A Study on Energy Demand and Consumption in Covenant University, Ota, Nigeria

Oyedepo, S. O, Adekeye T, Leramo, R.O, Kilanko, O, Babalola, O.P, Balogun A. O and Akhibi M. O
Mechanical Engineering Department,
Covenant University,
Ota, Ogun-State, Nigeria
Corresponding Author: Sunday.oyedepo@covenantuniversity.edu.ng

***Abstract* - In this study, energy audit was conducted at Covenant University to assess the pattern of electricity consumption in order to improve energy consumption efficiency in the University. Space cooling (29%) and lighting (29%) have the highest percentage electricity consumption in the university. In the academic buildings, maximum power is consumed in space cooling (49%). In the staff quarters, lighting application consumed maximum power (39%), followed by space cooling application (18%). The annual energy and cost saving potentials for replacing traditional fluorescent tube lights (FTLs) and incandescent bulbs with compact fluorescent lamps (CFLs) in the students' hostels and in the staff quarters are about 394 MWh, N4.8 Million ($30,000) and 641 MWh, N7.9 Million ($49, 375) respectively. For space cooling systems, the annual energy and cost saving potentials for replacing conventional resistance electric regulator fans with electronic regulator fans is about 367 MWh and N 9.8 Million ($61,250), respectively.**

Index Terms – Energy saving, University campus, Electricity consumption, Electricity demand

I. INTRODUCTION

The importance of energy availability in the economic growth, social and political development of every nation cannot be overemphasized [1]. Energy plays the most vital role in the economic growth, progress, and development, as well as poverty eradication and security of any nation. Uninterrupted energy supply is a vital issue for all countries today. The objective of the energy system is to provide energy services. Energy services are the desired and useful products, processes or indeed services that result from the use of energy, such as for lighting, provision of air- conditioned indoor climate, refrigerated storage, transportation, appropriate temperatures for cooking, industrial processes such as conversion of raw materials to final products, etc [2].

Large institutions, such as universities, consume large amounts of energy on a daily basis. Improving the energy practices at post-secondary institutions can not only directly decrease their environmental impact but also act as an example for change across the country. Because of their peculiar nature as knowledge transfer- based institutions, the energy source predominantly in use in the universities and other tertiary institutions for educational aids is electricity [3]. Therefore, the issues of electric energy availability, consumption and costs in universities with resident students and staff quarters can present a formidable challenge to any responsible administration. This is because its availability or otherwise can have profound effects not only on academic activities but also on the social and economic activities in the system [4].

In tertiary institutions, there is a considerable amount of population, including students, academic and administrative staff, researchers, and others who work or study in universities. Thus, energy needed for operations, including teaching and research, provision of support services, and in residential and hostel areas, it is almost comparable to small commercial. Since universities involve a large number of building users and facilities, environmental degradation caused by a huge amount of energy consumption by universities is getting to be a greater concern.

The University campus, being a miniature city with its power generating station consumes so much power for lighting, water supply, air-conditioning, ventilation, electrical heating equipment, and water heaters, amongst others. Conserving this energy will lead to reduction in energy consumption, operating costs, lesser lighting fixture replacements and reduction in accumulated heat generated by them, thereby leading to parts of the drive towards mitigating climate change and making buildings more environmentally sustainable [6].

Not only is energy consumption a significant cost to the University campus but it also contributes to the depletion of natural resources and environmental problems. At colleges and universities, energy consumption has a large impact on both financial and environmental interests. New construction, aging infrastructure, financial constraints, increasing energy costs, and environmental responsibility are motivating factors for University communities to re-evaluate their energy demand and related conservation programs [7].

Campus energy potential studies involve an energy auditing process that provides an opinion of the availability of energy efficiency resources on a campus and allows the development of cost and savings strategies. A campus energy potential study offers many of the same benefits as standard energy studies, such as an understanding of how efficient the campus is in energy utilization and a plan for energy reduction projects.

Unlike major economic sectors (industrial, commercial, transportation etc), very few campus energy potential studies had been carried out in recent past. Among which include the works of Unachukwu [3], Tang [4], Adelaja, et al. [5], Manjunatha, et al. [6], Choong, et al. [7], Wong, et al. [8], Aishwarya et al. [9] etc. None of these studies identified energy conservation measures, which when implemented on campus, will make the energy usage more efficient and less expensive. The need to bridge this important gap has provided the impetus for the current study.

The prime objectives of the present study are: (i) to investigate energy utilization pattern in Covenant University (ii) to raise awareness of the areas of energy savings at Covenant University and (iii) to recommend energy conservation measures to curb excessive energy consumption in the university.

