Energy Lens Software Used to Determine the Energy Usage of an Academic Building in a Tertiary Institution in Nigeria

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ABSTRACT

***T**he energy audit has its prime objective which is to evaluate a building's energy usage hence, recommend various energy management solutions that can satisfy increasingly demanding requirements of the power systems concerned. In historical building, with high energy consumption trends; decisions must be taken quickly to achieve rapid restoration of reduced energy usages and return of normal energy consumption condition with respect to the occupant behaviour or other energy audit abnormality. This study intends to explore the energy consumption within the month of August 2018 using Energy Software called Energy Lens. These techniques should recognize the existing occupants' behavioural characteristics in the building from using their appliances and lighting. The use of Energy Auditing software such as Energy Lens helps in assessing a wide range of different building types and environmental performance approach. From the analysis, the total energy consumption from the period of 1st august 2018 to 31st august 2018 was determined from the Energy Lens software to be 13,545kWh energy consumed. Heat loss of building (Q_{loss}) was calculated as 12.905W, the Building design heat loss (H) was calculated as 3.226W/K and Total ventilation heat loss (Q_{vent}) was calculated as 13,994.7W.*

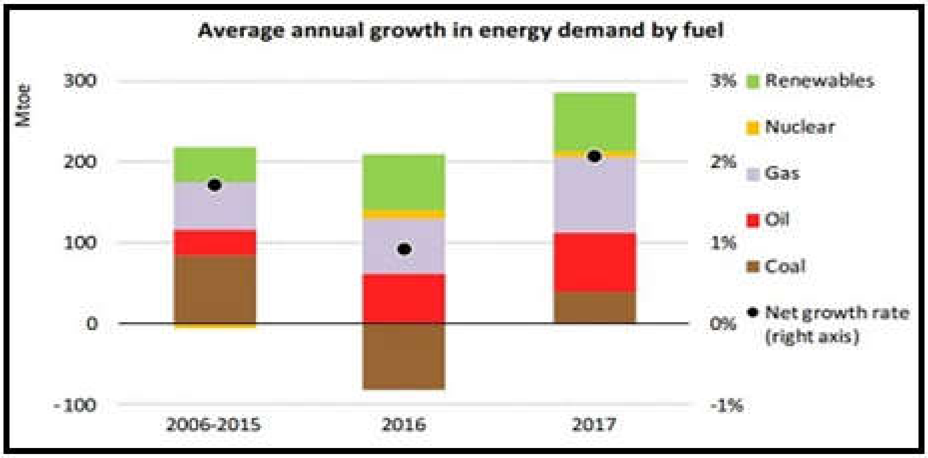
1. INTRODUCTION

An Energy audit can be used to develop an understanding of specific energy usage patterns of a particular building [2]. Increased energy demand trend in the world grew by 39% between1990 to 2008 and is predicted to increase by 40% between 2007 to 2030 [21]. Energy consumption in buildings has been identified to contribute up to 40% of the total world usage of primary energy sources [21]. Based on the theory of energy efficiency developed, it can be achieved through three main factors; a) Building design; b) Services design; and c) Occupant behavior [21]. Increased energy demand in buildings can be reduced by improving the efficiency of energy use. Although, based upon past studies show that this business is not an easy task.

In addition to concerns regarding the depletion of energy sources in the short term, energy saving can help to reduce the climatic impact of the huge emissions of carbon dioxide linked to the combustion of fossil fuels. The world's demand for energy grew by 2.1% in 2017; more than twice the previous year's rate according to new data form international energy Agency (IEA).

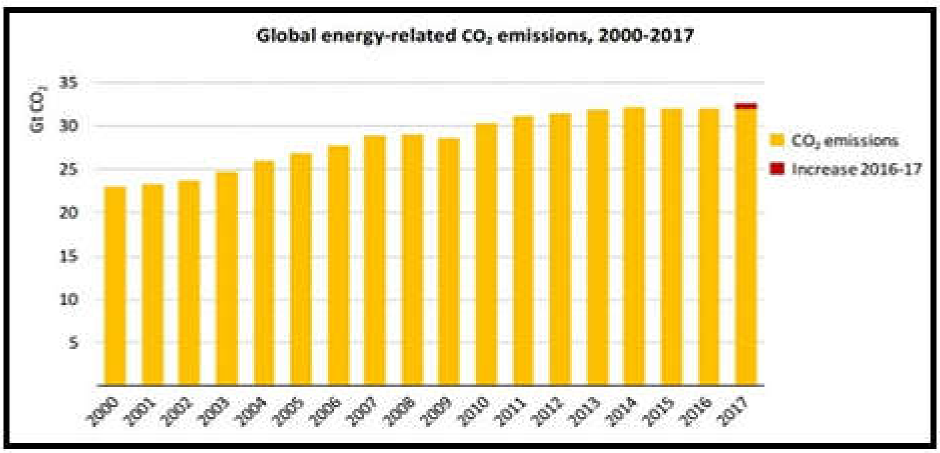
Graph 1.1 shows that the IEA noted (from Global and $C0_2$ Status Report) that 2016: 0.9% demand growth has been consistent with five-year average [6]. China and India accounted for over 40% of last year's rise in demand. 72% was met by oil, gas and coal. Renewable contributed 25% and remainder was supplied by nuclear power [5].

Electricity generation increased by 3.1% significantly than overall energy demand Global demand for natural gas grew by 3% in 2017 with fuel 22% of world's energy demand due largely to it increased availability and relatively low cost. 80% this demand growth came from industries and buildings which overtook the power sector as the top gas consumers for the first time in a decade meanwhile, coal grew by 1% reversing two year's downtrend due largely to increase in coal fired power generation in Asia [5].



