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Investigation into Electrical Energy Consumption in ABU Samaru Zaria

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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 Kaduna Electricity Distribution Company (KEDC) 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 KEDC, the University had to supplement KEDC supply by installing 7.74 MW 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 2018, 40% in 2019, 39% in 2020, 49.3% in 2021, 55.27% in 2022 and 37.3% as at May 2023. Some methods to reduce energy waste are recommended and sources other than fossil fuel Powered generators are suggested for future supplement of supply from KEDC.*

Keywords: *Electrical energy consumption pattern, bulk metering unit, energy generated, energy forecast, energy demand.*

1. INTRODUCTION

Electrical energy supply in Nigeria dates back to the colonial era where the first phase of Ijora Power station was commissioned to supply electricity to selected areas of Lagos and its environ. Nigeria had about 200 MW of electricity as at independence in 1960 under the Government Electricity Undertaking [1].

Soon after the civil war of 1967-1970, industrialization and socialization increased the demand for electrical energy as more of urban dwellers jettisoned traditional energy sources such as firewood to embrace electric cookers and other electronic gadgets. The increase in demand for electricity became a big challenge to the Nigerian government whose responsibility it is to provide and maintain adequate and stable electrical energy supply.

Energy demand is a function of per capita income and population growth. A country can only increase per capita income from low level to high level by increasing its use of commercial energy as this has raised economic outputs in many countries [2]. Generally, energy consumption pattern is done on a sectorial basis, which is analysis of energy consumption of each economic sector. This provides a deeper understanding of energy-economy interaction and a basis for projecting future energy consumption. It could also form a basis for fine tuning policies that includes well-focused intervention programs and appropriately designed investment projects.

A sectorial energy analysis divides the economy into five major categories which include: Household (Education inclusive) sector, industrial sector, agricultural sector, service sector and transport sector.

In Nigeria, the household sector is the largest consuming sector in the economy. It accounts for about a quarter of total commercial energy and over 90% of traditional fuels consumed. It accounted for 62%, 65% and 65.1% of total delivered final energy in 1995, 1997 and 1999 respectively.

Aluko 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 [3]. 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, 150-300 MW capacity demand distributed as follows; Hydro - 20%, Thermal- 70%, Solar- 5%, Wind- 5%.

Sambo, [4] 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; Use of renewable energy, energy conservation and efficiency, 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.

Jekayinfa studied the energy consumption pattern of selected mechanized farms in southwestern Nigeria [5]. 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;

i. light in all sections of the farms be switched off during holidays and on completion of each day's work,
ii. weak fluorescent tubes be replaced at the end of their effective performance period, and
iii. an energy management committee be set up to look into reduction of energy consumption.

Ajayi and Balogun, [6] 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.

Yusuf, [7] 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.

Kupolokun, [8] 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, [9] of the diesel and generators committee ABU Zaria highlighted the diesel consumption of the generators in ABU Zaria. He stated that a 500 kVA generator consumes 200 litres in about 4 hours, 800 kVA in about 3 hours, 350 kVA for about 5 hours, 250 kVA for 5 hours e.t.c for loads ranging from 80 Amperes to 5 Amperes.

Twerefou *et al.*, [10] found out in their study on energy consumption and economic growth that electricity and petroleum consumption were found to have a positive and significant impact on growth suggesting that policy choices should focus on enhancing the generation of these types of energy.