The contribution of this work lies in the fact that this is the first attempt in the history of the institution to formally evaluate energy and cost savings opportunities in the University. The work will, in addition to creating the necessary awareness on energy consumption pattern in the university, provides a reference point for planning, budgeting and future activities with respect to end-use energy efficiency and management measures in the University.

II. MATERIALS AND METHODS

2.1 *Study Area*

Covenant University (CU) is a private Christian University located at km 10 Idiroko road, Ota, South Western zone of Nigeria. It was inaugurated on 21st October 2002. The population of the University has grown from 1392 students at inception in 2002 to over 8319 students, 374 academic staff and 502 non-academic staff in 2011. The University is fully residential with 10 resident hostels with an estimated over 400 rooms per hostel building. In an addition, there are two colleges, six schools and twenty- two departments. There are also several public and academic buildings (University guest house, 2- cafeterias, university library, university chapel, shopping malls, lecture theatre, and sport centre). The university also has 206 staff housing units of various grades (1- bedroom flat, 2-bedroom flat, 3-bedroom flat and duplex). The university is indeed a mini- township.

2.1.1 *Data Collection and Analysis*

A walk through energy audit was carried out in order to acquire the power ratings of the electrical appliances/equipment used and electric power consumed in Covenant University.

In this study, the data collected include: average peak power consumed (2002-2011), total population of staff (academic and non - academic) (2002-2011), total population of students (2002 -2011), the disposable income of electricity (2002-2011), the electricity tariff (2002-2011).

All data collected were analyzed to identify energy conservation measures (ECMs), which when implemented, will make the energy usage more efficient, less expensive and more environmentally friendly.

The power consumption by equipment, applications as well as location is presented in form of charts for better understanding.

III. RESULTS AND DISCUSSION

3.1 *Breakdown of Major Electricity End Users*

The amount of energy use in a University campus depends on many factors. Key factors include the types of building envelope design, number of buildings (students' hostel, staff quarters, lecture rooms etc), student and staff population, operational efficiency of the electrical appliances, types of lamps and their efficacy, and building operation and maintenance. The first step in a breakdown of energy use is to establish a list of the major services or end users.

This section focuses on the various energy users in Covenant University.

3.1.2 *Electricity Consumption in Covenant University for Various end – uses*

A detailed breakdown of the energy loads (Fig. 2) in Covenant University reveal that both space cooling and lighting represent 29% of the total energy demand, followed by office equipment (especially personal computers, photocopiers and printers) (15%). Laboratory equipment/ machine is responsible for only 7% of total energy consumption while heating and cooking responsible for only 6% of energy consumption.

3.1.3 *Electricity Consumption in Academic Buildings*

Fig. 3 shows demand of electric power in the various academic buildings in Covenant University. College of Science and Technology (CST) building has the highest percentage of daily power consumption (21%). This is followed by the College of Development Studies (CDS) building (18%). Reason for this is because these buildings house up to 6 or 7 departments. For example CST building houses the following departments: Physics, Chemistry, Biology, Estate Management, Architecture, Building Technology, Biochemistry, Mathematics and Computer Science.