Graph: 1.1 Average annual growths in energy demand by fuel [5]

From 2000-2012 renewable energy grew at a rate higher than any other point in history with a consumption increase of 176.5 million tons of oil. The following features illustrate the growth in consumption of fossil fuels such as oil coal and natural gas as well as renewable sources of energy during this period, World energy consumption [37].



Graph: 1.2 Annual energy demands by region [5]

Graph 1.2 shows a steady continuous rise in the amount of CO_2 emissions from 2000 to 2017, indicating approximately 23.5Gt CO_2 to 32Gt CO_2 over this period. The poor management, unknown information on amount of energy consumed by building uses, occupants behavioural patterns toward energy usage decreases energy efficiency. Thus, it is necessary to conduct an energy audit to determine and understand the energy usage within the physics building of Federal University Wukari, this will enhance good energy management, improve energy efficiency within the building and reduce the amount of expenditure (Financial) on electricity being consumed. The objectives of an energy audit are to identify and develop modifications that will reduce the energy utilized by both building and its occupants. The main objectives of this study are:

i. Determine the Buildings Energy Heat Loss (Q_{loss}), Building Design Heat Loss (H) and Total Ventilation Heat Loss (Q_{loss}).
ii. Find possible solutions for proper energy management.
iii. Use a prototype energy tool (Energy Lens) to analyze the buildings energy status.
iv. Identify energy wastages within the building.

2. LITERATURE SURVEY

Energy is the basic necessity for the economic development of a country [22]. Many function necessary to present day living grind to a halt when supply of energy stops. It is practically impossible to estimate the actual magnitude of the past that energy has played in the building up of present day civilization. The availability of huge amount of energy in the modern times has resulted in a shorter working day [22]. The greater the per capital consumption of energy in a country, the higher is the standard of living of its people.

The power sector has existed for over 100 years. Throughout this time, it has experienced waves of change in structure and regulatory approach driven by technical and economic developments [22]. Probably, the most fundamental change taking place in the electric utility industry is the move toward a quantitative basic for the management of service reliability. Hence energy management is a systematic and scientific process to identify the potential for improvements in energy efficiency to recommend the ways with or without financial investment, to achieve estimated saving energy and energy cost. Thus, the need to conserve energy, particularly in the industry and commerce is strongly felt, as the energy cost takes up substantial share in overall cost structure of operation called management of resources or energy conservation. [12]. Therefore, energy efficiency has become a common target for every building; the European Directive 2010/31 provides that by 2020 every new building must consume very little fossil energy (Nearly zero Energy building) and from 2018 also building will have to meet this requirement [12].

Although, the objectives imposed by the new legislative references are very clear, modifying the existing heritage on many cases is not easy. For example, many building including public ones, in addition to consuming a lot of energy, are constrained by architectural, landscape, historical and artistic assets; therefore, it becomes difficult to improve their energy performance. The energy audit of physics building of federal University Wukari, the intervention and particularly the energy consumption reduction in the building allow the outline an overview of the accessible energy savings, and their costs. This research presents the development of a building performance and design tool that is intended to assist the Nigerian government with building codes and policies and also building practitioners with the design process.

2.1 Characteristics of the Building

The building is mainly built for academic purposes of Faculty of Pure and applied sciences, Federal University Wukari. The building has a plan configuration with a rather rectangular shape. The building is composed of one ground floor with 15 individual offices, 3 laboratories, 3 waste compound (WC) and 2 class rooms and 1 multi-purpose hall. The building has a V-shape roof, a maroon color roof sheet and is occupied 5 to 6 days per week. The root has an internal thermal insulation (ceiling), on the root and a flat slab on the root and the ground floor being the V-roof a maroon root. Regarding the translucent envelope is composed by double by glazing areas with low emissivity coating with internal shading system (interior blinds) and external over hangs. The AC system was design to provide the indoor cooling temperatures. The thermal comfort and the indoor air quality are provided by the Air Conditioning system with a radiant floor system [3]. Each office has an air conditioner and more in the laboratories while the WC is channeled water system.

2.2 Purpose of the Building Usage

This building is an academic building with offices and lecture rooms, hence it main purpose is to accommodate students during lecture periods and the offices are to accommodate both academic and non-academic staff for the research purposes, documentation and other non-academic activities. In addition, another source of electricity use in building miscellaneous electric load (MELs) that is totally impacted by building users. MELs is defined as "electricity –consuming loads that do not fall under conventional and uses, such as lighting, HVAC, and refrigeration. Studies show that MEL's energy intensity tends to increase while energy demand or conventional end uses is projected to decrease or remain unchanged.

2.3 Occupants of the building

The building is occupied accordingly, the academic offices are occupied by the staffs, non-academic offices (such as laboratory offices) are also occupied by the non-academic staffs, the classroom are occupied by the students for lecture/study and the laboratories for the research/experiment which are mostly occupied by the students during experimental research. The building operates for 6 working days (Monday to Saturday) per week from 8:00AM to 4:00PM.Therefore, many studies refer to occupant's role as a negative source of unnecessary or unexpected energy use. While, it can also be perceived as an opportunity to better efficiency and conservations. This purpose can be achieved through increasing building user awareness about energy efficient how impact technologies and also promoting environmental sustainability behaviors and actions.

2.4 Energy Lens Software

Energy lens is software used for charting and analyzing energy consumption rates within a building. Energy is use to monitor and manage energy use by energy managers, facilities managers, and energy services engineers advising them. This software was designed and built on a simple premise; you can only start to save energy when you clearly see how are using it. Energy lens seamlessly plugs in excel. It turns detailed, raw energy- consumption data into useful charts and figures which can be used to visually identify;

i. When and where you are wasting energy.
ii. How much energy being wasted.
iii. Progress made in reducing energy consumption.

