ENERGY AUDIT OF A FINANCIAL INSTUTUION TAKING DIAMOND BANK ALAUSA BRANCH AS CASE STUDY

BY

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CERTIFICATION

I certify that this research work was carried out by **Ogundiran, James Olusoji** of the Department of Mechanical Engineering, Faculty of Engineering Technology, University of Ibadan, Ibadan.

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DEDICATION

I dedicate this project work to God almighty, who has kept all his promises and never failed.

1.0. INTRODUCTION

1.1. General Background

Energy is simply the capacity to do work. Energy causes things around us to happen. We need energy in all that we do. In today's world, energy and its conservation is very important, this therefore births the need for renewable energy resource and also the need to maximize and manage energy hence energy management. When it comes to energy saving, energy management is the process of monitoring, controlling and conserving energy in a building or organization. This usually involves

i, Metering your energy consumption and collecting data

ii, Finding opportunities to save energy and estimating how much energy each opportunity could save.

iii, Taking action to target the opportunities to save energy

iv, Tracking your progress by analyzing your meter data to see how well your energy-saving efforts have worked.

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1.2. Statement of problem

Due to the present world's high dependence on energy there is the need to manage the available energy and its resource. This can be effectively achieved by proper energy audit.

Energy audit or auditing is an inspection, survey and analysis of energy flows for energy conservation in a building, processor or system to reduce the amount of energy input without negatively affecting the output(s). when the object of study is an occupied building then reducing energy consumption while maintaining or improving human comfort , health and safety are of primary concern. Beyond simply identifying the sources of energy use, an energy audit seeks to prioritize the energy uses according to the greatest to the least cost effective opportunities for energy savings.

1.3. Objectives

There are key objectives in taking this study, highlighted below in simple terms are objectives for this study;

1. To bring to light the importance of energy audit.
2. To help determine ways to reduce energy consumption per unit of product output.
3. To show the benefits and huge prospects of increased efficiency of energy use.
4. To identify and evaluate opportunities to reducing operating cost through energy conservation and planning.
5. To implement measures of energy conservation and realization of savings.

1.4. The scope

This study shall be limited to energy audit of a bank using preliminary energy use analysis which involves collecting and analyzing historic utility data and cost, and also level 1 audit which is the walk-through analysis that includes conducting on-site surveys, record observations and analyzing data to identify and provide low-cost or no-cost improvement measures..

1.5. Justification

Energy audit for any building either residential or commercial is vital. For residential building this a money saving practice, improving living conditions without necessarily increasing cost. For commercial building energy audit is required to reduce operations expense thereby increasing profitability. In the past many companies just considered utilities as ‘a cost of doing business’. By running an inefficient building, you are overpaying your utility for energy. A good building energy audit will point the way to reduce your energy costs by 10% to 40%. For large organizations this can be substantial and could mean the difference between staying afloat and going under.

1.6. Expected contribution*s*

- At the end of this project work it will be made clear the cost on utilities on the bank per day.

- At the end of this project work advices on corrective measures on areas where there is energy wastage would be suggested.

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2.0. LITERATURE REVIEW

2.1. Introduction

2.1.1. What is energy audit?

Just as we understand audit of account as an examination and verification of the income and expenditure of an individual or a body (organization), in the same light an energy audit is an evaluation of energy consumption in a home, business, or any other premises (including church buildings and financial houses). It is generally used to determine where energy can be saved or used more efficiently.

2.1.2. Why do we need to conduct energy audit?

There are a lot of reasons why we need to audit energy

In the short terms, it saves us money especially in times like this when the costs of fossil fuels, gas and electricity are rising. These days, there are many ways of saving energy. Conservation strategies and technologies are becoming increasingly sophisticated. So much so that, that in most cases, the time and money outlaid on energy audit often can be saved within a year, and will pay dividends thereafter.

In the medium term, the use of more and more electrical and electronic devices, in homes and industry, has begun to stretch our generating capacity there increasing the demand for energy. This invariably causes a strain in energy generated. Greater efficiency of energy use is the quickest and cheapest way to help the community meet this challenge.

