INVESTIGATION INTO ELECTRICAL ENERGY CONSUMPTION IN ABU SAMARU ZARIA

BY

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DECLARATION

I declare that the work in this thesis entitled 'Investigation into electrical energy consumption in ABU Samaru Zaria' has been performed by me in the department of mechanical engineering under the supervision of professor C. O. Folayan and Dr. D. S. Yawas. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this project report was previously presented for another degree or diploma at any university.

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CERTIFICATIION

This thesis entitled 'Investigation into electrical energy consumption in ABU Samaru Zaria by Ede Egbudu Godwin meets the regulations governing the award of the degree of Master of Science of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This thesis is dedicated to the memories of my late father Mr. Joseph Ede Agom who worked tirelessly to give us the best education.

ACKNOWLEDGMENT

I thank God almighty the giver of life for enabling me to complete this project. My sincere appreciation goes to my beautiful wife for all her love and encouragement towards the completion of this work. I also acknowledge all the support from Professor C. O. Folayan who has proved not only to be a teacher but a father. I thank Dr. E. J. Bala for his immense role and contribution to the project. I thank Dr. D.S Yawas, my second supervisor for his immense role in the completion of this thesis.

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ABSTRACT

This work centers on the study of the electrical energy consumption pattern of Ahmadu Bello University Samaru Zaria over a period of five years to establish the present energy demand and to project future demand .To obtain the amount and pattern of electrical energy consumption, statistical data for five years were collected for PHCN supply and generator supplement. These data were analyzed and forecast of future demand made based on the analysis. The study found out that due to power outages from PHCN, the University had to supplement PHCN supply by installing 7.74MW capacity Diesel and Petrol generators in both academic and residential areas. The power supplied by these generators constitute 42.6% of monthly energy consumption in 2003, 40% in 2004, 39% in 2005, 49.3% in 2006, 55.27% in 2007 and 37.3% as at May 2008.

Some methods to reduce energy waste are recommended and sources other than fossil fuel Powered generators are suggested for future supplement of supply from PHCN.

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NOMENCLATURE

ABU – Ahmadu Bello University

BBC – British Broadcasting Corporation

BMU – Bulk Metering Unit

CHP - Combined Heat and Power Plant

GDP – Gross Domestic Product

GNP – Gross national Product

HEAR – Honeywell Energy Analysis Report

MIS – Management Information System

NP – National Population

OCU – Oklahoma City University

PHCN – Power Holding Company of Nigeria

PTDF – Petroleum Technology Development Fund

CHAPTER ONE

INTRODUCTION

The genesis of electricity supply in Nigeria dates back to the colonial era. The colonial master commissioned the first phase of Ijora power station to supply power to selected areas of Lagos and the environs. On the whole, Nigeria had about 200MW of electricity as at independence in 1960 under the Government Electricity Undertaking (Oke et al, 2007).

The rate of growth of industries and urban cities was very drastic immediately after the civil war of 1967 to 1970 and because of increased level of socialization and industrialization, demand for electricity has increased drastically. Traditional firewoods have given way to electric cookers and other renewable energy sources such as biogas. Because of increased level of socialization and industrialization, demand for electronic gadgets increased drastically. This gave a big challenge to government whose responsibility is to maintain adequate supply of electricity to its citizen.

1.1 ENERGY CONSUMPTION OVERVIEW

Notwithstanding the importance of modern energy forms in raising economic output, they are often viewed as economic 'bads' not 'good' – a view that has gathered force in recent years and is the source of much confusion in energy and environmental policies. In some countries energy use is under attack not only from environmental group but also from finance ministries who see high energy taxes as a means of simultaneously raising revenues and reducing pollution. Energy demand in developing countries will rise enormously as per capita incomes and population grows.

No country has been able to raise per capital income from low levels to high levels without increasing its use of commercial energy. Modern energy forms have been proven to have raised economic output of many countries in the world (Anderson, 1997).

Studies show that there is an increase in the world's consumption of commercial energy over this century. Forecast of long-term energy demand vary considerably with assumption about the growth of per capita income and population.

In a macro or aggregate analysis, the factors considered to be affecting total national energy consumption are;

a. National Population (NP)

b. Levels of national income in terms of Gross Domestic Product (GDP) and

c. The level of national income In terms of Gross National Product (GNP)

Increasing population generally leads to increasing economic activities. Increase in population and economic activities in a Country /University leads to increase in consumption of energy. This generally results in more diverse energy application and additional energy uses.

Sectoral analysis or the analysis of energy consumption of each economic sector provides deeper understanding of energy –economy interaction. It thus provides a better basis for projecting future energy consumption. It can be the basis for fine tuning policies that includes well-focused intervention programs and appropriately designed investment project.

A sectoral energy analysis usually divides the economy into five major categories or sectors as outlined in table 1;

a. Household (Education inclusive) Sector

b. Industrial Sector

c. Agricultural Sector

d. Service Sector and

e. Transport Sector.

In Nigeria, the house hold sector is the largest consuming sector in the economy. It accounts for about a quarter of total commercial energy and over 90% traditional fuels, especially firewood. It accounts for 62%, 65% and 65.1% of total delivered final energy in 1985, 1987 and 1989 respectively.

Table1: Sectoral Final Energy consumption in Nigeria. (%)

SECTOR/YEAR	**1985**	**1987**	**1989**
House hold	62.0	65.0	65.1
Industry	15.0	15.0	11.3
Transport	22.0	19.0	20.2
Agriculture	0.4	0.4	.05
Services	0.6	0.6	2.5

Source: (Oke et al, 2007)

Energy is widely consumed in all these Sectors of the economy. Each sector is treated as having some unique characteristic and patterns of energy consumption. Sectoral energy analysis account for changes in the share of the contribution of each sector. It can also account for changes in specific energy consumption in each sector and thus, recognizes that the specific energy consumption of the total economy is not constant but changes over time. Finally, it can also account for changes in the energy consumption for each type of fuel such as wood, kerosene, gas and electricity over time. These changes are very pronounced particularly during periods of rapid economic growth and transformation.

There are several forms of energy; these are electrical, mechanical and thermal energy. Of all the final forms of energy, electricity stands out

Because of its advantages over others; Electricity is the cleanest of all the final forms of energy, it is also more convenient to use. It causes no pollution and it is always ready for use. Transportation of electricity is much easier than others.

This work focuses on the electrical energy consumption in the educational sector, the university in particular. The University energy consumption is one part of the sectoral analysis of energy consumption. Several surveys have been carried out around the world to know the consumption of energy in universities and how best to manage the available energy efficiently and improve the output and living standard of the University community.

1.2 ELECTRICAL ENERGY GENERATION AND CONSUMPTION IN NIGERIA

1.2.1 INSTALLATIONS

From available records, (Ajayi and Balogun, 1981) electricity generation in Nigeria began in 1896 when in Lagos 60KW of power was generated. The Nigerian electricity supply company (NESCO) commenced operation as an electricity utility company in Nigeria in 1929 with the construction of a hydroelectric power station in Kurra near Jos. Several other towns in Nigeria later established electricity supply by the installation of isolated generators in each town.

In 1946, the Nigerian Government Electricity undertaking was established to take over the responsibility for electricity supply in Lagos area. In 1950, a central body was established by the ordinance no. 15 of 1950 which transferred electricity supply and development to the care of a central body known as Electricity Corporation of Nigeria (ECN).

In 1962 another body known as the Niger Dams Authority (NDA) was established by an act of parliament. The authority was mandated to develop the hydro power potentials of the country. The energy produced by (NDA) was sold to ECN for distribution in Nigeria. In the same year the first 132KV line was constructed to link Ijora and Ibadan power stations. The operations of ECN and NDA were combined in 1972 to form a new organization known as National Electric Power Authority (NEPA). (Ajayi and Balogun, 1981). The bulk of the supply of energy to the country has been the main task of NEPA. NEPA was also mandated to maintain an efficient, coordinated and economic system of electricity supply to all parts of the nation and to propel the nation's technological and industrial growth.

However, the ever increasing demand for electricity occasioned by the linking of several communities to the national grid has made this mission largely unaccomplished. The inability of the nation to increase generation capacity has made the energy balance between production and consumption negative. The signing into law of the Electric Power Sector Reform Act 2005 on the 11th March, 2005 set the stage for the unbundling of NEPA into 18 companies. Nigerians are yet to see any improvement in the power sector despite all the metamorphosis. The university being an integral part of the country is not spared by the brown-outs, frequent heavily fluctuating voltages and most times complete blackouts.

Nigeria's power generating potential is adjudged the highest in Africa. This is attributed to the abundant natural gas reserve of about 188 trillion cubic feet, which is the 8th in the world; The country has enough associated gas potential to power giant thermal stations.

Despite Nigeria's huge electrical power generation potentials, its power supply situation has remained abysmally mournful. When other countries are encouraging investment in nuclear power to compliment other sources of energy, Nigeria is still struggling to tap fully the traditional sources of power.

The national electricity grid presently consists of eight generation stations, five thermal stations (Alike, 2006);

a. 40MW thermal power plant in ljora

b. 1320MW in Egbin

c. 1020MW in Sapele

d. 912MW in Delta and

e. 969.6MW in Afam Rivers State.

Their combined capacity is 4,261.6MW.

The country also has three hydropower stations, which are;

a. 760 MW Kanji Dam

b. 578.4 MW Dam in Jebba and

c. 600 MW Dam in Shiroro.

Their total generating capacity is 1938.4 MW.

These are summarized in the table below.

Table2: Power stations in Nigeria

HYDRO	**STEAM**	**GAS**	**AGO**
Kainji	Egbin	Sapele	Ijora
Jebba	Sapele	Afam	
Shiroro		Dalta	

Source: (Oke et al, 2007)

1.2.2 STATEMENT OF THE PROBLEM

The fewness and sparse distribution of generating points relative to the size of the country presents a big problem. The first problem is that clearly we have not invested sufficiently in total generating capacity, apparently being satisfied with the present estimated demand rather than a visionary attitude that more electricity generation stimulates more demand.

South Africa's generation capacity has hit 36,000MW and the country plans to construct an additional 5,000 MW by 2010. The country's highest average demand in history was 34,000MW, recorded in June 2005. (Alike, 2006)

A couple of years ago Ghana celebrated her 25 years of uninterrupted power supply.