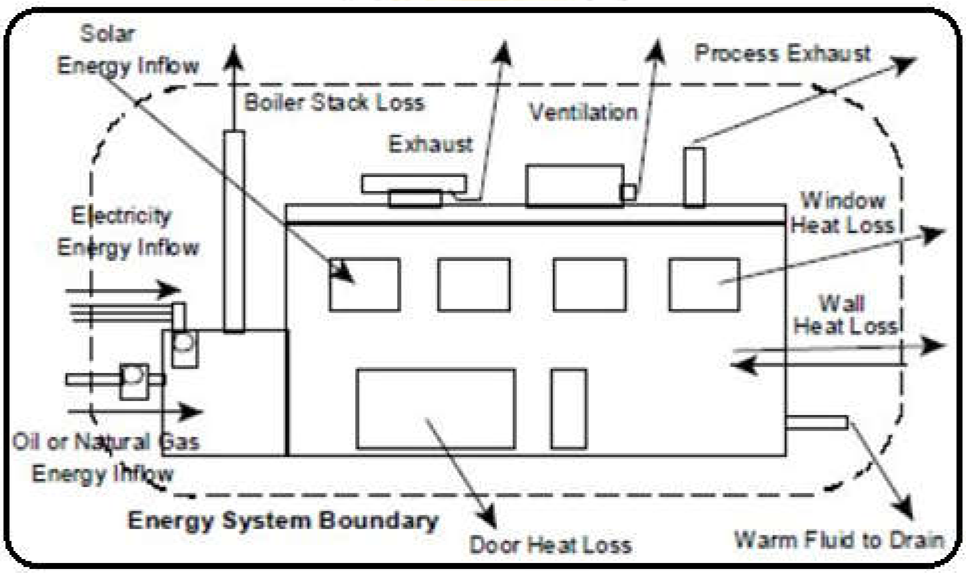


Fig 2.1 Facility energy system [10]

Energy lens focuses exclusively on, high-resolution interval energy data. The detail interval energy data makes analysis a chore. Using metering for effective management requires consumption to be detailed at regular periods throughout the day. It's a detailed record of energy usage that comes from automated meter reading made at regular intervals such as every 15minutes or half hour. But the fact is, no amount of time spent analyzing weekly or monthly figures will reveal the patterns energy saving opportunities detailed interval data displays in seconds. Therefore, energy lens analysis helps to see where energy is going, where it's being wasted, and how much progress you making at reducing consumption instead of haphazardly changing light bulbs, replacing equipment that is actually fine, and putting up vague 'save energy" posters, the insight that the detailed analysis gives helps you to prioritize and focus on the activities that brings you the biggest more energy savings. The first challenges involve, in defining a system, as noted by system we mean any energy consuming building, area within a building, operating system, collection of equipment. Many audits will involve "layers" of assessment with the scope of focusing from the facility level inwards to specific types of equipment. The second challenges are the more technically difficult one, as it involves the collection of flow. Data from various sources including direct measurement. It also likely involves the estimation of energy flows that cannot be directly measured, such as heat loss through a building wall, or invented air.

2.5 Type of Energy Audit: is classified into the following categories

i. **Walk-through audit:** This consist of a short on site visit of facility to identify areas where simple and inexpensive actions such as operating and maintenance measures can provide immediate energy-use and operating cost savings.
ii. **Utility costs analysis:** This includes careful evaluation of metered energy uses and operating costs of utility. The utility data over several years are evaluated to identify the patterns of energy use, peak demand, weather effect and potential for energy savings.
iii. **Standard energy audit:** This refers to comprehensive energy analysis for energy systems of the facility. Standard energy includes the development of a baseline for the energy use of the facility, evaluation of the energy savings, and the cost-effectiveness of selected energy conservation measures.
iv. **Detailed energy audit:** It is the most effective but time consuming energy audit type. It includes the use of instrument to measure energy system within the building (end uses such as lighting systems, office equipment, fans, chillers/air condition etc.

3. PROPOSED WORK

Equipment Used to Carry out Energy Audit of Physics Office includes:

i. Digital thermometer
ii. Voltmeter
iii. Ammeter
iv. Electric power meter
v. Air flow device
vi. Measuring tape

3.1 Method

The office of the physics building was measured, the length, breath of the building, length and breadth of the windows and as well the thickness of the concrete, building size with a measuring tape. The U-value method was used to evaluate the total ventilation loss of the building. The utility bills which were used in the software called energy lens to evaluate the various graphs daily total energy in 08:00am-16:00pm period: 1 August 2018-31 August, 2018 weekly power for 08:00an-16:00Pm period: Wednesday 1 August 2018- Tuesday 28 August 2018m all days of the week. The summary figures for 08:00am -16:00pm period: 1 August-31 August all days of the week which was used for analysis.

3.2 Measurement

Length of physics staff office:	12’+6.8” = 3.830m
Breadth of physics staff office:	12’+9” = 3.886m
Length of window:	4’+9.5” = 1.4605m
Height of physics staff office:	106’’= 2.692m
Internal length of physics staff office:	10’+9’’= 3.2766m
Breadth of window:	3’+9.5’’= 1.1557m
Number of Windows:	4
Number of door:	1
Number of wall sockets:	3
Number of light bulbs:	4