In long term, the world faces a crisis due to global warming. Most energy experts agree that the speediest, the least disruptive and the most effective response is to use energy more efficiently. Even a simple measure , such as ensuring g lights are turned off in an unoccupied space can ensure significant amounts of energy are saved and reduce the greenhouse gas emissions by tonnes over a year. And there are many other low cost or cost-free options. The basis for determining what measures will be of most use in any one particular situation is in knowing how much energy is currently being used, and for what purpose.

2.2 Specific audit techniques

2.2.1 Infrared thermography audit

The advent of high resolution thermography has enabled inspectors to identify potential issues within the building envelope by taking a thermal image of the various surfaces of a building. For purposes of an energy audit, the thermographer will analyze the patterns within the surface temperatures to identify heat transfer through convection, radiation, or conduction. It is important to note that the thermography ONLY identifies SURFACE temperatures, and analysis must be applied to determine the reasons for the patterns within the surface temperatures. Thermal analysis of a home generally costs between 300 and 600 dollars.

For those who cannot afford a thermal inspection, it is possible to get a general feel for the heat loss with a non-contact infrared thermometer and several sheets of reflective insulation. The method involves measuring the temperatures on the inside surfaces of several exterior walls to establish baseline temperatures. After this, reflective barrier insulation is taped securely to the walls in 8-foot (2.4 m) by 1.5-foot (0.46 m) strips and the temperatures are measured in the center of the insulated areas at 1 hour intervals for 12 hours (The reflective barrier is pulled away from the wall to measure the temperature in the center of the area which it has covered.). The best manner in which to do this is when the temperature differential (Delta T) between the inside and outside of the structure is at least 40 degrees. A well-insulated wall will commonly change approximately 1 degree per hour if the difference between external and internal temperatures is an average of 40 degrees. A poorly insulated wall can drop as much as 10 degrees in an hour.

2.2.2 Pollution audit

With increases in carbon dioxide emissions or other greenhouse gases, pollution audits are now a prominent factor in most energy audits. Implementing energy efficient technologies help prevent utility generated pollution.

Online pollution and emission calculators can help approximate the emissions of other prominent air pollutants in addition to carbon dioxide.

Pollution audits generally take electricity and heating fuel consumption numbers over a two-year period and provide approximations for carbon dioxide, VOCs, nitrous oxides, carbon monoxide, sulfur dioxide, mercury, cadmium, lead, mercury compounds, cadmium compounds and lead compounds

2.2. Levels of Audit and the information they should provide

All energy audit usually follow the same pattern but they vary according to the level of technological techniques used in the assessment process. An energy audit can be in a simple checklist which can be used to examine sources of energy, how energy is used and how much is consumed. It also can be a highly sophisticated, technical process involving careful metering and measurement of inputs and outputs. In summary the outcome should provide information on methods of reducing energy consumption.

The Australian Standard for energy recognizes three levels;

2.2.1. The level 1 or 'walk-through' Audit

The level 1 or 'walk-through' audit is usually a simple exercise that provides overview and directions for further investigation. Its main use is to determine whether the level of energy use on the premises is reasonable or excessive , to highlight any obvious efficiency measures, and provide initial benchmarks so that the impact of energy efficiency measures can be tracked and evaluated. It can also be used to plan a more comprehensive evaluation. This including few key measurements may be all householder needs.

2.2.2. The level 2 or Standard Energy Audit.

The level 2 or Standard energy audit is a reasonably detailed investigation of energy supply and use, and should provide clear recommendations for energy and cost-saving measures, along with the costs and benefits of each. This would be the normal level of investigation for a small business or a church.

2.2.3. The level 3 or Detailed Energy Audit.

The level 3 or detailed energy audit should provide all that is contained in the level 1 and the level 2 but at a much greater level of accuracy. It should be performed by a trained energy performance contractor, who may employ specialists or need to install meters or other technology. This would generally only be undertaken under the direction of architects or building engineers, where major energy efficiency works are being considered.

2.3. Overview of the energy audits general procedure.

Energy auditing is based on the capability to perform an investigation on the energy installations as well as on the building shell. The complete procedure involves the following three stages of registration/ data collection and diagnosis;

2.3.1. 1ST Stage: scheduling an energy audit- Collection of primary data and preliminary analysis of energy

At this initial stage, data and information is collected related to the present/current and past energy profile, the construction and utilization of every building/unit.