Ukoima and Ekwe, [11] in their work found out that for every 1% increase in electricity supply, an economy is expected to grow by 3.94%. Inversely, a 1% increase in real gross domestic product leads to a 0.34% increase in electricity supply and consumption. Although, with an improved current generating capacity of 7000 megawatts and distribution capacity of 4600 megawatts, factors such as an increase in load growth, poor maintenance of existing transmission and distribution facilities and lack of adequate physical structure still cause epileptic power situation in most parts of Nigeria. Their study recommended that policies aimed at boosting the generating and distribution of electricity supply in Nigeria should be maintained. This in turn would have a positive impact on the economy

Saveit, [12] 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:

i. To reduce the consumption of fossil fuels and utilize energy from sustainable sources where practicable.
ii. To reduce water consumption.
iii. To monitor and report energy performance in an appropriate way.
iv. To buy fuels at the most economic cost and to maximize the use of fuel types which cause least harm to the environment.
v. To promote energy awareness amongst staff and students.

vi. 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.
vii. To incorporate environmentally sensitive designs into both new and refurbished buildings complying with relevant standards and references.
viii. 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.
ix. 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, [13] 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, [14] 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 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;

i. Lighting controls in toilets which switch the lights on when people enter the toilets.
ii. Urinal controls to reduce the amount of water flushed down urinals.
iii. Pipe work insulation in boiler rooms.
iv. 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 saves 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). Save time, water and energy by taking a shower. Rather than running tap water until its 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 cloth line- tumble driers use huge amounts of energy.

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

The fewness and sparse geographical distribution of electrical energy generating points in Nigeria means that average distances over which electrical energy is distributed are high. This results in line voltage and power losses. 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. Zero voltages otherwise known as blackout, sustained low voltage (brown out) or frequently heavily fluctuating voltages have been the order of the day in Nigeria. This has made the desire to pay for such poor services quite understandably low.

From all the literature reviewed and to the best of our knowledge, no study on energy consumption pattern in ABU Samaru Zaria had been done that covers both academic and residential areas. In addition, no other study had looked into the energy consumption forecast. In view of these gaps and problems of short falls of electrical energy generation, transmission and distribution, there is need to study the energy consumption pattern of a Nigerian university with a view to making recommendations that would enable the university to adopt clear cut energy policy. In addition, the research would enable the university to plan and implement a concise energy mix that would solve the problems of inadequate energy supply and appropriate energy saving schemes.

2. MATERIALS AND METHODS

2.1 Survey of Electrical Energy Consumption from the Bulk Metering Unit (BMU)

Bulk metering of electricity consumption is one of the global best practices especially in large organizations. It reduces inefficiencies associated with collation of individual meter readings. A survey of electricity energy consumption in kilowatts hour (kWhr) was conducted using the Power Holding Company of Nigerian (KEDC) meter at the Bulk Metering Unit. Data chats on electricity consumption were obtained for about five years (2018-2022) on monthly bases

2.2 Survey of Electrical Energy Consumption from Generators

All the generators in the academic area were surveyed including all privately owned generators in the phase 1 community market, social center and Isa-Ramat community market. In addition, all the residential houses were combed to collate information on the number of houses that use generators to supplement KEDC supply. It should be noted here that generators are run when there is power outage from the Kaduna Electricity Distribution Company (KEDC). The numbers of hours run is a function of the number of hours power is out from KEDC. The capacities of the generators were recorded and 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. RESULTS AND DISCUSSION

Electrical energy consumption figures for about six years obtained from the Bulk Metering Unit (BMU) of the Ahmadu Bello University Samaru , Zaria were analysed and presented in Tables 1 to 6

Table 1: Electrical energy consumption from KEDC 2018

Month	**Energy Consumption (kWhr)**	**Energy Cost(N)***
JANUARY	405,200	21921320
FEBRUARY	263,400	14249940
MARCH	172,800	9348480
APRIL	211,200	11425920
MAY	160,400	8677640
JUNE	214,500	11604450
JULY	365,300	19762730
AUGUST	458,000	24777800
SEPTEMBER	487,800	26389980
OCTOBER	456,200	24680420
NOVEMBER	421,400	22797740
DECEMBER	267,000	14444700
Total	3,883,200	210081120
Month Average	323,600	17506760

*Energy cost based on multiyear tariff order (MYTO) No. NERC /302/2021 at N54.10 per kWhr