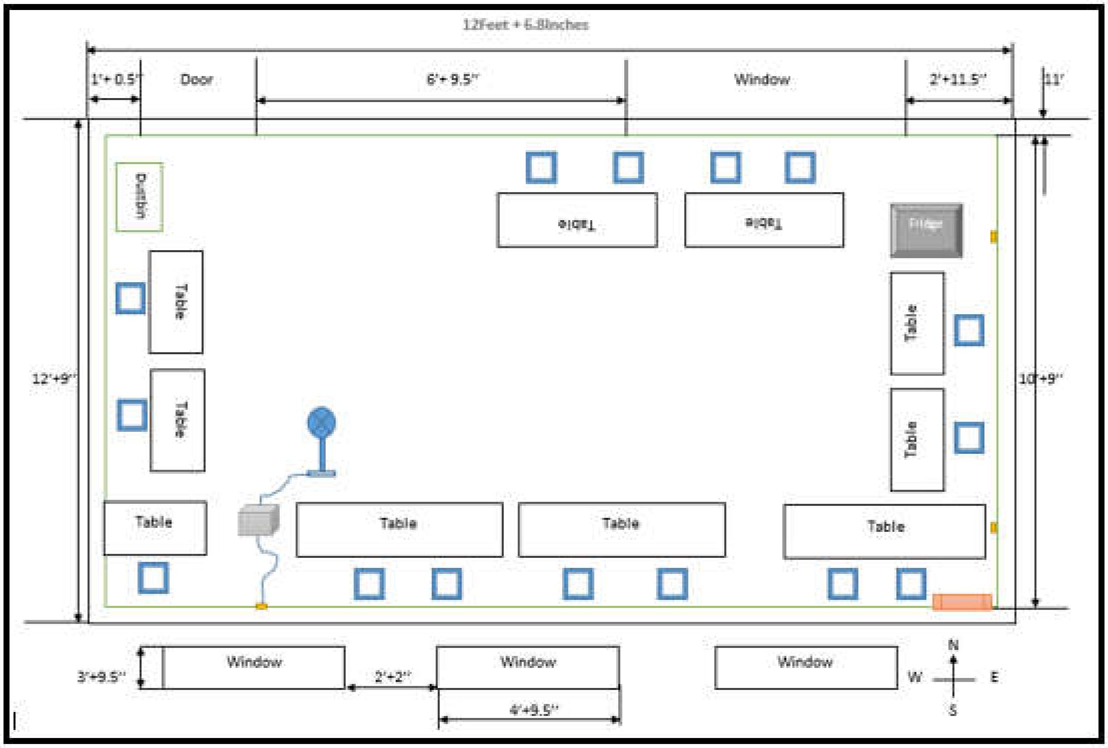


Figure 3.1 Design of Office Layout

3.3 Mathematical Calculation

In order to be able to size heating systems and assess the effects of any conservation measures, we need to calculate design heat loss for a building.

Consider that;

Let Qv = ventilation loss per Unit temperature = 0.33NV (W/N)

3.4 Conversion of Building Measurement

q_v = Ventilation loss per unit temperature

q_v = 0.33 NV (W/K)

In 1959 the Standard International measurement of units (S.I) where: 1ft = 12inch, 1Inch = 0.0254m, hence the conversion is achieved below. Given the following measurements:

Length of Physics Staff office: 12'+6.8"

Since

1ft = 12Inch

Then 12ft = 144Inch

144 Inches + 6.8Inch = 150.8Inch

Remembering that

1Inch = 0.0254m

Therefore 150.8Inch = 3.830m

Breath of physics staff office:	12'+9" = 3.886m
Length of window:	4'+9.5" = 1.46m
Height of physics staff office:	2.692m
Internal length of physics staff office:	3.2766m
Breadth of Window:	1.1557m

3.5 Calculation of Building Heat Loss, U-value Method

H = Building design heat loss
H = $Q_{loss}/\Delta T$
$Q_{loss} = (\sum AEUE)(TE - TO) + 0.33NV(TI - TO)$

Table 3.1 Calculation of Building Heat Loss, U-value Method

Element	Net Area (m^2)	U ($Wm^{-2}k^{-1}$)	Temp. difference (K)	Q(W)
W.WALL	10.46	0.34	296	1052.7
N.WALL	10.31	0.34	296	1037.6
N.WINDOW	1.687	5.60	296	2796.4
E.WALL/INTERNAL	8.821	1.20	269	2837.1
E.WALL/EXTERNAL	10.46	0.34	296	1052.7
S.WALL	10.31	0.34	296	1037.6
S.WINDOW	1.687	5.60	296	2796.4
ROOF	14.88	0.15	296	660.7
FLOOR	14.88	0.13	296	572.6
Total	83.495	14.04	2636	13,843.8

U-VALUES
External Walls = 0.34 $Wm^{-2}K^{-1}$
Windows = 5.60 $Wm^{-2}K^{-1}$
Roof = 0.15 $Wm^{-2}K^{-1}$
Floor = 0.13 $Wm^{-2}K^{-1}$
Internal Wall = 1.20 $Wm^{-2}K^{-1}$
Design Temperature = 23^oC
External Temperature = 27^oC
Length from Floor to Ceiling = 106''

Heat Loss = Q_{loss}
$Q_{loss} = (\sum AEUE)(TE - TO) + 0.33NV(TI - TO)$
$Q_{loss} = (\sum(10.46\ x\ 0.34))(300 - 296) + 0.33(296 - 300)$
Q_{loss} = 14.2256 + (-1.32)
Q_{loss} = 12.9056 W

H = Building design heat loss
H = $\frac{Qloss}{\Delta T} = \frac{12.9056W}{4K}$ = 3.226 WK^{-1}
Density of air = 1.225kg/m^3
Specific heat = 1004$JKg^{-1}K^{-1}$
Volume of the office = 40.066m^3
Average ventilation rate is 1.8 air changes per hour

Ventilation heat loss:

$$Q_{vent} = M_{air} * C_{air} * f_{air} * (T_{in} - T_{out})/3600$$
$$= V * \rho_{air} * C_{air} * f_{air} * (T_{in} - T_{out})/3600$$