This data/information can be retrieved with the aid of a structured and concise questionnaire which will be filled in after the first meeting between the energy auditor and the building /unit

manager who has authorized the energy audit. The foundations necessary for the completion of the questionnaire are information from the technical and administration managers of the building/unit as well as existing relevant data (fuel bills/invoices, technical drawings archived studies and catalogues, recorded measurements and readings etc.).
The preliminary analysis of all collected data should lead to the identification of the annual trend and monthly fluctuation/variation of the energy consumption and cost of the audited building/unit, which constitutes its energy profile. Initial energy data collected, should also lead to a first approximation on energy consumption allocation in every area and subsystem of the building/unit. This is a way to express the energy balance of the building/unit. At the end of this stage, the energy auditor can compose an initial catalogue with possible energy saving actions/activities for each building/unit, taking into consideration possible exemptions imposed by the owner.

2.3.2. 2nd Stage: Walk-through Brief energy audit

During this stage, a qualitative investigation of the building shell and the electro-mechanical installation is performed, and the findings are tabulated in a specific form. This data registration coupled with instantaneous sampling measurements helps to apportion energy use and thus leads to the energy balance of the building/unit.
This procedure coupled with the actions of the previous stage leads to a final determination of the energy savings potential, with the use of tiding-up measures and simple inexpensive measures/actions that don't need economic payback assessment through relevant energy studies. Additionally, it leads to a determination of the energy saving potential in specific areas and systems. For further examination a following stage, by specialists/consultants or by buildings' administration staff whenever its feasible. These potentially energy saving actions must be divided into three groups according to their saving potential for the particular building (high, medium and low).

2.3.3. 3rd Stage: In-site thorough energy audit

It involves collection (from in-site measurements) and processing of data as well as a full examination of the installed energy systems of the building/unit, which will permit to compose a thorough energy. This procedure will also permit a sound techno-economical evaluation of one or more energy-saving approaches, with medium to high investments specific systems after relevant study.
The energy audit procedure is completed with the presentation of all the energy saving proposals having the form of a summarized techno-economical report, which is composed by the energy auditor and presented to the building/unit manager.

2.4 Design criteria for an energy audit

In order to ensure that an effective audit can be developed whilst minimizing its cost, and due to the variety of audit types, the wide procedure should be designed on the basis of specific criteria. In the stage of energy audit planning, the following aspects should be specified or taken into consideration:

- Staff involvement; it is desirable the project to be directed by a person of managerial or board status to give authority to the audit and its outcomes. Whether it will be used or not outside assistance depends principally on the complexity of the site and its buildings and systems and on the availability of suitable staff.
- Site or building boundary; a single building such as an office block usually presents few problems as tot the boundary of the audit. For sites with multiple buildings it is often preferable to specify each individual building to be included, particularly if the buildings vary in construction and use. Furthermore, it is important to identify any building or department which is to be excluded from the audit for some reason.
- Depth of energy audit; the depth of the audit and the detail with which it will be reported should be determined by the availability of resources and the limit placed in the anticipated energy saving opportunities.
- Auditing time; careful timing of an audit will produce the best results. Programming should seek to take advantage of seasonal factors and other planned activities.
- Access to site; restrictions might be imposed on auditing staff working practices. Department heads and security staff should be notified of the programme and asked to co-operate in the smooth running of the audit.
- Reporting requirements; reporting procedures must be considered at an early stage. Note that the effort involved in evaluating findings and preparing a final report is normally at least as great as that spent on site work.

2.5 Preliminary energy considerations in energy audit

Data on energy consumption and production output, where appropriate, are vital to all but the simplest energy audit. To this end the collection and monitoring of consumption and the output data should begin as soon as auditing is considered. The longer the period that data are available for, the better for the energy auditing procedure will be. Even where complete records are available, for instance monthly electricity bills, weekly or daily meter readings taken independently can be of great help in analyzing energy use, loss or savings. In addition, when carrying out an energy balance, the more detailed consumption data will assist in quantifying specific energy flows and increasing the accuracy of the balance.
As far as the first stage of building unit energy audit is concerned, it is necessary to collect preliminary data related to its energy con summing behaviour. Thus it is purposeful to fill in the form (annex A) with the following:
- General information about the building:
Type of building, year of construction, type of services, ownership status, authorized representative, possible renovations, building area and volume, number of users and products and relevant service support equipment, operating status, typical floor-plan layout.
- Energy consumption data and energy invoices for the last five years:
Annual evolution of fuel and electricity consumption, monthly variation in consumption within the year under investigation.
- Status of energy management and any energy saving measures undertaken

Additionally, the following supporting data must be collected.