Though the Federal government's reform process increased generation from 1,900MW in 1999 to 3,200MW, supply has since reduced to an abysmally low level of 2150MW while the average national demand hover around 10,000MW.

Secondly, the eight (8) generation stations with more than half located along the coast and the rest along the mid-section of the country with a capacity of 6,000 MW is on the average 750 MW per generating station. When one shuts down or has a problem –due to poor water levels, disrupted fuel supply or turbine breakdown or outright sabotage- it depletes the national grid.

The sparse geographical distribution of generating points also means that average distances over which electrical energy is distributed are high – anywhere from 300 to 500 kilometers. This results in line voltage and power loses as high as 25% compared with 3% in the United States and 0.5% in Japan. Also the grid voltages in Nigeria are typically 330kv compared with increasingly 765kv in developed countries. Generally, the higher the grid line voltage, the lower the grid current hence for a given length of wire, the smaller the line power loss. Distribution problems are compounded when electrical wires are stolen and power transformers for stepping down and stepping up voltages along the way are broken down. Thus reducing distribution distances, increasing the gridlines voltages, improving security and maintenance culture are clear steps to be taken if electricity supply is to be improved.

Another area where we have problems is in the area of revenue collection. Residential, commercial and industrial consumers to whom the electricity is distributed at appropriate voltages (240 Volts for residential and commercial users in Nigeria, and higher for some commercial and industrial) have poor customer base services from the power holding company of Nigeria (PHCN). As at June 2002, PHCN revenue (customer base) was put at about 3.05 Million Naira for the year .83% of which where residential, 16% commercial and 0.4% industrial in a country that is about 140 million population with 446 Local government areas connected to the national grid out of 774. This is pitiful customer base. (Aluko, 2006)

Zero voltage otherwise known as blackout, sustained low voltage (brownout) or frequent heavily fluctuating voltages have been the order of the day in the experience of Nigerians. This has made the desire to pay for such poor services quite understandably low.

Poor recording of electricity used by customer, poor collection methods and outright fraud (payments not remitted to PHCN) have also been major problems.

Corruption and gross negligence at the Power Holding Company of Nigeria reached its peak at the beginning of the past administration when the national grid of PHCN was brought to a total collapse. A system collapse, which Nigeria last witnessed in 1991, was recorded twice within 72 hours on March 10 and 14 year 2000.

The collapse was blamed on a mysterious fire at Shiroro power station but corruption and gross negligence cannot be ruled out as remote causes.

The initial pumping of millions of dollars of oil revenue by government into the system to replace outdated equipment did not help matters as the money ended up in private pockets. (Alike, 2006) The whole system is corruption infested.

Nigerians and indeed investors are finding it increasingly unaffordable to do business in the country partly because of high cost of alternative power supply.

In view of the above mentioned problems and their attendant effect on the university community, there is need for the university to formulate new energy management policy that will ensure that the system depends less on the power from the national grid- as it is obvious that the power from the national grid cannot provide/satisfy the energy demand of the university.

1.2.3 JUSTIFICATION FOR THE RESEARCH

In view of the problems of electrical energy generation, transmission and distribution highlighted above, there is need to study the energy consumption patterns of a Nigerian university with a view to making recommendation that would enable the university to adopt clear energy policy.

The research would enable the university to plan and implement a concise energy mix that would solve the problems of inadequate energy supply and will enable the university to plan energy saving schemes or modes.

The unbundling of the National Electric Power Authority (NEPA) into 18 companies; 6 generating companies, 11 distributing companies and 1 transmitting company has not improved the performance of PHCN, hence the study would enable the university to look elsewhere for steady and reliable power supply supplement.

In addition energy consumption reviews shows that there is power shortage at the National level and in ABU. However, there is the need to study the pattern of electric power consumption in ABU in order to determine the extent of short fall and therefore recommend necessary steps for making up for current short fall and plan for future increase in electric energy demand. This is in conformity with reviewed studies at University of Glasgow; HEAR at OCU and "Save Power Committee" of PAN limited

1.2.4 AIMS AND OBJECTIVES

The investigation into electrical energy consumption in ABU Samaru, Zaria is aimed at identifying the present energy consumption; the energy needed by the university and develop energy management procedure which is at the leading edge of good practice.

More specifically, the investigation is aimed at achieving the following objectives:

a. To study the electrical energy consumption pattern of the university with respect to time of the year in order to determine future demands and to plan for appropriate installations to meet future demands.

b. To advise the university system on ways of reducing wastages if any.

c. To promote energy saving awareness, identify and encourage the university to implement energy saving measures.

SCOPE OF THE STUDY

This study is restricted to electrical energy consumption from

a. P.H.C.N

b. Diesel generators and

c. Petrol generators.

CHAPTER TWO

LITERATURE REVIEW

2.0 INTRODUCTION

Energy consumption of universities has been extensively investigated in the literature.

Many surveys have been carried out on different university campuses and based on the result obtained policies on energy management have been formulated for the universities.

2.1 ENERGY UTILIZATION IN ABU SAMARU ZARIA

Studies show that there are seven major types of energy used in ABU Samaru Zaria (Yusuf, 1998). These are;

a. Electricity

b. Diesel

c. Petrol

e. Kerosene

f. Gas

g. Wood and

h. Solar energy

2.1.1 ELECTRICITY FROM PHCN

In ABU Samaru, electricity from the Power Holding Company of Nigeria (PHCN) is received by incomer feeders at the Bulk Metering Unit (BMU). The incomer feeders contain bus bars, these bus bars distribute the electricity into the University feeders which in turn distributes the electricity to different parts of the university. The bulk metering of electricity is one of the global best practices in the energy sector. It helps to improve efficiency of readings and saves cost for the university.

2.1.2 GENERATORS

Due to power outages from PHCN, generators are used both in the academic and residential areas to supplement electricity from PHCN. These generators are powered by diesel and petrol. They form a substantial part of energy consumption in the university as summarized in the abstract.

2.1.3 OTHER TYPES OF ENERGY USED

The other types of energy utilized in the university includes kerosene for cooking and heating in residential areas, gas for cooking and heating, wood and solar energy. These also form a substantial part of energy consumed in the university.

2.2 REVIEW OF LOCAL STUDIES OF ELECTRICAL ENERGY CONSUMPTION PATTERN

Yusuf (1998) investigated the energy consumption in ABU main campus Samaru residence and came up with a distribution of utilization of various available energy. He said 80% of households in area A, 100% of households in Area C, 80% in area BZ, and 60% in Area F use Kerosene. He further said 100% of households in area A, 60% in area C, 100% in area BZ and 40% of household in area F use gas. While 60% of household in area A, 20% in area C, 60% in area BZ and 80% in area F use electricity. 20% of households in area A, 60% in area C, 0% in area BZ and 20% in area F use wood.

He concluded that kerosene and electricity are the most used both by students and staff for cooking.

Aluko (2004) investigated the electrical energy consumption of Nigeria and made recommendations on what each state government and University should do to improve what he called puny amount of electrical power generated for a country of 140 million people. This includes a mix of electrical energy sources such as hydro power plant, thermal power plant, solar energy, wind and nuclear reactors. He proposed for his state Ekiti, 150-300MW capacity demand distributed as follows;

Hydro - 20%

Thermal - 70%

Solar - 5%

Wind - 5%

Kupolokun, (2006) at the Baker institute energy forum x-rayed the global economic growth which necessitated the sustained band shift in crude Oil and Gas prices. He highlighted the need for capacity additions in line with global energy needs. He added that Nigeria's aspiration is focused on delivering significant capacity additions in both crude oil and natural gas. Specifically, the targets are to grow crude oil reserves to 40 billion barrels and production capacity to 4.5 million barrels per day in 2010, maximize oil and gas sector value to the economy. Other aspirations he said include creating as much revenue from gas as oil within the decade, addressing environmental issues, developing the domestic gas market and creating new industries out of the old oil industry.

He added that gas is being leveraged as the fuel to power Nigeria's economy. He said already, 15 new gas fired plants are under construction and will add over 7 giga watts of electricity to the national grid. Consequently, power sector growth is expected to translate into an increase in gas demand from less than 1 billion cubic feet per day to about 3 billion cubic feet per day representing over 50% annual growth.

He concluded that not only will the demand for gas increase but that gas flares are down by 40% and will continue to drop with a view to achieving flare out by 2008.

Garba, (2006) of the diesel and generators committee ABU Zaria highlighted the diesel consumption of the generators in ABU Zaria. He stated that a 500kVA generator consumes 200 litres in about 4 hours, 800KVA in about 3 hours, 350KVA for about 5 hours, 250KVA for 5 hours e.t.c for loads ranging from 80Ampheres to 5 Ampheres.

Sambo, (2006) presented a paper at the 2006 lecture week of the national association of Mechanical Engineering Student (NAMES) ABU Branch. He highlighted the need to cultivate sustainable energy utilization policy through internationally acceptable best practices such as;

a. Use of renewable energy

b. Energy conservation and efficiency

c. planning for use of nuclear energy for power generation and other peaceful uses. He concluded that the economy of Nigeria is mainly petroleum driven and that there is need to use the resources derived now from petroleum to develop other wealth generation activities for present and future generations.

"Save Power Committee" of Peugeot Automobile Nigeria Limited (2005) studied the factory's growing energy consumption occasioned by the huge electricity bills from Power Holding Company of Nigeria (PHCN). The committee identified body shop and machine shop as critical areas of power consumption. It recommended the installation of power shot-off devices to shot power out when equipment are not in use. The committee also recommended among others the following measures.

1. The switching off of air conditioners during break hours.

2. Turning off the computers when not in use.

3. Maximization of the use of sun light during the day and switching off electric bulbs and fluorescent tubes.

4. Nock off non-critical parts of the factory when generators are used to generate electricity.

5. Ensuring that all air conditioners, lightings and equipment are turned off after work. These measures reduced electricity consumption by as much as 15% per month after implementation.