$Q_{vent} = \frac{40.066\ x\ 1.225\ x\ 1.8}{3\ 600}\ x\ 1004\ x\ (300 - (-268))$
Q_{vent} = 13,994.7 W
Total Ventilation Loss = 13,994.7 W = 13.9 x 10^3 W

3.6 Description of Equipment and Software

i. **Digital thermometer:** for temperature measurement (K)
ii. **Electric power meter**: to measure the amount of electric energy consumed in the building.

iii. **Measuring Tape**: a thin metal, flexible ruler and used for measuring distance between two given points.

iv. **A voltmeter:** is an instrument that measures the difference in an electric circuit. An analog voltmeter moves a pointer across a scale in proportion to the circuit's cottage; a digital voltmeter provides a numerical display.
Any measurement that can be converted to voltage can be displayed on a meter that is properly calibrated: such as measurement include pressure temperature and flow. For a voltmeter to measure devices voltage, it must be connected in parallel to that device. This is necessary because objects in parallel experience the same potential difference.

v. **Ammeter**: an ammeter measures the electric current in a circuit, which the name is derived from the SI Unit for electric current, Ampere (A). For an ammeter to measure a device current, it must be connected in series to the device because object in series experiences the same current. Ammeters are design to work under a minimal burden, (Which refers to the voltage drop across the ammeter, typically a small fraction of a volt).

vi. **Air flow device:** Air flow is the movement of air from one area to another. The primary cause of air flow is the existence of pressure gradients. Air behaves in a fluid manner. Meaning particles naturally flow form areas of higher pressure to those where the pressure lower.

Atmospheric air pressure is directly related to attitude, temperature, and composition. The flow of air can be induced through mechanical means or can take place passively, as a function of pressure differentials present in the Environment. Air flow is classified into laminar and turbulent flow pattern. Laminar flow occurs when air can flow smoothly and exhibits a parabolic velocity profile. Turbulent flow occurs when there is an irregularity (disruption) which alters the direction of movement. Turbulent flow exhibits a flat velocity profile. Air flow can be simulated using computational fluid dynamics (CFD) modeling and can be can regulated by equipment called damper. Measuring of airflow is necessary in many applications such as ventilation (to determine how much air is being replaced) and engines to control the air fuel ratio).

4. RESULTS AND DISCUSSION

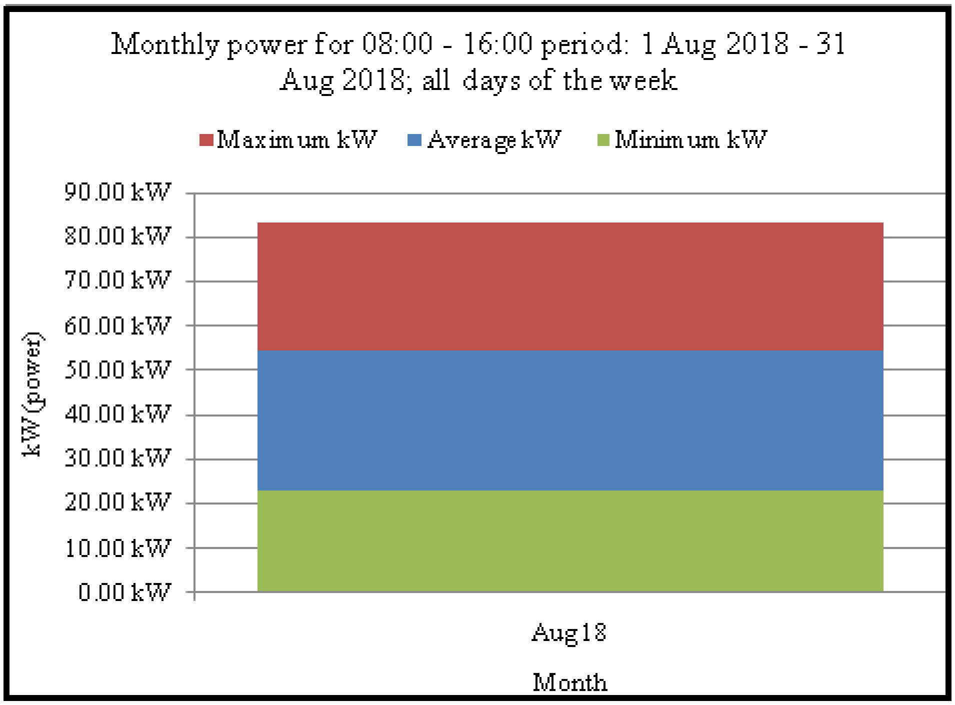
The table shows results from the Energy Lens software used in evaluating the Physics staff office building.

Table 4.1 Summary figures for 08:00 - 16:00 period: 1 Aug 2018 - 31 Aug 2018; all days of the week

Total over period		
Energy	13,545.000 kWh	
Daily energy		
Maximum	564.077 kWh	on Wed, 22 Aug 2018
Average	436.935 kWh	
Minimum	203.704 kWh	on Sat, 4 Aug 2018
15-minute energy		
Maximum	20.807 kWh	on Mon, 13 Aug 2018 between 15:00 and 15:15
Average	13.654 kWh	
Minimum	5.722 kWh	on Sat, 4 Aug 2018 between 08:45 and 09:00
15-minute power		
Maximum	83.23 kW	on Mon, 13 Aug 2018 between 15:00 and 15:15
Average	54.62 kW	
Minimum	22.89 kW	on Sat, 4 Aug 2018 between 08:45 and 09:00

Table 4.1 is the summary figures for the period of 08:00Am - 16:00PM from 1st August to 31st August 2018 all days of the week. 13,545.00kWh of energy was consumed. For the daily energy consumption, maximum energy consumed was 564.077kWh 0n Wednesday 22nd August 2018 with an average value of 436.935kWh at minimum of

203.704kWh on Saturday August 2018. From the energy consumption of given interval of 15minutes, it determines that the maximum energy consumed was 20.807kWh on Monday 13th August 2018 between 15:00 and 15:15 with minimum of 5.722kWh consumed on Saturday 4th August between 08:45 and 09:00 at average value of 13.654kWh. While the power consumed for the same period interval of 15minutes was determined to be 83.23kW on Monday 13th August between 15:00 and 15:15:00. At minimum value' 22.89kW as consumed on Saturday 4th August between 08:00 and 09:00 at average value of 54.62kW.