1. Energy bills and invoices for the audit period as well as for the past four years.
2. Plans and studies for the building and its electromechanical energy installations.
3. Construction/ structural and operational characteristics of the basic apparatus/ appliances.
4. Climatic data for the period in which the auditing is conducted.
5. Possible archived records with measurements from existing recorders or from theoretical estimations of the energy consumption levels at the building.

2.5. Costs

The costs of audits of audits clearly vary according to the type, the provider of the audit, the expense of the technology used in the assessment, the type of premises being assessed, and the types of changes being recommended as a result.

The cost of an energy audit can vary from a free service with low-cost measures(which nonetheless can result in significant energy savings), to an audit that will cost hundreds or thousands of dollars and recommend wholesale changes to structures and patterns of energy consumption. The cost will also vary according to the type premises to be audited, and the time and budgetary constraints of the person or group seeking the audit.

In simple terms, a Walk through audit can cost from zero dollar to several hundreds of dollars, depending on the size of the premises and the sophistication of the audit. A good quality standard energy audit will cost more, up to 1000 dollars plus. While a detailed energy audit can cost a several thousand to 10000 dollars.

3.0 METHODOLOGY

3.1 Introduction

This preliminary energy audit was conducted at a Diamond bank branch as the primary step of an objective to develop an energy efficiency roadmap to transform and to improve energy performance index (EPI).

3.2 Project scope

The geographical scope of the project comprised execution of a preliminary 2-day energy audit of one Diamond bank branch in Ikeja, Lagos Nigeria. The branch chosen for the exercise was the Alausa branch along Agidingbi road in Ikeja Lagos state.

The systems studied and assessed as part of the energy audit process includes

- HVAC systems (heating, ventilating and air conditioning): this is the technology of indoor and vehicular environmental comfort. Split ACs
- Lighting Systems: TFL lights and CFL bulbs.

3.3 Preliminary energy audit report

Diamond bank alausa branch is located at no4 ashabi cole street, alausa. It is a one storey building, painted grey as the background, with strokes of green, blue and white, and sited on a three plot of land. The building is fenced round with a grey coloured gate.

3.3.1 Lighting System

The lighting system of the Bank branch was assessed through visual observation and technical specification data recording. The resulting information related to the lighting fixture types, quantity and loads is presented below.

Overall Lighting System Characteristics

AREA	FITTING TYPE	
	2 X 36 W	**4 X 18 W**
Ground floor	36	42
First floor	21	34
Total fitting	57	76
Total Load (KW)	4.104	5.472

Detailed lighting Breakdown: Ground floor

AREA	FITTING TYPE	FITTING LOAD (W)	QUANTITY	LOAD (W)
Atm room	CFL/PL	18	8	144
Filmdex room	TFL	36	4	144
Customer's toilet	CFL/PL	18	4	72
Passage to customer's toilet	CFL/PL	18	4	72
Cash withdrawal counter	TFL	36	16	576
Cash deposit counter	TFL	36	16	576
Staff toilet 1	CFL/PL	18	4	72
Staff toilet 2	CFL/PL	18	4	72
Staff toilet area	CFL/PL	18	6	108
Passage to vault	CFL/PL	18	24	432
Cash deposit room	TFL	36	22	792
Customer service area 1	TFL	36	4	144
Customer service area 2	TFL	36	4	144
Store/file room	CFL/PL	18	4	72
Operations store room	CFL/PL	18	4	72
Operations work space	CFL/PL	18	32	576
Connecting lobby to cash room	TFL	36	6	216
Banking hall	CFL/PL	18	64	1152
Hall way	CFL/PL	18	10	180
		TOTALS	240	5.04KW