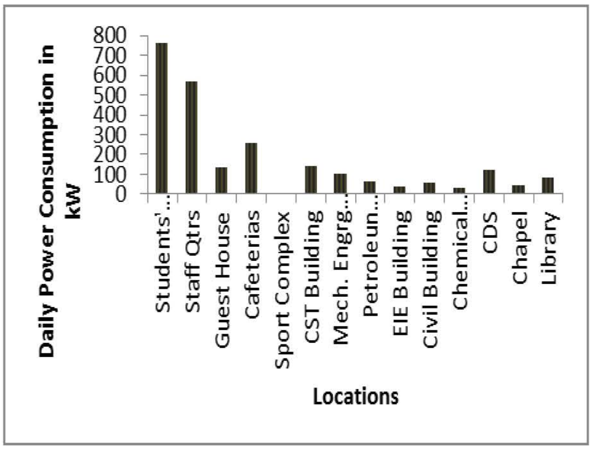

Fig. 1. Daily Power Consumption at Different Locations in Covenant University

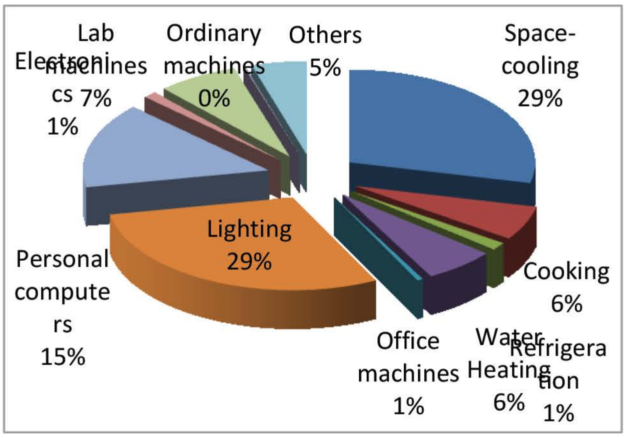

Fig. 2. Electricity Consumption in Covenant University for Various end- uses

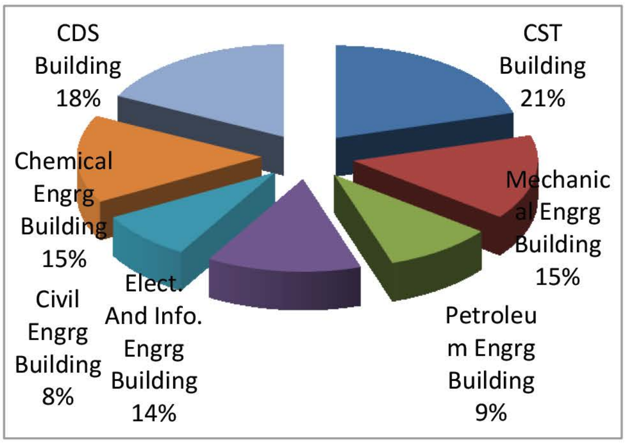

Fig. 3. Electricity Consumption by Various Academic Buildings

CDS building houses the following departments: Sociology, Psychology, Mass Communication, Business Studies, Political Science & International Relations, Languages, Economic, Banking & Finance and Accounting. Some of these departments have laboratories equipped with power consuming equipment/machines for research. Civil engineering building has the least demand for electric power (9%). This is due to the fact that the department has little electric power consuming equipment as at the time this study was carried out.

3.1.4 *Electricity Consumption in Academic Buildings for Various End-uses*

Fig. 4 shows electricity demand in academic areas in Covenant University. It's quite clear from the chart that maximum power is consumed in comfort applications (49%) such as air circulation appliances (fans) and air conditioners. To reduce the consumption in these applications, awareness about the energy conservation is very important and effective step. Laboratory equipment/ workshop machine takes 26% of total electric power consumption in the academic buildings. Efficient utilization of energy in this section is possible by carrying out constant preventive maintenance measures of the equipment/ machine, replacement of worn - out parts and replacing old machine/ equipment with efficient equipment. Lighting with 17% of total power consumption is an application where energy efficiency can be achieved very easily by replacing old appliances by new efficient ones.

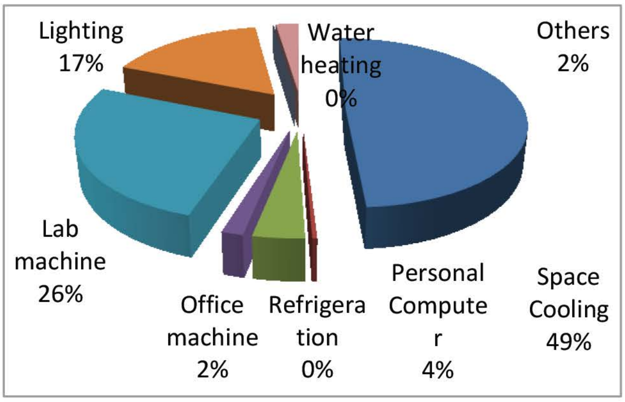

Fig. 4. Electricity Consumption in Academic Buildings by Various end – uses

3.1.5 *Electricity Consumption in Residential Area for Various End-uses*

Fig. 5 shows electricity demand in residential areas (staff quarters) in Covenant University. The lighting application consumed maximum power (39%). This is followed by space cooling application (18%) such as air circulation appliances (fans) and air conditioners. Cooking and water heating applications take 12% of total electric power consumption in the residential areas. From this survey, the greatest potential for energy savings in the residential areas of this university is in the lighting and space cooling. To reduce the consumption in these applications, awareness about the energy conservation is very important and effective step.