Jekayinfa, (2006) studied the energy consumption pattern of selected mechanized farms in southwestern Nigeria. He is of the department of agricultural engineering, Ladoke Akintola University of technology Ogbomoso. He studied the feed mill, hatchery, mechanical workshop, piggery, poultry and administrative sections and concluded that energy use was good in the farms. He however recommended that;

1. Light in all sections of the farms be switched off during holidays and on completion of each day's work.

2. Weak fluorescent tubes be replaced at the end of their effective performance period.

3. An energy management committee be set up to look into reduction of energy consumption. (Jekayinfa, 2006)

Ajayi and Balogun, (1981) in a paper published in the journal of the Nigerian Society of Engineers titled Electric energy demand and growth in Nigeria described the historical development of the electricity industry in Nigeria, presented the trend of energy consumption and production. They also presented a projection for future electrical energy consumption pattern based on the trend equations and available data. They concluded by tasking the relevant authorities to take radical steps to ensure that sufficient generation capacities are established as rapidly as possible. They also suggested that long term plans be made to cope with the growing energy needs of the country. They said priority must be placed on establishing generating stations with renewable sources of energy and then utilizing the gas from the wells which are at the moment being flared. They said research work on solar energy must be intensified and pilot projects put on hand. The growth of energy demand is high and all available means must be used to meet this demand.

2.3 REVIEW OF STUDIES OUTSIDE NIGERIA

Saveit, (2004) investigated the energy consumption pattern at the University of Glasgow, He said that the objective of the investigation was to meet or exceed environmental legislation and approved codes of practice and to minimize environmental impact as far as is practicable. To achieve these, he recommended the formation of an energy management committee with the following terms of reference:

1. To reduce the consumption of fossil fuels and utilize energy from sustainable sources where practicable
2. To reduce water consumption
3. To monitor and report energy performance in an appropriate way
4. To buy fuels at the most economic cost and to maximize the use of fuel types which cause least harm to the environment
5. To promote energy awareness amongst staff and students
6. To identify and implement energy saving measures and practice energy efficiency throughout all the premises, plant and equipment where it is cost effective to so do
7. To incorporate environmentally sensitive designs into both new and refurbished buildings complying with relevant standards and references
8. To target a reduction in energy consumption in line with the government's goal of cutting carbon dioxide emissions in tackling the threat of climate change.
9. To promote good energy management practices to other organizations.

He concluded that the university did implement his recommendations and the leading edge of good practice. He said a subcommittee of the estate, policy and strategic committee was mandated to implement his recommendation and that the university had saved so much from it.

Geuder, (2006) studied the energy consumption of Mississippi State University and conservation modes and an immediate 11 percent saving of cost of energy was noticed. The university's annual energy cost rose from $4.8 million in 1996 to nearly $15 million in 2006. It became essential to become more energy-conscious than ever as a practical matter. A cross-campus committee developed a resource efficiency plan that proposed immediate and long-term measures designed to save millions of dollars. Some involved infrastructure supply and operations maintenance, but many are common-sense measures that have a cumulative impact. Techniques such as ensuring lights and individual heating and cooling units are turned off at the end of each day, as well as lowering thermostats during the winter have contributed to the savings. Mississippi State University also implemented a holiday conservation plan from December to January to further reduce consumption without jeopardizing facilities or on-going projects.

Coffey, (2006) used the Honeywell Energy Analysis Report (HEAR) to save money and reduce energy consumption for Oklahoma City University. She concluded that "in higher education, there's always a money crunch", whatever can be done to save utility costs increase the funds available for initiatives that directly benefit students. She said Oklahoma city university (OCU) is tackling the challenges of energy cost management through the use of a new tool, the Honeywell Energy Analysis Report (HEAR). She said HEAR gives OCU a way to understand and address two primary business issues in the light of rising prices: The need to find out where and how much energy is being used and the need to minimize excessive energy use. She said prior to HEAR, University buildings were individually metered. After reviewing utility rates, the University determined that a central metering system would be more effective. OCU reduced its 26-meter system to four (4) resulting in reduced rate and a decline in electric charges.

She concluded that HEAR had turned data into dollars for the university.

Energy and Environmental Management Unit of the University of Bristol (2005) studied the historical energy consumption of the university and commenced the implementation of energy and water management programme. Some of the energy saving measures are;

- Lighting controls in toilets which switch the lights on when people enter the toilets
- Urinal controls to reduce the amount of water flushed down urinals
- Pipe work insulation in boiler rooms
- The University of Bristol has equally been awarded £23,800 (Twenty three thousand eight hundred pounds) by the community energy programme to carry out a detailed feasibility study into combine heat and power plant (CHP). A combined heat and power plant is an installation where heat and electricity is generated in a single process. The heat is used for a variety of purposes including space heating, community heating and processes.
- Other save water initiatives are;

- Fitting of insulation to water pipe work-running taps waiting for them to get hot can waste a lot of water
- Turn the tap off while you brush your teeth and rinse at the end with a mug of water. A family of four can save a bath full of water every third day this way.
- Take showers instead of baths. A bath uses up to 90 litres (18 gallons) of water.

Shower use an average of only 30 litres (7 gallons). So save time, water and energy by taking a shower.

- Rather than running tap water until it's cool keep a bottle of cold water in your refrigerator.
- Wash vegetables in a bowl, not under a running tap. Soaking vegetables makes them easier to peel. A running tap wastes 10 litres than necessary.
- Don't overfill the kettle for just one drink. Heat the amount of water you really need.
- Don't site fridge close to the cooker or boiler- if this is unavoidable, leave a good gap between them.
- Dry your clothes on a clothe line- tumble driers use huge amounts of energy.

The drive for energy saving have not only reduced the carbon dioxide emissions but has provided the University income which was reinvested in even more energy saving initiatives.

2.4 THE PRESENT WORK

This work centers on the survey of electrical energy consumption in the Samaru campus of ABU. It has looked into the pattern of electricity consumption, the monthly variations in consumption and the reason for the variations. The work also looked at the privately generated energy as a result of the shortfall from the public power supply. From the information obtained, calculations were made and forecast of future energy demand was made. Recommendations on how to improve energy generation, consumption and utilization was also made

CHAPTER THREE

METHODOLOGY

3.1 SURVEY OF ELECTRICAL ENERGY FROM PHCN THROUGH THE BULK METERING UNIT OF AHMADU BELLO UNIVERSITY

A survey of electrical energy consumption in Kilowatts hour was conducted using the Power Holding Company of Nigeria (PHCN) meter at the bulk metering unit. The bulk metering of electricity consumption helps to save cost for the university. This is one of the global best practices in the energy sector for most universities in the world. When metering of electricity consumption is distributed, inefficiency of readings sets in, unnecessary cost is incurred and by the time the separate meter consumption is collated, the aggregate cost would be higher than that of a centralized metering system.

Electrical energy consumption data was collected from the Bulk metering unit for five years (2003 – 2008) on monthly bases. These data were analyzed to show various distributions.

3.2 SURVEY OF ELECTRICAL ENERGY FROM GENERATORS

All the generators in the academic area were surveyed including all privately owned generators in the phase 1 community market, social centre and Icsa-Ramat community market. In addition all the residential houses were combed to collate information on the number of houses that use generators to supplement PHCN supply. It should be noted here that generators are run when there is power outage from the Power Holding Company of Nigeria (PHCN). The numbers of hours run is a function of the number of hours power is out from PHCN. The capacities of the generators were recorded; their average load was calculated based on their daily operation log book. Diesel consumption per month was calculated from their rate of consumption and the number of hours loaded.

3.3 COLLATION OF INFORMATION FROM THE INTERNET

As is the case with modern day researches, extensive internet research was conducted to establish energy consumption pattern of other universities. Outside the shores of this country, emphasis is laid on the reduction of energy consumption through the implementation of a number of measures. For the developed economies, energy availability is not the problem, the issue is the high cost of energy. Energy for them has become a key factor in deciding the product cost at micro economic level as well as dictating the inflation and debt burden at macro economic level. Energy cost is a significant factor in economic activity and on per with other factors of production such as land and labour. The imperative of an energy shortage situation calls for energy conservation measures, which essentially mean using less energy for the same level of activity. They therefore conduct energy audits at regular intervals to address issues of maintenance, pollution control, safety, cost and savings, reliability of energy supply etc.

In the third world economies especially Nigeria, electrical energy availability is a major problem. The issue of over consumption is not there because you hardly even get the energy to consume. The cost implication comes in when alternative power generation is attempted. In Nigeria for instance, investors are finding it extremely unaffordable to do business partly because of high cost of alternative power supply as the price of diesel is soaring high on daily bases. All these phenomena and many others were looked at from the internet.

An introductory letter was obtained from the postgraduate coordinator with which valuable and confidential information like the student population, staff population and housing population were accessed from the management information system (MIS) and housing and passages units.

These information were used to analyze results obtained and presented in chapter 4.

A factory visit was paid to Peugeot Automobile Nigeria (PAN) Limited and information was collected from the "Save Power Committee" on recommendations of the committee's work and results obtained on implementation of same.

CHAPTER FOUR

RESULTS AND DISCUSSION

From the readings taken from the bulk meter, electrical energy consumption for each month of year 2003 to 2008 is tabulated in tables 3 to 8 below.