Detailed lighting breakdown: 1st floor

AREA	FITTING TYPE	FITTING LOAD (W)	QUANTITY	LOAD (W)
Exclusive lounge	TFL	36	16	576
Exclusive lounge	CFL/PL	18	8	144
Server room/ups room	TFL	36	8	288
Store	CFL/PL	18	8	144
Casual staff room	CFL/PL	18	4	72
Pantry/Kitchen	CFL/PL	18	16	288
Staff toilet 1	CFL/PL	18	4	72
Staff toilet 2	CFL/PL	18	4	72
Hall way 1	CFL/PL	18	8	144
Hall way 2	CFL/PL	18	8	144
Marketing floor	CFL/PL	18	28	504
Marketing floor	TFL	36	18	648
Bm's office	CFL/PL	18	8	144
Secretary's office	CFL/PL	18	8	144
Conference/ICU office	CFL/PL	18	12	216
ICU manager's office	CFL/PL	18	8	144
Hallway 3	CFL/PL	18	8	144
Driver's room	CFL/PL	18	4	72

		TOTAL	178	3.96 KW

3.3.2 HVAC SYSTEM

The HVAC system of the bank was assessed through visual observation and technical specification data recording. The resulting information to the HVAC unit types, theoretical capacities is presented below.

Overall HVAC system characteristics

AC TYPE	QUANTITY	RATINGS (HORSEPOWER HP)	RATINGS (W)
Split unit	25	1.5	1118.549808
Industrial split unit	2	4	3728.49936
Total	27		4.847KW

Samsung split unit ac

Detailed HVAC breakdown: Ground floor

AC TYPE	QUANTITY	RATINGS (HP)	RATINGS (W)	TOTAL (KW)
Split unit	16	1.5	1118.549808	17.8967
Industrial split unit	1	4	3728.49936	3.7285
Total	17			21.6252

Detailed HVAC breakdown: 1st floor

AC TYPE	QUANTITY	RATINGS (HP)	RATINGS (W)	TOTAL (KW)
Split unit	9	1,5	1118.549808	10.0667
Industrial unit	1	4	3728.49936	3.7285
Total	10			13.7952

3.3.3 OTHER ELECTRICAL APPLIANCES

This includes computers, photocopying machine etc. Other electrical appliances of the bank were assessed through visual observation and technical specification data recording.

Hp printer 300series

Hp monitor 23xi

Detailed other Appliances breakdown for both ground floor and first floor

APPLIANCE TYPE	QUANTITY	APPLIANCE LOAD (W)	LOAD(W)
CPU (elite serie s 8000f)	25	135	3375
Monitor (Hp Pavilion 23xi)	25	30	750
Photocopying machine	2	300	600
Hp 300 Scanner	2	2.5	5
Hp printer	2	410 (active)	820
Total	56		5.550KW

Hp ScanJet 300

4.0 DISCUSSION

Energy audit of the bank started on the 13th of March 2015 and concluded on the 15th of March 2015.

Data collection for lighting system started on the 13th of March 2015 and was concluded on the same day

4.1 Details of lighting system in the building.

Lighting Systems: TFL lights and CFL bulbs.

TFL- Trouble free lights

	TFL lights (36W)
GROUND FLOOR	72
1ST FLOOR	42
	114

CFL- Compact fluorescent lamp

A compact fluorescent lamp (CFL), also called compact fluorescent light, energy-saving light, and compact fluorescent tube, is a fluorescent lamp designed to replace an incandescent lamp; some types fit into light fixtures formerly used for incandescent lamps. The lamps use a tube which is curved or folded to fit into the space of an incandescent bulb, and compact electronic ballast in the base of the lamp.

Compared to general-service incandescent lamps giving the same amount of visible light, CFLs use one-fifth to one-third the electric power, and last eight to fifteen times longer. A CFL has a higher purchase price than an incandescent lamp, but can save over five times its purchase price in electricity costs over the lamp's lifetime. Like all fluorescent lamps, CFLs contain toxic mercury which complicates their disposal. In many countries, governments have established recycling schemes for CFLs and glass generally.

The principle of operation in a CFL bulb remains the same as in other fluorescent lighting: electrons that are bound to mercury atoms are excited to states where they will radiate ultraviolet light as they return to a lower energy level; this emitted ultraviolet light is converted into visible light as it strikes the fluorescent coating on the bulb (as well as into heat when absorbed by other materials such as glass).

CFLs radiate a spectral power distribution that is different from that of incandescent lamps. Improved phosphor formulations have improved the perceived color of the light emitted by CFLs, such that some sources rate the best "soft white" CFLs as subjectively similar in color to standard incandescent lamps.