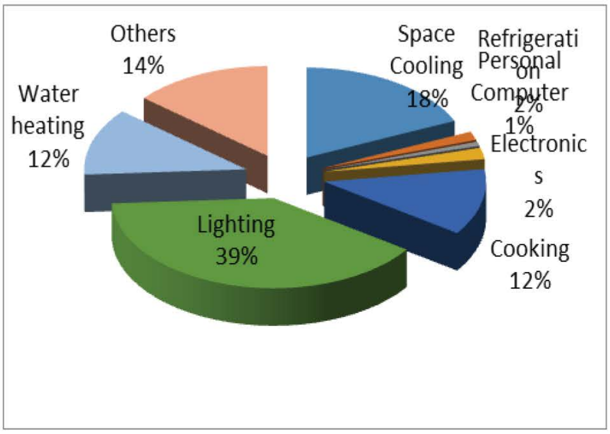

Fig. 5. Residential Energy Consumption for Various end – uses

3.2 *Annual Electricity Consumption*

Table I presents the annual electricity consumption and total population (students and staff) of Covenant University campus for the period of ten years (2002 - 2011). Per capita consumption of electricity in Covenant University during the period of consideration varies from 50 kWh/person to 522 kWh/person. Variation in per capita consumption of electricity is due to epileptic power supply from national grid. The University was able to overcome the challenge of power supply from national grid in 2010/2011 when it started getting supply from a private power supply using gas generator.

Fig. 6 shows the annual cost of electricity profile in millions of Naira. The marginal increase in electricity consumption from 2008 as compared to the previous years is attributed to increasing population, growing number of staff residential and academic buildings, increases in commercial activities, and a fairly steady power supply within the campus. With increase in electricity consumption in the university, there was rising in electricity bills from about N27.6 million in 2002 to over N139 million in 2011.

The rise in electricity bill is basically due to about 112% hike in tariff from N5.8/kWh in in 2002 to N12.30/kWh in 2011.It is therefore expected that with constant year round electricity supply, consumption and hence the energy bill will likely double the current figure. This information is very important as it will help policy makers and all stakeholders of Covenant University to be aware of the desired need to reposition the University towards adopting energy efficiency measures that will not only save costs but minimize environmental fallouts from electricity generation.

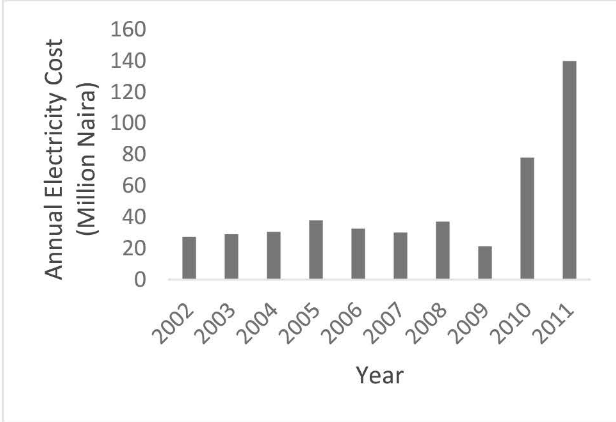

Fig. 6. Annual Electricity Cost Profile.

IV. NEEDS FOR ENERGY MANAGEMENT IN COVENANT UNIVERSITY

The goal of any organization is to have employees behave in a manner consistent with the company's mission and goals i.e aligning absolutely with the core values, adhering to a code of ethics and matching actions with beliefs across a variety of situations [31]. Meanwhile, integrity play a fundamental role in employee pattern of alignment, sound moral, ethical principles and organization productivity [15]; [36]. Moreover, absenteeism, unwarranted breaks, stealing of organization property, converting office equipment for personal use, gossiping etc. are characteristics of unethical conducts and are liable to affect organization productivity [26]; [32]; [34]. However, the organization level of productivity is directly proportional to employee level of commitment and satisfaction, thus, the commitment and satisfaction becomes immaterial if it does not infused with integrity [10]; [11]. Integrating values of integrity into the day-to-day operation of an organisation will promote employees ethical behaviour, prevent damaging lapses while tapping into human instincts for moral though/action and as well enhanced sustained productivity [11].

Therefore, we propose the null hypothesis that; H_2: *Integrity will not in any way contribute to organizational productivity.*

V. EMPLOYEE COMMITMENT AND PRODUCTIVITY

As Covenant University's enrollment grows, new buildings are constructed and there is increase in the use of technology, hence, there is significant increase in the use of electrical energy. Therefore, there is need efficient utilization of electricity at every place wherever possible so as to avert unplanned power outages and reduce electricity bills.