4.1 ELECTRICAL ENERGY CONSUMPTION FROM PHCN **2003**

Table 3: ELECTRICAL ENERGY CONSUMPTION FROM PHCN **2003**

MONTH	ENERGY CONSUMPTION (KWHR)	ENERGY COST(₦) @ ₦4 PER KWHR + 5% VAT AND METER MAINTENANCE CHARGES
JANUARY	405,200	1701940.00
FEBRUARY	263,400	1106380.00
MARCH	172,800	725860.00
APRIL	211,200	887140.00
MAY	160,400	673780.00
JUNE	214,500	901000.00
JULY	365,300	1534360.00
AUGUST	458,000	1923700.00
SEPTEMBER	487,800	2048860.00
OCTOBER	456,200	1916140.00
NOVEMBER	421,400	1769980.00
DECEMBER	267,000	1121500.00
TOTAL	3,883,200	16310640.00
MONTH AVERAGE	323,600 KWHR	

4.2 ELECTRICAL ENERGY CONSUMPTION FROM PHCN 2004

Table 4: ELECTRICAL ENERGY CONSUMPTION FROM PHCN

2004

MONTH	ENERGY CONSUMPTION (KWHR)	ENERGY COST(₦) @ ₦4 PER KWHR + 5% VAT AND METER MAINTENANCE CHARGES
JANUARY	269,600	283180.00
FEBRUARY	293,800	308590.00
MARCH	376,300	395215.00
APRIL	448,400	470920.00
MAY	491,300	515965.00
JUNE	411,800	432490.00
JULY	431,700	453385.00
AUGUST	397,100	417055.00
SEPTEMBER	271,100	284755.00
OCTOBER	222,700	233935.00
NOVEMBER	297,500	312475.00
DECEMBER	222,300	233515.00
TOTAL	4,133,600	4341480.00
MONTH AVERAGE	344,467 KWHR	

4.3 ELECTRICAL ENERGY CONSUMPTION FROM PHCN 2005

Table 5: ELECTRICAL ENERGY CONSUMPTION FROM PHCN

2005

MONTH	ENERGY CONSUMPTION (KWHR)	ENERGY COST(₦) @ ₦4 PER KWHR + 5% VAT AND METER MAINTENANCE CHARGES
JANUARY	257,100	270055.00
FEBRUARY	335,400	352270.00
MARCH	363,000	381250.00
APRIL	343,800	361090.00
MAY	352,900	370645.00
JUNE	433,100	454855.00
JULY	393,700	413485.00
AUGUST	517,900	543895.00
SEPTEMBER	381,700	400885.00
OCTOBER	291,800	306490.00
NOVEMBER	321,400	337570.00
DECEMBER	210,200	220810.00
TOTAL	4,202,000	4413300.00
MONTH AVERAGE	350,167 KWHR	

4.4 ELECTRICAL ENERGY CONSUMPTION FROM PHCN **2006**

Table 6: ELECTRICAL ENERGY CONSUMPTION FROM PHCN

2006

MONTH	**ENERGY CONSUMPTION (KWHR)**	**ENERGY COST(₦) @ ₦4 PER KWHR + 5% VAT AND METER MAINTENANCE CHARGES**
JANUARY	358,000	376000.00
FEBRUARY	744,700	782035.00
MARCH	463,600	486880.00
APRIL	157,200	165160.00
MAY	108,900	114445.00
JUNE	244,500	256825.00
JULY	185,000	194350.00
AUGUST	189,100	198655.00
SEPTEMBER	251,400	264070.00
OCTOBER	245,300	257665.00
NOVEMBER	211,900	222595.00
DECEMBER	194,600	204430.00
TOTAL	3,354,200	3523110.00
MONTH AVERAGE	279,517 KWHR	

4.5 ELECTRICAL ENERGY CONSUMPTION FROM PHCN 2007

Table 7: ELECTRICAL ENERGY CONSUMPTION FROM PHCN

2007

MONTH	ENERGY CONSUMPTION (KWHR)	ENERGY COST(₦) @ ₦4 PER KWHR + 5% VAT AND METER MAINTENANCE CHARGES
JANUARY	181,300	190465.00
FEBRUARY	183,300	192565.00
MARCH	197,400	207370.00
APRIL	143,700	150985.00
MAY	154,500	162325.00
JUNE	216,300	227215.00
JULY	318,100	334105.00
AUGUST	410,900	431545.00
SEPTEMBER	311,100	326755.00
OCTOBER	284,600	298930.00
NOVEMBER	295,100	309955.00
DECEMBER	292,500	307225.00
TOTAL	2,988,800	3139440.00
MONTH AVERAGE	249,067 KWHR	

4.6 ELECTRICAL ENERGY CONSUMPTION FROM PHCN 2008

TABLE 8: ELECTRICAL ENERGY CONSUMPTION FROM PHCN

2008

MONTH	ENERGY CONSUMPTION (KWHR)	ENERGY COST(₦) @ ₦4 PER KWHR + 5% VAT AND METER MAINTENANCE CHARGES
JANUARY	409,900	430495.00
FEBRUARY	385,100	404455.00
MARCH	362,700	380935.00
APRIL	363,400	381670.00
MAY	326,900	343345.00
TOTAL	1,848,000	1940900.00
MONTH AVERAGE	369,600 KWHR	