Graph 4.1 Monthly powers for 8:00am – 16:00pm period of 1st August 2018 to 31st August 2018; all days of the week

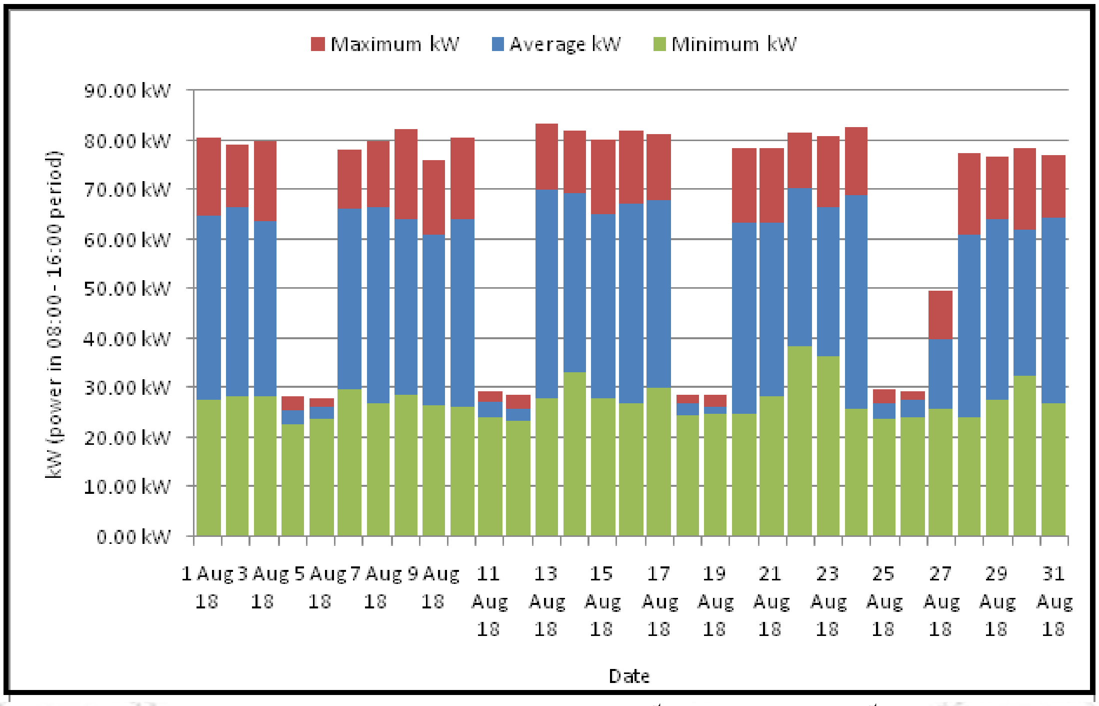
The graph 4.1 above shows the maximum, minimum and average in monthly power consumed from 1st August 2018 to 31st August 2018 within the working period 8:00AM to 16:00PM all days of the week. From the graph, it is determined that the maximum power consumed is 83.2296285kW where the minimum power consumed yielded the value of 22.8891081kW with 54.61693197kW average power consumed on 18th August 2018.

Table 4.2 Daily figures for 08:00 - 16:00 period: 1 Aug 2018 - 31 Aug 2018

	Date	Average kW	Maximum kW	Minimum kW	Total kWh	
	Wed, 1 Aug 2018	64.75	80.49	27.69	518.025	
	Thu, 2 Aug 2018	66.38	79.01	28.41	531.065	
	Fri, 3 Aug 2018	63.79	79.95	28.19	510.359	
	Sat, 4 Aug 2018	25.46	28.37	22.89	203.704	
	Sun, 5 Aug 2018	26.30	28.18	23.81	210.435	
	Mon, 6 Aug 2018	66.03	78.12	29.89	528.237	
	Tue, 7 Aug 2018	66.62	79.75	26.89	532.984	