4.1 *Energy Saving Opportunity*

"Electricity saved is electricity generated". In today's scenario, developing nations, such as Nigeria is facing various challenges of saving electricity. Various electric appliances ranging from lighting bulbs to space cooling systems (e.g fans and air conditioners) are flooded into the market, which are not energy efficient. Hence requirement of energy efficient devices is of utmost importance in view of the futuristic energy requirements. The uses of electricity in office and house hold appliances like air conditioner, refrigerator, electric cooker is obvious and if these devices can be made more energy efficient, handsome amount of electricity can be saved in Covenant University campus.

In this section, selected areas of intensive energy uses are considered for energy and cost saving potentials in the University:

4.1.1 *Lighting*

Lighting units play a major role in the consumption of electricity in the campus as shown in Fig. 2 and 5. This area offers several energy saving opportunities.

The common types of light throughout the campus are traditional fluorescent tube light (FTL) (40 W) and incandescent bulbs (60 W).

To assess possibility of energy saving through lighting in the university, the total energy consumption by lighting and its cost for each location was calculated by the equations 1 to 3. Energy and cost saving potentials through replacement of existing light fixtures (incandescent bulbs and FTL) with energy efficient lamps (compact fluorescent lamps (CFLs)) in students' hostels and staff quarters are presented in Table 4.

The total energy demand (TED) in kW (i.e the amount of electricity being pulled out of the power grid at any given moment) is given by:

$$TED = \frac{SW}{1000}.n \times F_d \quad (in\ kW)$$
(1)

where n is the number of lamps, SW is the system wattage and F_d is the demand factor. F_d is the assumed average percentage of available lighting used at a building's peak time. In this study, the demand factor is taken as 100% (all the lights are always switched on).

The total energy consumption from lighting (TEC) in kWh is determined as follows,

$$TEC = \frac{SW}{1000} \times n \times h \quad (in\ kWh)$$
(2)

where h is the total hours lighting is used during the year.

The total energy consumption cost (TECC) is computed as:

TECC = TEC x CUE (in Naira)
(3)

where CUE is the current cost of a unit electricity in Nigeria tariff.

Proposed lighting fixtures are the energy efficient light bulbs and appropriate lamp holders. The estimation of cost and consumption of the proposed fixtures was done using the same calculations for the existing luminaire fixtures.

Fig. 2 and 5 show that lighting units play major role in the consumption of electricity in the University. This energy user offers energy saving opportunities.

The common types of lighting fixtures throughout the campus are traditional fluorescent tube light (FTL) (40 W) and incandescent bulbs (60 W). Proposed lighting fixtures are the energy efficient light bulbs and appropriate lamp holders. The estimation of cost and consumption of the proposed fixtures was done using the same calculations for the existing luminaire fixtures.

In this study, hours of operation in a year of electric appliances in students' hostels, lecture rooms is assumed to be a function of period the students spend in the school. Hence, h is assumed to be 1440 hours (if students are to spend 6 months in a session, average of 8hrs / day x 180 days). For staff quarters (average of 8hrs/day x 365 days = 2920 hours).

Cost of a unit electricity in Nigeria tariff is N12.30 /kWh (7.69 US cent/kWh)

Students' hostels and staff quarters are considered for energy and cost saving potentials by replacing current lighting fixtures with energy efficient bulbs.

The above equations 1 to 3 are used to compute energy and cost savings for replacement of incandescent bulb (60 W) and FTL (40 W) with CFL (25 W) in the students' hostels and staff quarters. The results are presented in Table 2.

Total cost saving (Students' hostels & Staff quarters) = N 4,533,829.2 + 8,228,176.02 = N 12,762,005.22 ($79,762.53)

Total number of conventional FTL and incandescent bulbs = 23,114

Cost of replacing each conventional FTL and incandescent bulb with CFL (25 W) = N 500 ($3.13)

Total cost of replacing conventional FTL and bulb = N 23,114 x 500 = N 11,557,000 ($72,231.25)

Capital cost recovery time = (11,557,000)/(12,762,005.22) = 0.91 yr

From above analysis, the annual energy saving potentials for replacement of traditional fluorescent tube light (FTL) (40 W) and incandescent bulb (60 W) with CFL (25 W) in students' hostels and staff quarters are about 394 MWh and 644 MWh respectively. The annual cost saving potential for replacement of FTL (40 W) and incandescent bulb (60 W) with CFL (25 W) in the same locations are about N4.8 million and N7.9 million respectively. The capital cost recovery time for replacing all conventional FTLs and incandescent bulbs is around 0.91 year.

4.1.2 *Space Cooling Systems*

Fig. 2 and 4 show that space cooling system also consume significant amount of electric energy. Energy and cost savings in space cooling systems are evaluated in this section.