There are two types of CFLs: integrated and non-integrated lamps. Integrated lamps combine the tube and ballast in a single unit. These lamps allow consumers to replace incandescent lamps easily with CFLs. Integrated CFLs work well in many standard incandescent light fixtures, reducing the cost of converting to fluorescent. 3-way lamp bulbs and dimmable models with standard bases are available.

Non-integrated CFLs have the ballast permanently installed in the luminaire, and only the lamp bulb is usually changed at its end of life. Since the ballasts are placed in the light fixture, they are larger and last longer compared to the integrated ones, and they don't need to be replaced when the bulb reaches its end-of-life. Non-integrated CFL housings can be both more expensive and sophisticated. They have two types of tubes: a bi-pin tube designed for conventional ballast, and a quad-pin tube designed for electronic ballast or conventional ballast with an external starter. A bi-pin tube contains an integrated starter, which obviates the need for external heating pins but causes incompatibility with electronic ballasts. Non-integrated CFLs can also be installed to a conventional light fixture using an adapter containing built-in magnetic ballast. The adapter consists of a regular bulb screw, the ballast itself and a clip for the lamp's connector.

Non-integrated bi-pin double-turn CFL

CFLs have two main components: magnetic or electronic ballast and a gas-filled tube (also called bulb or burner). Replacement of magnetic ballasts with electronic ballasts has removed most of the flickering and slow starting traditionally associated with fluorescent lighting, and has allowed the development of smaller lamps directly interchangeable with more sizes of incandescent bulb.

Electronic ballasts contain a small circuit board with rectifiers, a filter capacitor and usually two switching transistors. The incoming AC current is first rectified to DC then converted to high frequency AC by the transistors, connected as a resonant series DC to AC inverter. The resulting high frequency is applied to the lamp tube. Since the resonant converter tends to stabilize lamp current (and light produced) over a range of input voltages, standard CFLs do not respond well in dimming applications. Special electronic ballasts (integrated or separate) are required for dimming service.

CFL light output is roughly proportional to phosphor surface area, and high output CFLs are often larger than their incandescent equivalents. This means that the CFL may not fit well in existing light fixtures. To fit enough phosphor coated area within the approximate overall dimensions of an incandescent lamp, standard shapes of CFL tube are a helix with one or more turns, multiple parallel tubes, circular arc, or a butterfly.

Some CFLs are labeled not to be run base up, since heat will shorten the ballast's life. Such CFLs are unsuitable for use inpendant lamps and especially unsuitable for recessed light fixtures. CFLs for use in such fixtures are available. Current recommendations for fully enclosed, unventilated light fixtures (such as those recessed into insulated ceilings), are either to use "reflector CFLs" (R-CFL), cold-cathode CFLs or to replace such fixtures with those designed for CFLs. A CFL will thrive in areas that have good airflow, such as in a table lamp.

	CFL(18W)
GROUND FLOOR	168
1^{ST} FLOOR	136
	272

4.2 Details of HVAC systems in the building

HVAC (stands for Heating, Ventilation and Air Conditioning) equipment needs a control system to regulate the operation of a heating and/or air conditioning system. Usually a sensing device is used to compare the actual state (e.g. temperature) with a target state. Then the control system draws a conclusion what action has to be taken (e.g. start the blower).

Direct digital control: Central controllers and most terminal unit controllers are programmable, meaning the direct digital control program code may be customized for the intended use. The program features include time schedules, setpoints, controllers, logic, timers, trend logs, and alarms. The unit controllers typically have analog and digital inputs that allow measurement of the variable (temperature, humidity, or pressure) and analog and digital outputs for control of the transport medium (hot/cold water and/or steam). Digital inputs are typically (dry) contacts from a control device, and analog inputs are typically a voltage or current measurement from a variable (temperature, humidity, velocity, or pressure) sensing device. Digital outputs are typically relay contacts used to start and stop equipment, and analog outputs are typically voltage or current signals to control the movement of the medium (air/water/steam) control devices such as valves, dampers, and motors. Groups of DDC controllers, networked or not, form a layer of system themselves. This "subsystem" is vital to the performance and basic operation of the overall HVAC system. The DDC system is the "brain" of the HVAC system. It dictates the position of every damper and valve in a system. It determines which fans, pumps, and chiller run and at what speed or capacity. With this configurable intelligence in this "brain", we are moving to the concept of building automation.