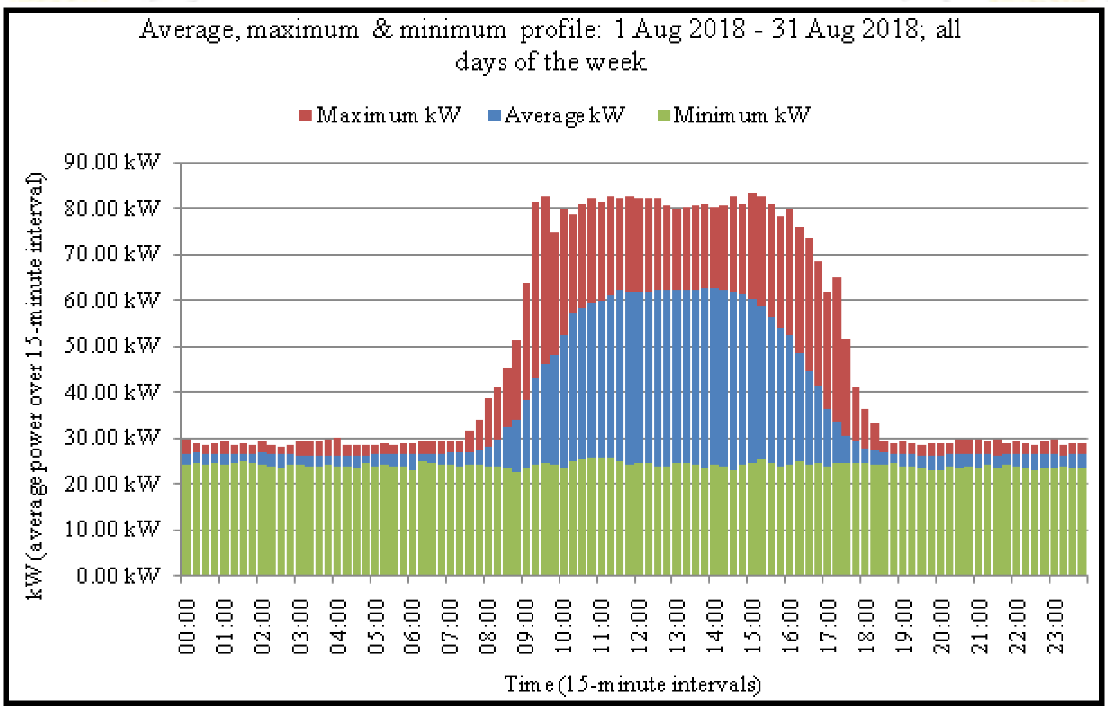
	Wed, 8 Aug 2018	64.08	82.43	28.76	512.669	
	Thu, 9 Aug 2018	60.91	76.09	26.73	487.268	
	Fri, 10 Aug 2018	64.14	80.56	26.36	513.134	
	Sat, 11 Aug 2018	27.24	29.50	24.01	217.903	
	Sun, 12 Aug 2018	25.79	28.89	23.59	206.307	
	Mon, 13 Aug 2018	69.90	83.23	28.08	559.187	
	Tue, 14 Aug 2018	69.22	81.95	33.30	553.733	
	Wed, 15 Aug 2018	65.21	80.31	28.03	521.663	
	Thu, 16 Aug 2018	67.26	82.10	26.99	538.047	
	Fri, 17 Aug 2018	68.02	81.29	30.26	544.191	
	Sat, 18 Aug 2018	26.93	28.61	24.64	215.476	
	Sun, 19 Aug 2018	26.28	28.65	24.76	210.236	
	Mon, 20 Aug 2018	63.39	78.51	24.91	507.083	
	Tue, 21 Aug 2018	63.25	78.39	28.30	506.028	
	Wed, 22 Aug 2018	70.51	81.66	38.70	564.077	
	Thu, 23 Aug 2018	66.66	80.80	36.39	533.292	
	Fri, 24 Aug 2018	68.95	82.52	25.89	551.594	
	Sat, 25 Aug 2018	27.04	29.84	23.93	216.329	
	Sun, 26 Aug 2018	27.72	29.53	24.07	221.741	
	Mon, 27 Aug 2018	39.79	49.76	26.04	318.311	
	Tue, 28 Aug 2018	60.97	77.56	24.11	487.796	
	Wed, 29 Aug 2018	64.07	76.74	27.61	512.522	
	Thu, 30 Aug 2018	61.96	78.46	32.61	495.643	
	Fri, 31 Aug 2018	64.50	77.02	27.06	515.962	

Table 4.2 above is a daily figures for the month of 1st August 31st in the within the period of 08:00 to 16:00. The table shows the maximum, minimum and average consumption rate each day.



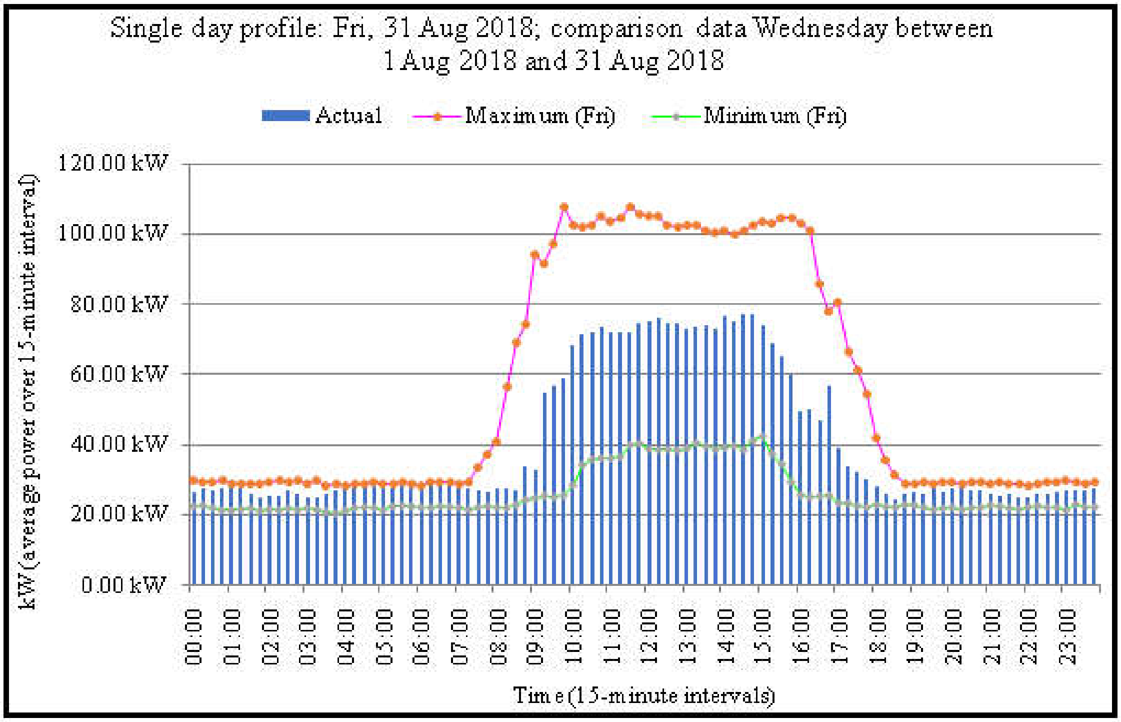
Graph 4.2 Daily powers in 8:00am-16:00pm period: 1st August 2018 to 31st August 2018