NOTE: The cost of electricity includes 5% VAT and Meter maintenance charges

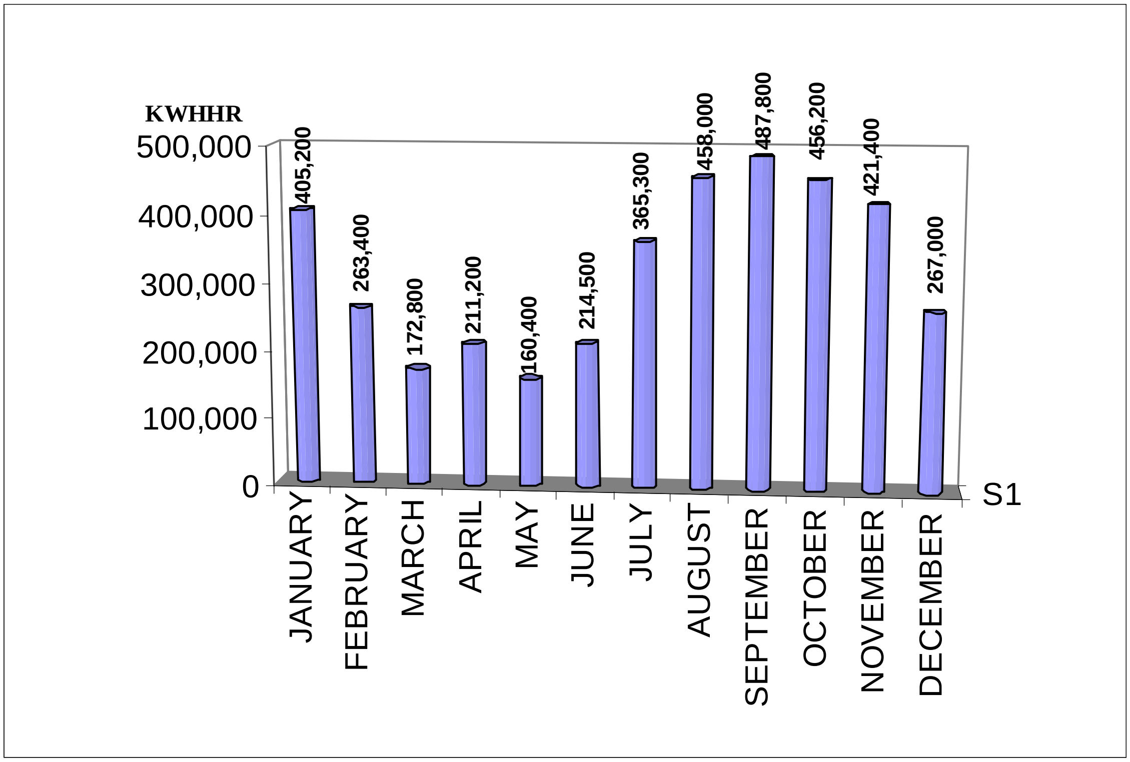

Figure 1: HISTOGRAM OF ELECTRICAL ENERGY CONSUMPTION FROM PHCN 2003

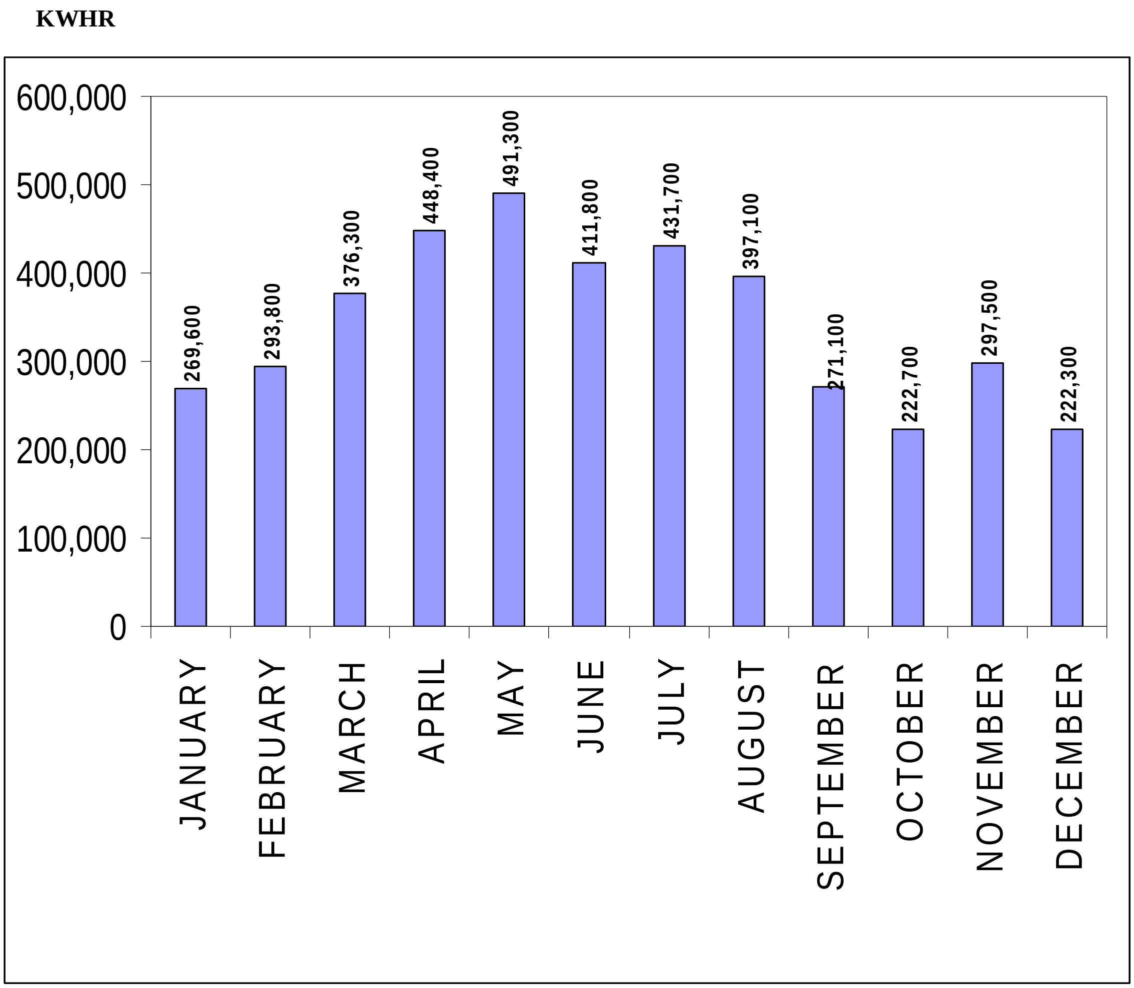

Figure 2: HISTOGRAM OF ELECTRICAL ENERGY CONSUMPTION FROM PHCN **2004**

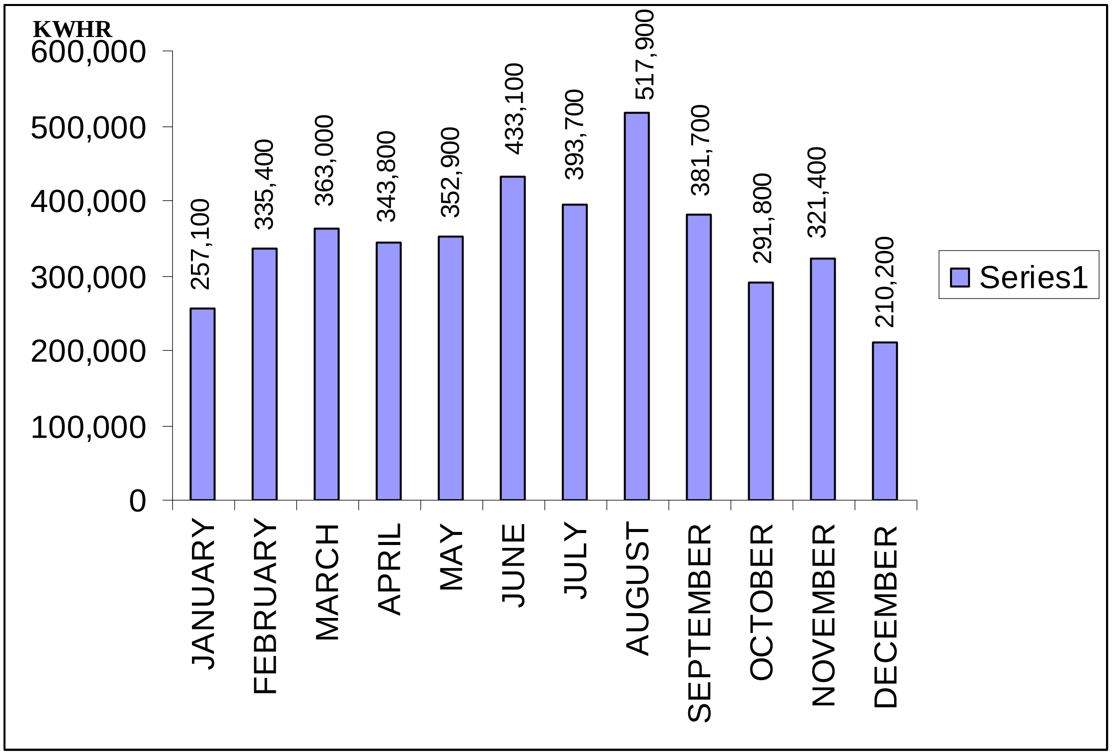

Figure 3: HISTOGRAM OF ELECTRICAL ENERGY CONSUMPTION FROM PHCN 2005

KWHR

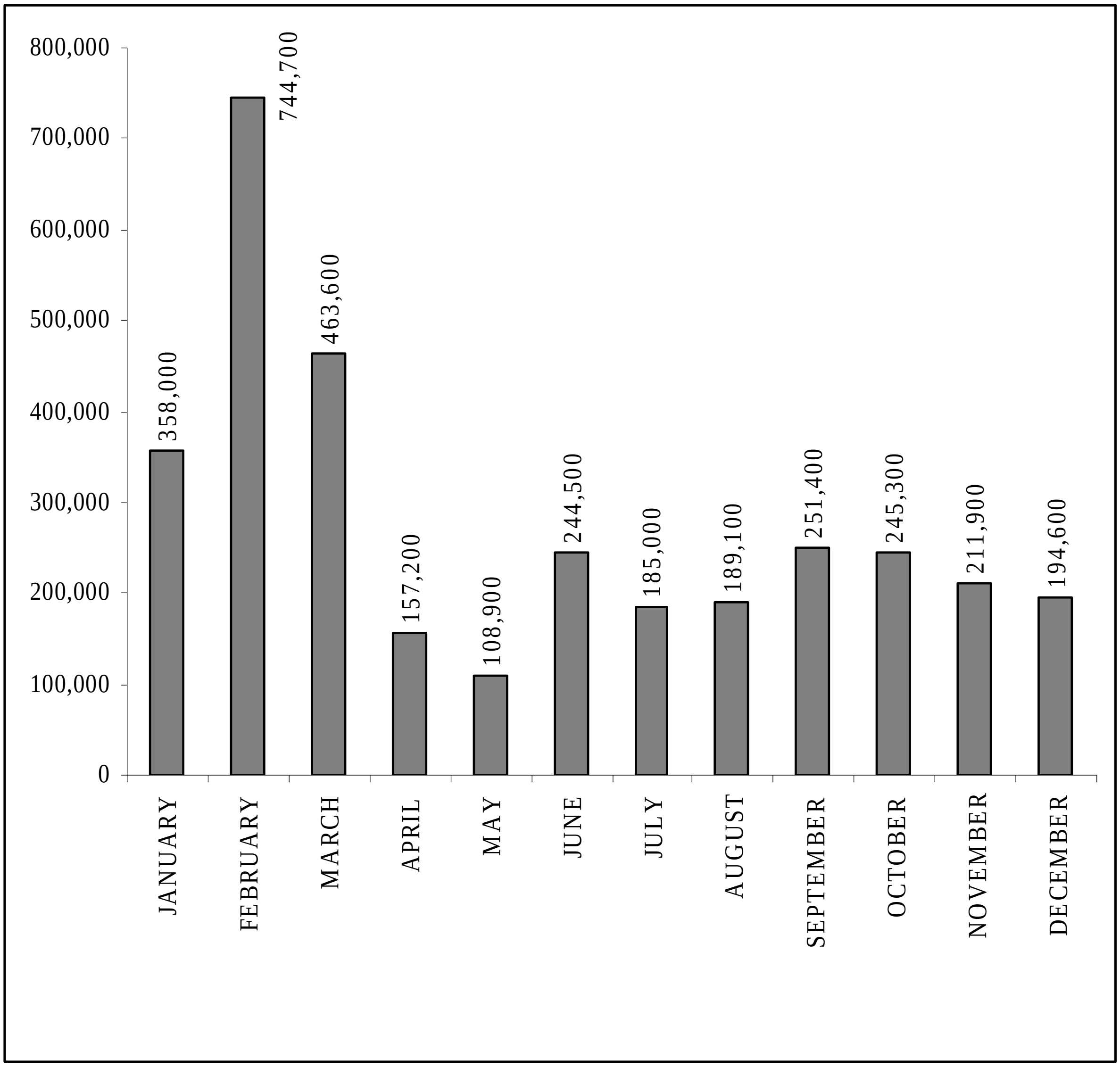

Figure 4: HISTORGRAM OF ELECTRICITY CONSUMPTION FROM PHCN 2006

KWHR

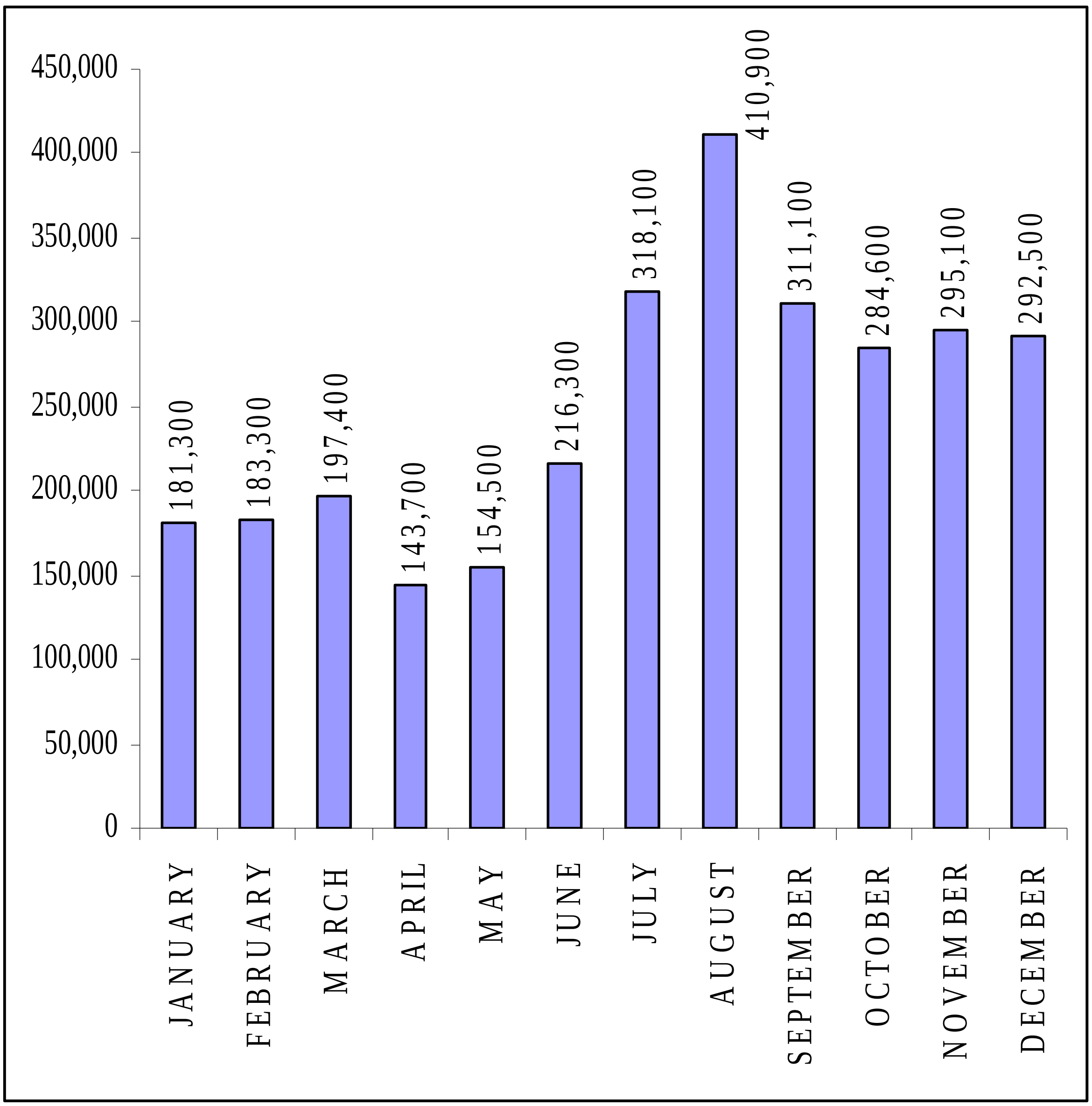
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
181,300
183,300
197,400
143,700
154,500
216,300
318,100
410,900
311,100
284,600
295,100
292,500
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER

