553,093.42	753,639.28

*Table 3: Electricity Consumption of Facilities at UEW, Winneba Campuses  
Source: UEW 2022 Field Study*

Note: This bill represents cumulative billings derived from table 2 for Central Campus, Peku Building, Faculty Block, South Campus, University Hall, and Student's Centre encompassed as spending at Winneba campuses for two months in perspective. The billing information comprises 7 bulk meters. Source: UEW 2022 Field Study



*Figure 3: May 2021 and November 2021 Electricity Consumption and Charges*



Note: This is an overview description of energy consumption for the month of May 2021 and November 2021 at the University of Education, Winneba – Winneba Campuses

### *3.3. Factors That Influence Expenditure on Electricity*

The second research question for this study sorts to find answers to what accounts for the increase in the cost of electricity bills at the University of Education, Winneba. The following were gathered as factors that influenced the increase in energy usage at the University of Education, Winneba.

#### 3.3.1. Occupancy Behaviour

The study gathered that occupancy behaviour significantly contributed to the growing increase in electricity bills at the university. Responses from a larger number of respondents representing 78%, indicated that the majority of occupants in various offices paid little attention to using energy efficiently, while 22% of respondents suggested that they paid attention to conserving energy at the workplace.

The study gathered that office occupants mostly left air conditioning units on and running while absent from their office for one reason or the other. These durations lasted between five minutes and one hour, leaving the offices empty (without occupants). The study gathered that some office occupants, on some occasions, left either or both their air-conditioning units or ceiling fans on, left their lights on, and went home after office hours. It is evident that occupants of office spaces did not practice the same energy efficiency behaviours they did in their various homes with the perception that these office blocks in question were not run on their own funds. Furthermore, in the absence of the provision of a kitchenette, some officeholders came to their offices with water kettles to prepare breakfast. In some instances, some office holders or occupants left personal electric and or electronic devices on and running while attending brief or long meetings in other offices. This clearly suggests that the attitude of members in various offices played a significant role in the surge in expenditure on electricity bills. The study also gathered that in some offices there were refrigerators that were virtually empty but were still running at full capacity. Data gathered indicated that occupants, in some cases, used both ceiling fans and air conditioners at the same time while in the office. These practices cumulatively have contributed to the increase in the total monthly wattage of electricity used by the university.

#### 3.3.2. Temperature

Between the hours of 8:00 a.m. and 10:00 a.m., the temperature in various offices at the University of Education, Winneba, lies between 26° – 28° C (79° – 82°F). During such periods, energy could be conserved, whereas members considered keeping their air-conditioning units off and resorting to using either natural ventilation (opening operable windows for natural ventilation) or a combination of natural ventilation and ceiling fans rather than other than active cooling (running air-conditioning units).

Data gathered from 81% of respondents suggested that occupants run their air-conditioning units during these hours at temperatures as low as 18°C on air-conditioning units. Despite this practice, all respondents representing 100% agreed that the temperature within such periods was reasonably cool. This indicates that the office temperatures did not warrant the use of air-conditioning units between those times. Between 11:00 a.m. and 4:00 p.m., the temperature rises up usually between 28° – 31° C. Occupants indicated that during these periods, they could not help relying on air-conditioning units for active cooling. However, between the hours of 4:00 p.m. into late at night, around 10:00 p.m. (in cases where occupants stay overtime to work), the temperature in various offices falls between 27 – 29 degrees Celsius. Such hours ideally permit office occupants to use natural ventilation. However, occupants still maintain their air-conditioning units during such hours, even in conducive natural room temperatures. Direct sunlight reflected through windows did not greatly affect room temperature because glass slide windows were tinted; hence it was eco-friendly to occupants.

#### 3.3.3. Health Implications

24% of respondents agreed that they practised energy-efficient office habits because it was healthier. Such practices included opting for natural ventilation and minimal usage of artificial illumination to artificial illumination and cooling. This section of respondents suggested that health implications associated with excessive exposure to artificial light and cold temperatures were reasons for using natural ventilation from operable windows rather than active cooling. 76% of respondents did not consider health implications while using artificial lights and artificial cooling.