Building automation system: More complex HVAC systems can interface to Building Automation System (BAS) to allow the building owners to have more control over the heating or cooling units. The building owner can monitor the system and respond to alarms generated by the system from local or remote locations. The system can be scheduled for occupancy or the configuration can be changed from the BAS. Sometimes the BAS is directly controlling the HVAC components. Depending on the BAS different interfaces can be used. Today, there are also dedicated gateways that connect advanced VRV / VRF and Split HVAC Systems with Home Automation and BMS (Building Management Systems) controllers for centralized control and monitoring, obviating the need to purchase more complex and expensive HVAC systems. In addition, such gateway solutions are capable of providing remote control operation of all HVAC indoor units over the internet incorporating a simple and friendly user interface.

It was natural that the first HVAC controllers would be pneumatic since engineers understood fluid control. Thus, mechanical engineers could use their experience with the properties of steam and air to control the flow of heated or cooled air.

After the control of air flow and temperature was standardized, the use of electromechanical relays in ladder logic to switch dampers became standardized. Eventually, the relays became electronic switches, as transistors eventually could handle greater current loads. By 1985, pneumatic controls could no longer compete with this new technology although pneumatic control systems (sometimes decades old) are still common in many older buildings.

By the year 2000, computerized controllers were common. Today, some of these controllers can even be accessed by web browsers, which need no longer be in the same building as the HVAC equipment. This allows some economies of scale, as a single operations center can easily monitor multiple buildings.

	SPLIT UNIT	INDUSTRIAL UNIT
GROUND FLOOR	14	1
1ST FLOOR	11	1
	25	2

4.3 Details of other appliances

APPLIANCE TYPE	QUANTITY	APPLIANCE LOAD (W)	LOAD(W)
CPU (elite series 8000f)	25	135	3375
Monitor (Hp Pavilion 23xi)	25	30	750
Photocopying machine	2	300	600
Hp 300 Scanner	2	2.5	5
Hp printer	2	410 (active)	820
Total	56		5.550KW

5.0 RESULTS

5.1 Results

5.1.1 Electrical Consumption

This energy audit was carried out for two days. Below is consumption rate for lighting, HVAC system and Other appliances for a working period of about 12 hours, from7am to 7 pm for one day.

Electrical consumption for Lighting for both ground floor and 1st floor per day

AREA	LOAD (KW)	CONSUMPTION PER HOUR(KW)	CONSUMPTION FOR 12HOURS (KWH) PER DAY
Ground floor fittings	5.04	5.04	60.48
1ST floor fittings	3.96	3.96	47.52
TOTAL CONSUMPTION PER DAY			108

Electrical consumption for HVAC systems for both ground floor and 1st floor

AREA	LOAD (KW)	CONSUMPTION PER HOUR (KWH)	CONSUMPTION PER DAY
Ground floor HVAC	21.6252	21.6252	259.5024
1st floor HVAC	13.7952	13.7952	165.5424
TOTAL CONSUMPTION PER DAY			425.0448

Electrical consumption for Other Appliances

APPLIANCE	LOAD (KW)	CONSUMPTION PER HOUR (KWH)	CONSUMPTION IN 12 HOURS PER DAY (KWH)
All appliances in use	5.550	5.550	66.6
Total			66.6

5.1.2 Calculations

Total electrical consumption= total consumption for lighting + total consumption for HVAC + total consumption for Other appliance

Total electrical consumption for working hours = total electrical consumption

(i) Total consumption for lighting = total consumption for ground floor + total consumption for 1st floor,

Total consumption for ground floor (lights) = (144 + 144 +72 + 72 + 576 + 576 + 72 + 72 + 108 + 432 + 792 + 144 + 144 + 72 + 72 + 576 + 216 + 1152 + 180)W / 1000
= 5.04 KW

Total consumption for 1st floor (lights) = (576 + 144 + 288 + 144 + 72 + 288 + 72 + 72 + 144 + 144 + 504 + 648 + 144 + 144 + 216 + 144 + 144 + 724)W / 1000
= 3.96 KW