The daily power consumption in whole month of August 2018 within the working period from 08:00AM to 16:00PM. From the graph, the highest maximum power consumed was on Monday 13th August of the same day of the month with 83.2296285kW. At minimum, 38.69527898kW was consumed on Wednesday 22nd August of the month with an average value of 70.50901896kW of same day 22nd August 2018.



Graph 4.3 Average, Maximum and Minimum Profile: 1st August 2018 – 31st August 2018; all days of the week

The graph (Graph 4.3) above showing the maximum profile of 82.51517297kW at time (point) of 09:30, minimum profile of 25.93329274kW at point of 11:00 and average profile of 62.10529499kW at point of 13:00 from the Wednesday 1st August to Friday 31st August all days of the week.



Graph 4.4 Single day profile: Fri, 31 Aug 2018; comparison data from Fridays between 1 Aug 2018 and 31 Aug 2018

The graph 4.4 above is a single day profile comparison between Friday 31st August 2018 and Wednesday 1st August 2018 showing the maximum, minimum and the average power consumed for just a day. From the graph, it determined that maximum power consumed is 107.4402282kW on Friday at 09:45 with 4221085355kW minimum power consumed at exactly 15:00 on same day, resulted about 77.022923739kW average power consumed at a point value of 14:45.

5. ANALYSIS AND DISCUSSION OF RESULTS

From the result of the analysis for which the rate of power consumption at daily bases for one month, from 1 Aug. to 31 Aug. the characteristic of power consumption due to the occupant behavior is displayed as in the following graphs above for time (Hr.) against power (kW).Wed. 1 Aug the maximum value of power consumed is 77.45kw at the point of 08:30 and the minimum value consumed is 59.30 KW at the point of 10:30, Thursday 2 Aug maximum value of power consumed is 62.84 kW at the point of 17:30 with minimum power consumption value of 47:93 kW at the point of 15:30, Friday 3 Aug. maximum value of power consume is 66.29 KW at the point of 17:15 and the minimum value consumed is 37.32 kW at the point of 15:15, Sat 4 Aug maximum value of power consumed is 29.76 kW at the point of 20:45 and the minimum value consumed is 22.38 kW at the point of 13:00, Sunday 5 Aug. maximum value consumed is 29.24kW at the point of 18:15 and the minimum is 22.59 kW at the point of 18:30, Mon 6 Aug maximum power consumed is 54.41 kW at the point of 17:30 and minimum is 36.03 at the point of 15:41 kW at the point of 14:45 while Wed 8 Aug. maximum value consumed is 71.49 kW and minimum value consumed is 47.83 kW at the point of 15:30.

The analysis shows that during working hours, much power is consumed from 8:00 to 16:00 and declines after work closed. The rate of power consumption drastically declined on weekend (Saturday to Sunday) due to absent of the occupants in the office. On Friday, the rate of power consumption also declines earlier than the other working days.

6. CONCLUSION

From the daily energy consumption from the Wed. 1st August to Friday 31st August 2018 from start of working hour 8:00am to the close 16:00pm, it revealed that the maximum energy consumed was Monday 13th August 2018 with 83.23kW and at minimum value of 28.08kw given the average of 69.90kW and total energy consumption of 559.187 kW, where the least energy consumed during the days of the month was Sunday 5th August 2018 at maximum value of 28.18kW and minimum of 23.8kw with average of 26.30kW and total energy consumed for the 210.435kWh.This shows that energy consumption is less over weekend (Sunday to specific) and high during working days.

The study of this research was conducted at Federal University Wukari, Taraba State of Nigeria finding way to decrease energy consumption and expenditure (cost). The development of the University with time will also lead to the increase in number of students. Use of new technological facilities increases the Utilization energy. The need for energy conservation measures is necessary to tackle excess energy consumption in the University.

The study shows that Federal University power consumption gradually increases during working days and decreases over weekend in addition, functionality building such as staff office building consumed more power due to the types of appliances used for different functions by the occupants. Space cooling and lighting have the highest percentage of power demand in the University. The total energy consumed per month from 31st August to 31st August is 13,450kwh at maximum consumption energy consumption 564.Kwh with minimum value of 203.70Kwh.This can be concluded from the study that adoption energy efficiency measures to be part of the University policy strategy brings not only reduction energy audit demand rather energy conservation management policy such as enhancing the efficiency of electrical appliances proper use of day lighting and sockets, maximizing natural ventilation. This can ensure the energy efficiency of a building and cost reduction.

In energy audit of a building, the heat absorbed by the building is equal to the heat ($H_{loss} = Q_{loss}$) determines good performance of a building. The heat loss determined from the building is 12,9056W where the H-value yielded 3.226kW/h due to the Q-loss by the change in temperature of the building at density of air 1.22kg/m^3 of the office. At the average ventilation if a 1.8 air change per hour, the total ventilation loss (Q_{vent}) is determine to be 13, 94.7W. Therefore, the effective performance of a building is about it heat gain and the heat loss where the dampness results in its deterioration.

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