#### 3.3.4. Illumination

In Winneba, the sun rises mostly from the east around 5:50 a.m. and sets around 6:00 p.m. Illumination during the hours of 8:00 a.m. to 9 a.m. in offices whose blocks that did not directly face the rising sun was usually low. However, these offices that found themselves away from direct illumination from the rising sun at the east quickly gained good illumination between 9 and 5 p.m. Irrespective of the general situation of good illumination. Office occupants still keep their lights on throughout the day. 79% of respondents kept their lights on during the day amidst good illumination in the office spaces while keeping window blinds or curtains down, while 21% considered keeping their window blinds or curtains open during the day to allow natural sunlight into their office spaces.

Windows within the aisle of office blocks were identified as mostly transparent. The majority of respondents represented by 83%, mentioned the need for privacy as a concern in some cases; hence they kept window blinds shut or curtains drawn throughout the day while using artificial lights inside their offices.

### 3.3.5. Increase in Staff Strength

The study gathered that one significant cause of the increase in wattage usage by the university was the increase in staff strength. The staff ratio of the university has doubled over time due to the growing student population and meeting the institution's needs through human resources. This has gone in sync with infrastructural investment on the university campuses in Winneba, which has also doubled. Once more staff are employed vis-a-vis the construction of more office blocks in an attempt to meet the growing demands of the institution, it is consequential to expect an increase in expenditure through financial projections and subsequently experiencing it.

### 3.3.6. Utility Tariff Adjustments

The study gathered that adjustments by the energy distributor, Electricity Company of Ghana (ECG), contributed to the increase in electricity adjustments. However, respondents agreed that practising energy-efficient use of electricity in their offices could have helped check the increases in expenditure to a significant extent.

### 3.3.7. Socio-demographic Determinants

This study used review documents as part of data collection instruments. From data gathered through questionnaires and review documents, the study supports that various individual (socio-demographic and psychological) and situational (contextual and structural) factors may influence energy saving. (Frederiks, Stenner, and Hobman 2015). Cibinskiene, Dumciuvienė, and Andrijauskiene, (2020) opine that the concept of socio-demographics refers to the definition of a group according to its sociological and demographic characteristics. They further state that socio-demographic determinants include age, gender, education and literacy, employment status, socioeconomic status and income, dwelling characteristics, and geographical location. At the University of Education, Winneba, it was identified that socio-demographics influenced members' attitudes toward energy usage in their various offices.

## 4. Conclusions

21st-century goals of greening the environment and saving energy, and shifting from fossil fuel to environmentally friendly fuel processes are pivotal considerations in the United Nations Environmental Program's agenda for Sustainable Development Goals. Energy waste is a growing global challenge that needs to be addressed. Solar energy as an alternative energy source other than hydrothermal energy is cost-efficient in its long-term cost benefits, considering that it is designed to reduce monthly power bills and expenditure on fuel needed to run plant generators during power outages. The use of solar energy as an alternative approach supports the use of environmentally friendly energy since it is considered the cleanest renewable energy source in the world, with Ghana having it abundantly. This is in connotation with the United Nations Environmental Program's initiative for promoting the practice of using renewable energy. There should be sensitization on energy conservation in the university. This should be followed up with the implementation of policies that are structured to help the institution use energy efficiently to reduce the high cost of expenditure on electricity bills. Accompanied by the need for behavioural change is the monitoring of how energy is used in offices. Considering the installation of photocells in offices will control the frequency of lights being turned on in offices, while the use of one-way vision windows for windows in lobbies will also allow light into offices and still ensure privacy without occupants needing to use window blinds and curtains during the day – a practice which forces them to turn lights on during the day rather than resorting to natural illumination. These practices going-forward will lead to a projected significant decrease in expenditure on electricity at the University of Education, Winneba.

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