To assess possibility of energy and cost savings through space cooling systems in the university, the same procedure for lighting is used. Energy and cost saving potentials through replacement of existing space cooling systems with energy saving space cooling systems in students' hostels and staff quarters are considered.

Replacement of Resistance Regulator Fans by Electronic Regulator Fans

The common types of fan available on the campus are resistance regulator fans with power rating 70 W at full speed. Replacing these fans with electronic regulator fans having power rating 40 W at full speed, considerable amount of energy and money would be saved. Table 3 presents results of energy and cost savings for replacement of resistance regulator fans with electronic regulator fans.

Total number of resistance regulator fans = 6513

Cost of replacing resistance regulator fans with electronic regulator fans = ₦ 1500 ($ 9.38)

Total cost of replacing resistance regulator fans = ₦ 6513 x 1500 = ₦ 9,769,500 ($ 61,059)

Capital cost recovery time = (9769500)/ (5197071.72) = 1.88 yr

Hence, the capital cost recovery time for replacing all resistance regulated fans in the students' hostels and staff quarters is around 1.88 years.

VI. SOLUTIONS TO REDUCE ELECTRICITY CONSUMPTION

The energy consumption in Covenant University can possibly be brought down by energy management and proper usage of the resources. The following points shed light on the ways that can be profitably implemented in order to lower consumptions and manage electricity.

- *Efficient Lighting Upgrades*

  Compact fluorescent lamps (CFLs) are generally considered best for replacement of lower incandescent lamps at homes. They are energy saving lamps. These lamps have efficacy ranging from 55 to 65 lumens/watt. The average rated lamp life is 10,000 hours, which is 10 times longer than that of a normal incandescent. They offer excellent colour rendering properties in addition to the very high luminous efficiency.

  The greatest advantage of the CFLs is its energy efficiency during use, with much less energy lost to heat. The CFLs typically convert about 45% of the electricity to visible light, whereas the incandescent bulbs only about 10% [12]. Since the CFL's take advantage of both passive and semiconducting electronic components, they involve complex manufacturing flows and induce greater energy demand.

- *Retrofitting ballasts and lighting for lower costs and higher efficiency*

  Fluorescent lights need ballasts (i.e devices that control the electricity used by the unit) for starting and circuit protection. Ballasts consume energy. Existing fluorescent ballasts can be replaced with improved electromagnetic ballasts and electronic ballasts. This could raise the efficiency of the fixture by 12% to 30%.

  The new electromagnetic ballasts reduce ballast losses, fixture temperature, and system wattage. Since they operate at cooler temperatures, they last longer than standard electromagnetic ballasts.

- *Use of Time Scheduling Device for Power Supply*

  The advent of embedded systems has given a scope to make programmable devices such as the timer circuit to control the power supply. The device is programmable and each day's time table can be fed into it. The device will operate the power supply only when there is a lecture and otherwise switched off, thus, operating on a pre-determined schedule.

- *Use of Bureau of Energy Efficiency (BEE) Star Rated Electrical Appliances*

  The University should use and promote the replacement of appliances to BEE Star-Rated appliances. This further adds to energy saving. Emphasis on using such appliances should be popularised and awareness should be increased in the favour of energy saving.

- *High efficiency equipment*

  High efficiency equipment reduces the energy needed to deliver a given level of energy services or produces more energy service per unit of energy. A careful observation of Fig. 5 shows that space cooling, lighting and personal computers are items which consume the bulk of the energy supplied to the university, thus flagged areas for potential improvement of efficiency.

- *Reducing cooling demand (need for air conditioning)*

  In Covenant University, energy demand for space cooling can be reduced by:

  - Controlling solar gains by avoiding excessive glazing, use of shading and blinds, glazing with the lowest solar heat gains factor;
  - Selecting office equipment with reduced heat output;

- Making use of thermal mass materials and night ventilation to reduce peak temperatures
- A building design that maximizes natural ventilation (air passing from one side to the other side of the building)

- *Reducing energy use for lighting*

  Energy use for lighting in Covenant University can be reduced by
  - Appropriate window design and glass to make maximum use of daylight while avoiding excessive solar gain
  - Energy efficient lighting systems (e.g. using task lighting to avoid excessive background luminance levels;

- *Use of Energy Management Device Based on Image Processing*

  The lighting and power supply can be controlled by occupancy sensing. The feature of this device is that it controls the power supply of any place by sensing occupancy by any human. The distinguishing feature is that only human occupancy is detected. This device uses image processing and pattern recognition. This device is found to be an efficient method to implement energy management at a low cost. The Management should endeavor to install an occupancy sensor in the students' hostels, lecture rooms and staff offices where a lot of energy is wasted by leaving light on even when nobody is in the room or office.