FIGURE 5: HISTOGRAM OF ELECTRICAL ENERGY CONSUMPTION FROM PHCN 2007

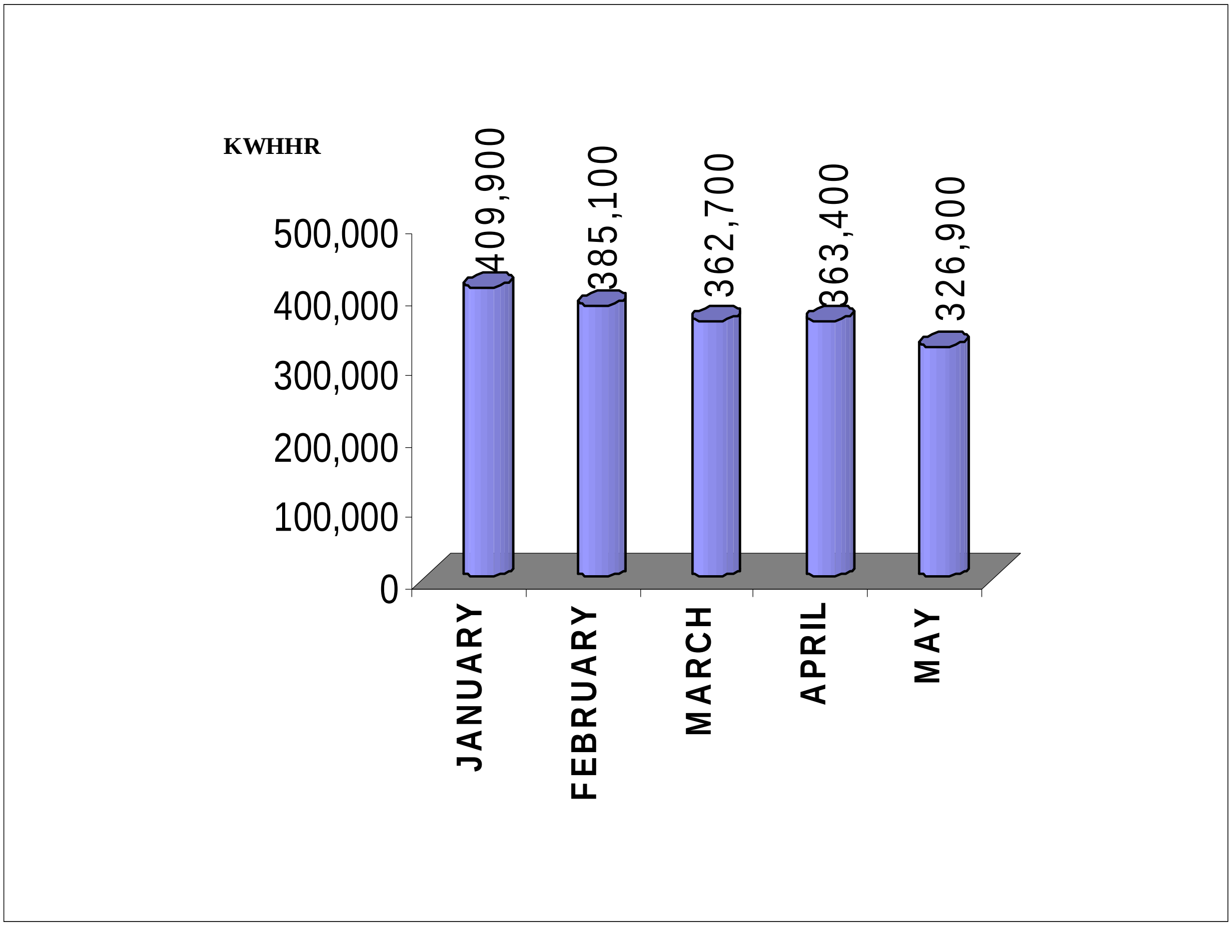

Figure 6 : HISTOGRAM OF ELECTRICAL ENERGY CONSUMPTION FROM PHCN 2008

4.7 PER CAPITA ELECTRICAL ENERGY CONSUMPTION

Let E= Energy consumed

P= Per capita electrical energy consumption.

PL= Population

The per capita electrical energy consumed for year 2007 is given by

P= E/PL x 100/95 …………..equation (1) (Ajayi and Balogun, 1981)

Energy consumed E = Energy consumption from PHCN + Energy Consumption from Generators.

Energy consumption from PHCN = 2,988,800kwhr

Energy consumption from generator for the year =137,677.79Kwhr * 12

=1,652,133.5Kwhr

Energy consumed E = 4,640,933.5Kwhr

ABU staff and student population PL as at 2007 = 39833 {sourced from MIS}

Therefore per capita energy consumption P for 2007 from equation (1) is = 4,640,933.5/39833 *100/95 =122.64Kwhr.

4.8 ENERGY CONSUMPTION FORECAST

If by 2015, the population of staff and student increase to say 50,000 then from equation (1) the energy needed or required to power the university will be;

122.64 = Energy required/50,000 *100/95

Energy required to power ABU for a population of 50,000 by 2015 is = 5,825400Kwhr per annum using E = P x 50,000 x 100/95.

4.9 DISCUSSION

Generally, there are two broad factors that influence the pattern of electrical energy consumption of the university, these are

a. Availability of energy from PHCN

b. Level of activities in the university.

As can be seen from the table and histogram, the pattern of electricity consumption is not uniform, there are variations from month to month. These variations are always due to the two broad factors outlined above.

AVAILABILITY OF ENERGY FROM PHCN

Nigeria has not tapped fully into the huge energy generation potentials as highlighted in the introduction of this project. There is hardly anywhere in this country where energy is available 24 hours a day. There are frequent outages in the University on daily bases due to;

(i) Water level at the hydro generation stations

(ii) Gas supply at the thermal power plants and

(iii) Poor infrastructure.

When water levels are high especially during the rainy seasons, power availability will be high and the consumption will equally be higher at these periods. When however water levels at the generation stations are low, frequent blackouts will be witnessed and consumption will be low.

For the thermal power plants, when gas supply is interrupted, power availability will be low and sometime completely absent. Consumption at such periods is always low. However power is available when there is constant gas supply. Consumption at such periods is high.

Infrastructural condition at the Power Holding Company of Nigeria is another pivotal factor that determines the availability of power supply.

When there are constant breakdown of transformers for stepping up and stepping down power, availability will be affected and consequently consumption. Incidences of vandalisation and lack of proper maintenance of infrastructure have accounted for most blackouts nationwide, such incidences reduces availability and consumption.

LEVEL OF ACTIVITY IN THE UNIVERSITY

Periods when the university is in session and there are serious academic activities, all lighting points in the different classrooms are put on, laboratories and workshops are operating, consumption of electricity will be high. When the University is on vacation and most students and some lecturers have traveled, activities will be at a low and electrical energy consumption will equally be low.

These factors combine to determine the amount of electrical energy and the pattern of consumption.

2003

From figure1 the University electrical energy consumption pattern for year 2003 is thus; in line with the broad factors that affect the consumption, there was an appreciable consumption in January with a value of 405,200 kwhr. Most likely the University was in session in the month of January: There was a drop in February due to unavailability of electricity from PHCN. There was a fluctuating drop in consumption between March and

June due to a combined effect of vacations and availability. From July when the rains have fully started to fall, there was a relatively steady increase up to November in the region of 400,000kwhr per month. In December when all activities are at the lowest ebb due to vacation, there was a drop in consumption to 267,000kwhr. A month average of 323,600kwhr was noticed in year 2003.

2004

From Figure 2 the electrical energy consumption pattern for year 2004 is similar to that of 2003 except there was a general drop in availability throughout the year. The highest consumption were noticed in April and May (448,4000kwhr) and (491,300kwhr) probably because the first semester examination was written in those months and activities were at high level. Also during these periods, the weather is normally very hot and a lot of energy is used for cooling. The average monthly consumption for the year was 344,467kwhr. Again in December we noticed a drop to 222,300kwhr due to vacation.

2005

From Figure 3 the pattern for 2005 is not different from that of the previous years. A steady increase from January to March then a drop in April. The fluctuation continued till the end of the year. Again there was a drop in December when virtually the campus is without students. A month average of 350,167kwhr was recorded.

2006

From figure 4 the highest ever consumption was recorded in 2006, February precisely though the pattern is relatively same with other years. Availability is one reason to explain the high consumption recorded in the month of February and perhaps all other factors were favorable. A monthly average of 279,517kwhr was obtained which indicate an over all drop compared to the previous year.

2007

From figure 5 there is a steady decline in the average consumption per month in 2007 and this is a reflection of the degeneration of the supply system from the main source of power. The average monthly consumption was 249,066kwhr a drop from that of the previous year.

2008

From figure 6 the pattern for 2008 up to May shows a bit of appreciation in consumption. The average monthly consumption so far is 369,60kwhr. The building of an injection sub-station in the university has made this improvement possible. However concrete steps must be taken by the University to provide cheap alternative generation capacity to stem the monthly variation due to poor availability from the national grid.