Total consumption for lighting = 5.04 + 3.96
= 9 KW

(ii) Total consumption for HVAC = total consumption for ground floor + total consumption for 1st floor

Total consumption for ground floor = (17896.7 + 3728.49936) / 1000
= 21.6252KW

Total consumption for 1st floor = (1118.549808 + 3728.49936) / 1000
= 13.7952KW

(iii) Total consumption other appliances = (3375 + 750 + 600 + 5 + 820) / 1000
= 5.55KW

Therefore,

Total consumption per hour = 5.04 + 9 +5.55
= 19.59 KWH

Finally

Total consumption for 12 hours (per day) = 19.59 X 12
= 235.08 KWH

Total consumption in one month = 235.08 X 20(working days)
= 4701.6 KWH

5.2 Cost

Tariff class	Energy Unit Cost(N/KWH)	Fixed charge(N/month)
Residential R1	4.0	N/A
Residential R2	12.83	750
Residential R3	22.50	26269
Residential R4	22.50	164174
Commercial C1	17.06	750
Commercial C2	20.91	23814
Commercial C3	20.91	148435
Industrial D1	16.87	1000
Industrial D2	21.92	195252
Industrial D3	21.92	198447
Special A1	16.15	750
Special A2	16.15	43125
Special A3	16.15	65625
Street Lighting S1	12.40	650

The table on the previous page is a table of electricity tariff for lagos Ikeja Disco (distribution company).

The energy audit was conducted at a Diamond bank, Ikeja branch, thus the above tariff plan applies.

The bank falls under the commercial consumers designated as C2.

Bank's tariff class	Energy unit cost (Naira/KWH)	Fixed charge (N/Month)	Bank's consumption per month (KHW)
Commercial C2	21.91	23814	4701.6
Total cost per month (Naira)			126826.056

5.2.1 Calculations

Total cost of electricity consumption per month = (Total consumption X Tariff) + Monthly fixed charge

Total consumption	=	4701.6 KWH
Tariff	=	21.91 (Naira)
Fixed Charge	=	23814 (Naira)

Total cost of electricity consumption per month = (4701.6 X 21.91) + 23814

= 103012.056 + 23814

= 126826.056

Total cost of consumption per month = N126826.056

= N126826.06

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

In conclusion it has been shown that Diamond Bank Alausa branch consumes about 4701.6KWH of electrical energy on Lighting, Heating Ventilating and Air Conditioning systems (HVAC), and other Electrical appliances, in a month given a steady constant supply of power from PHCN for a period of twelve straight hours (7am to 7pm). Total energy expended per hour is 19.59KWH, and for a period of twelve hours is 235.08 KWH. For a period of twenty working days, total consumption is 4701.6KWH.

Finally with a tariff and fixed charge of N21.91 and N23814 respectively, total amount expended on power in a month is N126826.056 which is N126826.06

6.2 RECOMMENDATIONS

Given the result that a total of N126826.056 is spent on a monthly basis, the following recommendations are advised to reduce consumption and cost on electrical power.

i, Reduction of working hours. It is advised that working hours in the bank premises should be cut by an hour. A period of 7am to 6pm should be stipulated and strictly adhered to. This would be reduce total consumption to 214.5KWH per day and 4290KWH per month.. This translates total cost of N117807.9 per month. An average of N9018.156 is saved monthly. In a year about N108217.87 is saved.

ii, Complete replacement of all TFL bulbs with CFL bulbs. CFL bulbs are low energy bulbs with ratings of 18W as compared to TFLs with ratings 36W. Replacing 114 TFL bulbs with rating of 36W with CFL bulbs with 18W would reduce total consumption by half.

114 TFL bulbs = 36W X 114
= 4.1KW
114 CFL bulbs = 18W x 114
= 2.052KW

Cost on energy consumption for 114 TFL bulbs in a month is N21580.47, while for 114 CFL bulbs is N10790.23. About N10790.23 is saved monthly and a total of N129482.84 is saved in a year.

iii, Appliance should be switched off completely from power source when not in use.

iv, Every form of unprofitable Saturday banking should be stopped to reduce further consumption of electrical energy.

v, Turn on equipment/system based on operational hours of building.

vi, Adopt mechanical or natural ventilation for areas not requiring air conditioners.

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