- *Encourage Energy-Saving Behavior*

  A number of colleges and universities are successfully using no-cost and low-cost public awareness campaigns to reduce energy use on campus. One popular—and effective—energy awareness program is the Dorm Energy Challenge, in which residence halls compete against one another to make the largest energy reductions or simply to improve their own energy performance. Other popular programs include "Green Crib Certified" awards for students with eco-friendly dorm rooms and "Eco Reps" programs to encourage peer-to-peer sustainable behavior in residence halls. This strategy also can be adopted in Covenant University in order to save energy.

- *Replacing Resistance Regulator Ceiling Fans with Electronic Regulator*

  Electronic regulators are the latest type of regulators available in the market. These are much smaller in size than the electric resistance regulators. Electronic regulators use capacitors instead of resistors to decrease the voltage. Capacitors regulate the fan speed by regulating the waveform of power supply. These do not get heated up and thus save electricity when the fan is running at lower speeds (at higher speeds electricity consumption of fan is the same with both regulators). These regulators save up to 40% of energy consumption at speed 1 and about 30% at speed 2 compared to electric regulators.

  From this study, it is shown that the electronic regulator is more energy efficient but experience suggests that resistive regulators are more durable. Though it is still mentioned here as a possible option to reduce energy consumption by the space cooling system – ceiling fan used in Covenant University.

- *Better Management Practices*

  Besides enhancing the efficiency of electrical appliances, better management practices should also be adopted. Students and staff should be educated to switch off the lights directly at the end of the day when not in use. It is important to unplug electrical appliances which are seldom used because these appliances will consume little energy when plugged continuously although they are switched off.

CONCLUSIONS

In this study, an energy audit was conducted at Covenant University in Nigeria looking for ways to reduce energy consumption and costs. With time, the numbers of students are increasing, use of new facilities and technology are also increasing the utilization of electricity is going to increase. Hence, there is need for energy conservation measures to curbs excessive energy consumption in the University.

This study reveals that at Covenant University electricity consumption increased from 324.12 to 3942 MWh from 2002 to 2011 as the population increased from 1461 to 3197. Moreover, buildings of more functionality consume more electricity as more types of appliances are used for different functions. Space cooling and lighting have the highest percentage of electricity consumption of the total energy demand in the University.

The annual cost of electricity profile for the period under consideration (2002 to 2011) rose from ₦ 27.6 Million ($172,500) in 2002 to over ₦ 139 Million ($868,750) in 2011. The result of this study shows that the annual energy and cost savings for replacement of traditional fluorescent tube light (FTL) and incandescent bulbs with CFL in students' hostels and staff quarters are about 394 MWh, N 4.8 Million ($30,000) and 644 MWh, N7.9 Million ($49,375) respectively. While the capital cost recovery time for replacement of all conventional FTLs and incandescent bulbs is around 0.91 year. Considering space cooling system (ceiling fan) the annual energy and cost savings for replacement of conventional resistance electric regulator fans with electronic regulator fan are about 367 MWh and N 9.8 Million ($61,250) respectively. The capital cost recovery time for replacement of all resistance electric regulator fans in the University is around 1.88 years.

From this study it can be concluded that the adoption of energy efficiency measures as part of the overall University developmental policy strategy would not only bring about substantial reduction in peak electricity demand but also in electricity bills, while resulting in energy conservation. Some of the policy options which the University can take to reduce energy spending include *inter alia:* enhancing the efficiency of electrical appliances, utilization of day-lighting, maximizing natural ventilation and better management practices. A well-articulated and vigorously pursued energy efficiency policy measures in the university can result in an estimated annual savings in electricity consumption of about 16 %. This certainly will ensure sustainable development in the university and possibly eliminate the pressure for the installation of additional electric generators (diesel or gas). This type of energy audits can be replicated at other University campus to reduce electricity bills.