4.9.1 ELECTRICAL ENERGY CONSUMMED FROM GENERATORS

1. 800KVA MAIN GATE GENERATOR

   Average Load/Month =170A
   Voltage = 400V
   Average Hours Run per Month = 150 hours per month
   Energy = IVT
   Energy Consumed/Month = 170 * 400* 150
   = 10,200,000 Whr
   = 10,200 kwhr per month.

2. 250KVA SENATE BUIDING GENERATOR

Average Load/Month =100A
Voltage = 400V
Average Hours Run per Month = 150 hours
Energy = IVT
Energy Consumed/Month =100* 400* 150
= 6,000 Kwhr per month.

3. 500KVA FACULTY OF MEDICINE GENERATOR
Average Load/Month =80A
Voltage = 400V
Average Hours Run per Month = 150 hours
Energy = IVT
Energy Consumed/Month = 80 * 400 * 150
= 4,800 Kwhr per month.
There are two 500 KVA Generators in faculty of medicine.
Therefore energy consumed per month = 4,800 * 2= 9,600 Kwhr per month

4. 320KVA BOOSTER STATION GENERATOR
Average Load/Month =60A
Voltage = 400V
Average Hours Run per Month = 150 hours
Energy = IVT
Energy Consumed/Month = 60 * 400 * 150
= 3,600kwhr per month.

5. 500KVA KASHIM IBRAHIM LIBRARY GENERATOR
Average Load/Month =75A
Voltage = 400V
Average Hours Run per Month = 150 hours
Energy = IVT
Energy Consumed/Month = 75 * 400 * 150
= 4,500 Kwhr per month.

6. 100KVA SICK BAY GENERATOR
Average Load/Month = 20A
Voltage = 400V
Average Hours Run per Month = 150 hours
Energy = IVT
Energy Consumed/Month = 20 * 400 * 150
= 1,200 kwhr per month.

7. 169KVA LODGES GENERATOR
Average Load/Month =30A
Voltage = 400V
Average Hours Run per Month = 150 hours
Energy = IVT
Energy Consumed/Month = 30 * 400 * 150

= 1,800 kwhr per month.

8. 500KVA WATER WORKS GENERATOR
Average Load/Month = 80A
Voltage = 400V
Average Hours Run per Month = 150 hours
Energy = IVT
Energy Consumed/Month = 80 * 400 * 150
= 4,800 Kwhr per month.
There are two 500 KVA Generators in Water works.
Therefore energy consumed per month = 4,800 * 2= 9,600 Kwhr per month

9. 45KVA ROCKY FELLER GUEST HOUSE GENERATOR
Average Load/Month = 15A
Voltage = 400V
Average Hours Run per Month = 150 hours
Energy = IVT
Energy Consumed/Month = 15 * 400 * 150
= 900 kwhr per month.

10. 250KVA AMINA GENERATOR
Average Load/Month = 50A
Voltage = 400V
Average Hours Run per Month = 150 hours
Energy = IVT
Energy Consumed/Month = 50 * 400 * 150
= 3,000 Kwhr per month.
Total power consumed from the above generators = 50,400 Kwhr per month. --(a)

Six additional diesel generators around the academic area were surveyed. They are Biotech, Estate, Energy Research, BBC Studio, PTDF and Chemistry generators. Their combined power generation is 16,800 Kwhr. --------------- (b)

16,800kwhr + 50,400 Kwhr = 67,200kwhr per month.

All privately owned diesel and petrol generators within the phase 1 Community Market, Social Center, ICSA-Ramat Community Market and all residential areas were surveyed. Their combined power generation is = 70,477.79 Kwhr per month.

---------(c)

Total power generation = (a) + (b) + (c)

= 50,400 + 16800 + 70,477.79 Kwhr = 137,677.79 kwhr per month.

Total generator power is = 137,677.79 kwhr per month.

4.9.2 PERCENTAGE OF POWER FROM GENERATORS

If the above power is superimposed on the PHCN power supply then, the percentage of power consumption from generators are as shown; 137, 677.79/323,600 * 100 = 42.6 % in 2003.

137,677.79/344,467 * 100 = 40 %   in 2004.

137,677.79/350,167 * 100 = 39 %   in 2005.

137,677.79/279,517 * 100 = 49.3 % in 2006.

137,677.79/249,067 * 100 = 55.27% in 2007.

137,677.79/369,600 * 100 = 37.3 % as at May 2008.

If we add generator and PHCN supply in other to determine percentage of total power privately generated, then;

Total power consumed in 2003 is;

137,677.79 + 323,600 = 461,277.79 Kwhr

Percentage of private power generated/Total power consumption is;

137,677.79/461,277.79 = 29.85 %

29.85% of total energy consumed in 2003 was privately generated.

Total power consumed in 2004 is;

137,677.79 + 344,467 = 482,144.79 Kwhr

137,677.79/482,144.79 * 100 = 28.6 %

28.6 % of total energy consumed in 2004 was privately generated.

Total power consumed in 2005 is;

137,677.79 + 350,167 = 487,844.79 Kwhr

137,677.79/487,844.79 * 100 = 28.22 %. 28.22 % of total energy consumed in 2005 was privately generated.

Total power consumed in 2006 is;

137,677.79 + 279,517 = 417,194.79 Kwhr

137,677.79/417,194 * 100 = 33%

33 % of total energy consumed in 2006 was privately generated.

Total power consumed in 2007 is;

137,677.79 + 249,067 = 386,744.79 Kwhr

137,677.79/386,744.79 * 100 = 35.60 %

35.60 % of total energy consumed in 2007 was privately generated.

Total power consumed in 2008 is;

137,677.79 + 369,600 = 507,277.79 kwhr

137,677.79/507,277.79 * 100 = 27.14 %

27.14 % of total energy consumed in 2008 was privately generated. These are summarized in the table below;

Table 9: Percentage privately generated Power

YEAR	TOTAL MONTHLY POWER CONSUMED (PHCN +PRIVATE GENERATION) (KWHR)	PERCENTAGE OF PRIVATE POWER GENERATED/TOTAL CONSUMPTION (%)
2003	461,277.79	29.85

2004	482,144.79	28.60
2005	487,844.79	28.22
2006	417,194.79	33.00
2007	386,744.79	35.60
2008	507.277.79	27.14

4.9.3 INSTALLED CAPACITY OF GENERATORS IN ABU SAMARU ZARIA

GENERATOR	CAPACITY {KVA}
Main gate	800
Senate building	250
Faculty of Medicine	500* 2 = 1000
Booster station	320
Kashim Ibrahim Library	500
Sick Bay	100
Lodges	169
Water works	500*2 =1000
Rockey Feller guest house	45
Amina Hall	250

Biotech	250
Estate	27
Energy Research	200
BBC Studio	40
PTDF	250
Chemistry	250
Community Market	145.03
Social centre	89.25
Icsa Ramat community market	91.1
Area C	305.7
Area Bz	367.2
Area F	391.5
Area G	191.7
Area E	205.2
Area 1 quarters	0.95
Soni quarters	6.5
Agric quarter 11	13.3
Area 3 quarters	128.3
Area A	350
TOTAL	7736.75KVA = 7.74MW

4.9.4 DIESEL CONSUMPTION BY GENERATORS

1. MAIN GATE GENERATOR

200 LITRES = 3.5 hours
150 hours = 8571 liters per month

2. SENATE BUILDING GENERATOR
200 LITRES = 5 hours
150 hours = 6,000 liters per month

3. FACULTY OF MEDICINE GENERATOR
200 LITRES = 3 hours
150 hours = 10,000 liters per month

4. BOOTER STATION GENERATOR

200 LITRES = 4 hours

150 hours = 7,500 liters per month

5. KASHIM IBRAHIM LIBRARY GENERATOR

200 LITRES = 4.5 hours

150 hours = 6,667 liters per month

6. SICK BAY GENERATOR

200 LITRES = 5 hours

150 hours = 6,000 liters per month

7. LODGES GENERATOR

200 LITRES = 5 hours

150 hours = 6,000 liters per month.

8. WATER WORKS GENERATOR

200 LITRES = 3 hours

150 hours = 10,000 liters per month

9. ROCKY FELLER GUEST HOUSE GENERATOR

200 LITRES = 7 hours

150 hours = 4,286 liters per month

10. AMINA HOSTEL GENERATOR

200 LITRES = 4 hours

150 hours = 7,500 liters per month

Total amount of diesel consumed per month = 72,524 liters

Table 10: ENERGY GENERATED AND DIESEL CONSUMPTION

GENERATOR	ENERGY COMSUMPTION PER MONTH (KWHR)	DIESEL CONSUMPTION PER MONTH (LITERS)	COST OF DIESEL @ N100 PER LITER
MAIN GATE	10,200	8,571	857,100.00
SENATE BUILDING	6,000	6,000	600,000.00
FACULTY OF MEDICINE	4,800	10,000	1,000,000.00
BOOSTER STATION	3,600	7,500	750,000.00
KASHIM IBRAHIM LIBRARY	4,500	6,667	666,700.00
SICK BAY	1,200	6,000	600,000.00
LODGES	1,800	6,000	600,000.00
WATER WORKS	4,800	10,000	1,000,000.00
ROCKY FELLER	900	4,286	428,600.00
AMINA HALL	3,000	7,500	750,000.00

From the total power generated and the amount of diesel consumed, it is clear that the generators are inefficient. We therefore recommend that these generators be changed and more fuel efficient ones installed.

4.9.5 ENERGY GENERATED ANALYSIS FOR 2007

TABLE 11: ENERGY GENERATED ANALYSIS FOR 2007

MONTH	ENERGY CONSUMPTION (KWHR)	ENERGY CONSUMPTION PER UNIT (KWHR PER UNIT) FOR A POPULATION OF 39,833(source: MIS)
JANUARY	181,300	4.551502523
FEBRUARY	183,300	4.601712148
MARCH	197,400	4.955690006
APRIL	143,700	3.60756157
MAY	154,500	3.878693546
JUNE	216,300	5.430170964
JULY	318,100	7.985840886
AUGUST	410,900	10.31556749
SEPTEMBER	311,100	7.810107198
OCTOBER	284,600	7.144829664
NOVEMBER	295,100	7.408430196
DECEMBER	292,500	7.343157683

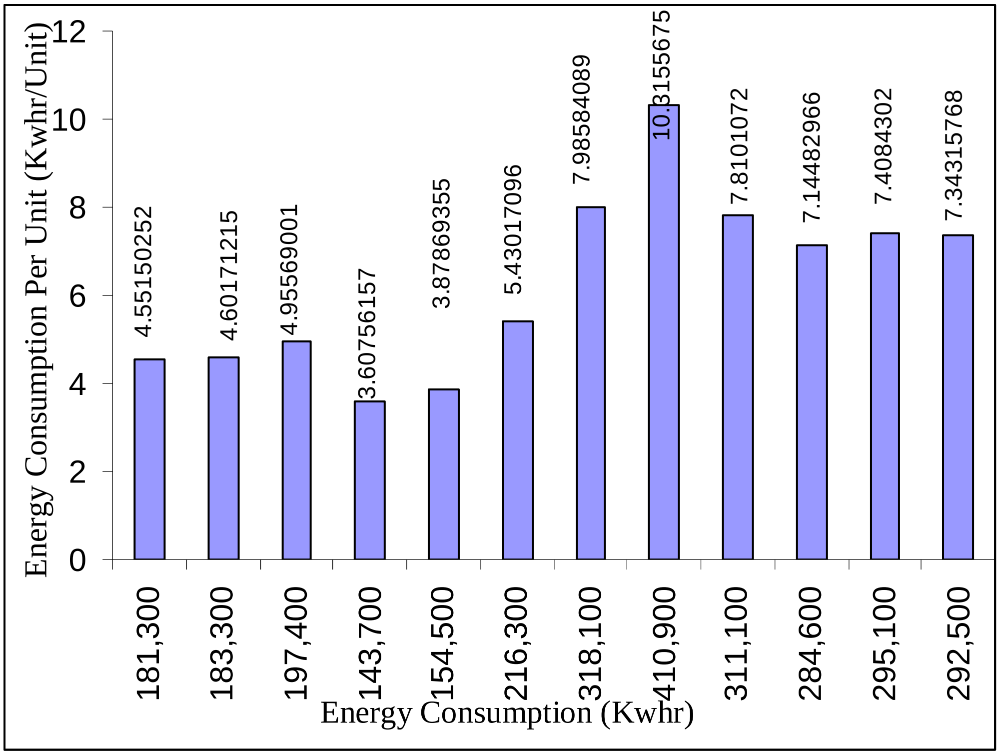

FIGURE 7: HISTOGRAM OF ENERGY GENERATED ANALYSIS FOR 2007

4.9.6 PROPOSAL ON ENERGY MIX FOR THE UNIVERSITY

The Electrical energy consumption forecast shown in section 4.8 is indicative of the required energy to power the University. The figure is a far cry of what is available for consumption. The following energy mix is therefore proposed to address the shortfall.

Electricity from PHCN	**60%**
Diesel Generators	**24%**
Solar Energy	**6%**
Biogas	**10%**

This implies that the University needs;

7.7Mwhr of electricity from PHCH per day

3.1Mwhr of electricity from Generators per day

0.8Mwhr of electricity from solar energy per day

1.3Mwhr of electricity from Biogas per day

For energy demand of 4,640,933.5Kwhr per annum.

These will meet all the energy need of the University.

4.9.7 ENERGY CONSERVATION MODE

a. When you are not using your computer, turn it off. Enable the power down features. Screen savers don't save energy.

b. Maximize the use of daylight; turn off lights when there is daylight.

c. Switch office equipment off at night, a photocopier left on over night uses enough energy to make five thousand three hundred copies.

d. Switch off light when you are leaving a room for more than 15 minutes and when you go home from office. Lighting an empty office overnight wastes enough energy to heat water for 100 cups of coffee.

e. Don't leave your fridge door open for longer than necessary.

f. Turn off your TV from the set. Standby can use as much as 10% - 60% of electricity that would be used if it is on.

g. Dry your cloth on a cloth line – tumble driers use huge amounts of energy.

h. The University can conduct energy audits to identify energy saving initiatives and opportunities for improving good housekeeping.

i. Reduce decorative lighting where possible.

j. Buy low energy light bulbs.

k. Buy energy efficient electrical equipment.

l. Ensure laboratory equipment are not left running unnecessarily.

m. Ensure someone is responsible for switching off light and equipment after work

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 SUMMARY

From the work recorded in this thesis, it is clear that energy shortages are imperative and that immediate and long –term measures need to be taken to forestall the situation in Ahmadu Bello University. Capacity addition is necessary for Nigeria and ABU management in particular from generation to distribution of electrical energy. Adequate planning and implementation of recommendations are essential. ABU can borrow a leaf from policies and strategies adopted by other Universities outside Nigeria as recorded in the text above with minimal adjustments to suit the peculiarity of Nigeria. This will improve electrical energy availability and use.

Although the Bulk Metering of electricity by ABU is in compliance with global best practices in Universities, capacity addition in the area of generator power is necessary to supplement the rather epileptic power supply from PHCN.

In conclusion, investment in both human capacity and infrastructure in the energy sector of the University is a worthy venture and long-term benefits abound for both staff and students.

5.2 CONCLUSION

The correct situation of the country's inadequate generation of electricity is not felt because industrial setups have alternative generation capacities and use PHCN supply minimally.

This on the other hand seriously affects the cost of production and makes it impossible for our industries to compete with imported goods.

This therefore calls for a well coordinated and articulated energy policy formulation for the university. Knowledge of determinants and pattern of energy consumption as recorded in this thesis is required for appropriate energy policy formulation.

5.3 RECOMMENDATION

From the results obtained, it is clear that electricity supply from PHCN is not adequate. It is also certain that generation of alternative electricity through the use of diesel generators is very expensive. In view of these facts, the following recommendations are imperative.

a. University to develop solar energy by installing solar water heaters in houses as in Niger Republic (ONESOL). Also to install solar panels for special applications.

b. University to negotiate large-user tariff regime with PHCN, this will save cost for her.

c. University to request for a dedicated power line subject to less fluctuation.

d. University to replace inefficient diesel generators with more fuel efficient generators.

e. To utilize the abundant biogas from poultry wastes and cows dungs

f. University to set up energy audit committee to check over- consumption of diesel and electricity. Their terms of reference should be to implement the following;

Educate the University community to ensure laboratory equipment are not left running unnecessarily.

Educate the community to ensure someone is responsible for switching off light and equipment after work.

Maximize the use of daylight; turn off lights when there is daylight.

Conduct energy audits to identify energy saving initiatives and opportunities for improving good housekeeping.

Educate the University community to ensure office equipment are switched off at night.

Educate the University community to buy energy efficient electrical equipment

Educate the University community to reduce decorative lighting where possible. Educate the University community to buy low energy light bulbs.

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APPENDICES

APPENDIX 1: Sectoral Final Energy consumption in Nigeria. (%)

SECTOR/YEAR	1985	1987	1989
House hold	62.0	65.0	65.1
Industry	15.0	15.0	11.3
Transport	22.0	19.0	20.2
Agriculture	0.4	0.4	.05
Services	0.6	0.6	2.5

APPENDIX 2: Power stations in Nigeria

HYDRO	STEAM	GAS	AGO
Kainji	Egbin	Sapele	Ijora
Jebba	Sapele	Afam	
Shiroro		Dalta	

Source: (Oke et al, 2007)

APPENDIX 3. Installed Generating Plant

Type	INSTALLED CAPACITY MW	AVAILABLE CAPACITY MW	WRITTEN OFF MW
Thermal	3976	1538	375
Hydro	1900	1550	100
Total	5876	3088	476

Source: (Oke, et al, 2007)

APPENDIX 4: PHCN Power stations and their installed capacity.

POWER STATION	AVAILABLE FACTOR	AVERAGE (MW) CAPACITY	AVERAGE (M W) AVAILABILITY	INSTALLED (MW)
EGBIN	0.4817	880.00	635.90	1320.00
SAPELE	0.1776	435.00	181.14	1020.00
DELTA	0.4092	640.00	373.20	912.00
KAINJI	0.5210	500.00	395.96	760.00
AFAM	0.2509	383.00	154.29	623.00
SHIRORO	0.8761	600.00	525.68	600.00
JEBBA	0.8323	578.00	481.42	578.00
AJAOKUTA	0.0000	0.0000	0.0000	110.00
IJORA	0.0699	20.00	4.54	65.00
OTHERS	0.7492	9.00	7.34	9.80
TOTAL		4,045.40	2,761.47	5,998.19

SOURCE: (Oke, et al, 2007)

APPENDIX 5: Prospective power stations in Nigeria

S/N	POWER PLANT	RATING(MW)
1	Zungeru Hydro	5x190 (950)
2	Mambila Hydro	12x325 (3900)
3	Makurdi Hydro	6x177 (1062)
4	Lokoja Hydro	10x187 (1870)
5	Onitsha Hydro	7x150 (1050)
6	Ikom Hydro	4x184 (736)
7	Gurara (Abuja) Hydro	3x100 (300)
8	Geregu Thermal	3x180 (324)
9	Abuja Thermal	3x100 (300)
10	Kaduna Thermal	3x150 (450)
11	Onitsha Gas/Lignite	8x150 (120)
12	Oron Thermal	8x15 (120)
13	Oji River Thermal	2x60 (120)
14	Makurdi thermal	3x300 (1200)
	TOTAL	13,582

APPENDIX 6: Nigerian national grid in 1973 and 1996

Description	1973	1996
0.4kv Transmission lines (Km)	441	12,928
1.1kv Transmission lines (km)	1986	7929
3.3kv Transmission lines (Km)	1262	5000
132kv transmission lines (Km)	1012	6000
330/132kv substations	6	23
132kv/33kv substations	14	91

Source: Oke et al, 2007

APPENDIX 7: Strategic 330Kv Transmission Lines and Substations

S/N	Description	Length (KM)
1	Gombe-Potiskum-Maiduguri	399
2	Jos-Makurdi	286
3	Aliade-New Haven	210
4	New Haven-Alaoji	175
5	Gombe-Yola	240
6	2nd Benin-Onitsha + River Niger crossing	131
7	Birnin Kebbi- Sokoto	140
8	Shiroro- Abuja DC	144
9	Yola- Jalingo-Bala-Nghu	476
10	Aba-Calabar	148