REFERENCES

[1] Oyedepo, S.O (2014), 'Towards achieving energy for sustainable development in Nigeria', Renewable and Sustainable Energy Reviews 34: 255–272

[2] Oyedepo, S. O (2012), 'Energy Efficiency and Conservation Measures: Tools for Sustainable Energy Development in Nigeria', IJEE Volume 2, Issue 3, PP. 86-98

[3] Unachukwu, G.O (2010), Energy savings opportunities at the University of Nigeria, Nsukka, Journal of Energy in Southern Africa, Vol. 21, No 1, 2 – 10

[4] Tang, F.E (2012), 'An Energy Consumption Study for a Malaysian University', World Academy of Science, Engineering and Technology International Journal of Environmental, Ecological, Geological and Mining Engineering Vol.6 No: 8, 99 – 105

[5] Adelaja, A.O, Damisa, O, Oke, S.A, Ayoola, A.B and Ayeyemitan, A.O (2008), 'A survey on the energy consumption and demand in a tertiary institution', *Mj. Int. J. Sci. Tech.*, *2*(02), 331-344

[6] Manjunatha, P.M, Balachandra,T.C, Dsouza, O and Naik, B (2013), 'Energy Audit, Conservation and Power Factor Improvement for BMSIT Campus', International Journal of Research in Engineering and Technology, Vol.2 (11), Pp 354 – 359

[7] Choong, W.W, Chong, Y.F, Low, S.T and Mohammed, A.H (2012), 'Implementation of Energy Management Key Practices in Malaysian Universities', International Journal of Emerging Sciences 2(3), 455-477

[8] Wong, W.P, Liu, A.M.M and Fellows, R.F (2005), 'Use of Electrical Energy in University Buildings: A Case Study in Hong Kong', Surveying and Built Environment Vol 16(2), 7-18

[9] Aishwarya, C, Diwakhar, R, Ganesh, S and Harikrishna, N (2013), 'Energy Management, Conservation, Monitoring and Generation in a Campus', International Journal of Application, Innovation in Engineering & Management, Volume 2 (4): 553 – 563

[10] Joseph C. L, Ricky Y.C. C, Tsang, C.L and Danny H.W. L (2004), 'Electricity use characteristics of purpose-built office buildings in subtropical climates', Energy Conversion and Management 45: 829–844

[11] Bordass B, Cohen R, Standeven M and Leaman A (2001), 'Assessing building performance in use 3: Energy performance of the probe buildings', Build Res Inf , 29(2):114–28.

[12] Tosenstock, S. (2007), 'Another perspective. Electric Perspectives', Vol 32, No. 5 pp100-105

TABLE I: ANNUAL ELECTRICITY CONSUMPTION

Year	Electricity Consumption (kWh)	Total Population	Per Capita Consumption of electricity (kWh/person)
2002	324120	1461	222
2003	331128	3093	107
2004	332004	4497	74
2005	334632	6009	56
2006	332880	6693	50
2007	3293760	7095	464
2008	3442680	7272	473
2009	2934600	8056	364
2010	3871920	7416	522
2011	3942000	8319	474

TABLE II: ENERGY AND COST SAVINGS FOR REPLACEMENT OF FTL (40W) AND INCANDESCENT BULB (60W) WITH CFL (25W) IN STUDENTS' HOSTEL AND STAFF QUARTERS

Location/Fixture Type	No of Fixture	Annual Energy Consumption (MWh)	Annual Energy Cost		Annual energy saving (MWh)	Annual cost saving	
			(M₦)	(US$)		(M₦)	(US$)
Students Hostels							
FTL(40 W)	14,216	818.84	10.07	62,937.5	307.06	3.78	24,625
CFL (25 W)		511.78	6.29	39,312.5			
Incandescent bulb (60W)	1221	105.49	1.30	8,125	61.54	0.76	4,750
CFL (25 W)		43.96	0.54	3,375			
Staff Quarters							
FTL (40 W)	1980	231.26	2.84	17,750	86.72	1.06	6,625
CFL (25W)		144.54	1.78	11,125			
Incandescent bulb (60 W)	5697	998.11	12.28	76,750	582.23	7.16	44,750
CFL (25 W)		415.88	5.12	32,000			

TABLE III: ENERGY AND COST SAVINGS FOR REPLACEMENT OF RESISTANCE REGULATOR FANS (70W) WITH ELECTRONIC REGULATOR (40W) IN STUDENTS' HOSTEL AND STAFF QUARTERS

Location/Fixture Type	No of Fixture	Annual Energy Consumption (MWh)	Annual Energy Cost		Annual energy saving (MWh)	Annual cost saving	
			(M₦)	(US$)		(M₦)	(US$)
Students' Hostels							
RRF*(70 W)	4595	463.18	5.70	35,625	198.51	3.26	20,375
ERF* (40 W)		264.67	2.44	15,250			
Staff Quarters							
RRF* (70 W)	1918	392.04	4.82	30,125	168.02	2.06	12,875
ERF* (40W)		224.02	2.76	17,250			

RRF* - Resistance regulator fans, ERF* - Electronic regulator fans, M₦ - Million Naira