Source: Bulk metering unit, ABU Zaria

Table 2: Electrical energy consumption from KEDC 2019

Month	**Energy Consumption (kWhr)**	**Energy Cost(N)***
JANUARY	269,600	14585360
FEBRUARY	293,800	15894580
MARCH	376,300	20357830
APRIL	448,400	24258440
MAY	491,300	26579330
JUNE	411,800	22278380
JULY	431,700	23354970
AUGUST	397,100	21483110
SEPTEMBER	271,100	14666510
OCTOBER	222,700	12048070
NOVEMBER	297,500	16094750
DECEMBER	222,300	12026430

Month	Energy Consumption (kWhr)	Energy Cost(N)*
Total	4,133,600	223627760
Month Average	344,467	18635646.67

*Energy cost based on multiyear tariff order (MYTO) No. NERC /302/2021 at N54.10 per kWhr

Source: Bulk metering unit, ABU Zaria

Table 3: Electrical energy consumption from KEDC 2020

Month	Energy Consumption (kWhr)	Energy Cost(N)*
JANUARY	257,100	13909110
FEBRUARY	335,400	18145140
MARCH	363,000	19638300
APRIL	343,800	18599580
MAY	352,900	19091890
JUNE	433,100	23430710
JULY	393,700	21299170
AUGUST	517,900	28018390
SEPTEMBER	381,700	20649970
OCTOBER	291,800	15786380
NOVEMBER	321,400	17387740
DECEMBER	210,200	11371820
Total	4,202,000	227328200
Month Average	350,167	18944016.67

*Energy cost based on multiyear tariff order (MYTO) No. NERC /302/2021 at N54.10 per kWhr

Source: Bulk metering unit, ABU Zaria

Table 4: Electrical energy consumption from KEDC 2021

Month	Energy Consumption (kWhr)	Energy Cost(N)*
JANUARY	358,000	19367800
FEBRUARY	744,700	40288270
MARCH	463,600	25080760
APRIL	157,200	8504520
MAY	108,900	5891490
JUNE	244,500	13227450
JULY	185,000	10008500
AUGUST	189,100	10230310
SEPTEMBER	251,400	13600740
OCTOBER	245,300	13270730
NOVEMBER	211,900	11463790
DECEMBER	194,600	10527860
Total	3,354,200	181462220
Month Average	279,517	15121851.67

*Energy cost based on multiyear tariff order (MYTO) No. NERC /302/2021 at N54.10 per kWhr

Source: Bulk metering unit, ABU Zaria

Table 5: Electrical energy consumption from KEDC 2022

Month	Energy Consumption (kWhr)	Energy Cost(N)*
JANUARY	181,300	9808330
FEBRUARY	183,300	9916530
MARCH	197,400	10679340

Month	Energy Consumption (kWhr)	Energy Cost(N)*
APRIL	143,700	7774170
MAY	154,500	8358450
JUNE	216,300	11701830
JULY	318,100	17209210
AUGUST	410,900	22229690
SEPTEMBER	311,100	16830510
OCTOBER	284,600	15396860
NOVEMBER	295,100	15964910
DECEMBER	292,500	15824250
Total	2,988,800	161694080
Month Average	249,067	13474506.67

*Energy cost based on multiyear tariff order (MYTO) No. NERC /302/2021 at N54.10 per kWhr

Source: Bulk metering unit, ABU Zaria

Table 6: Electrical energy consumption from KEDC 2023

Month	Energy Consumption (kWhr)	Energy Cost(N)*
JANUARY	409,900	22175590
FEBRUARY	385,100	20833910
MARCH	362,700	19622070
APRIL	363,400	19659940
MAY	326,900	17685290
Total	1,848,000	99976800
Month Average	369,600	19995360

*Energy cost based on multiyear tariff order (MYTO) No. NERC /302/2021 at N54.10 per kWhr

Source: Bulk metering unit, ABU Zaria

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

i. availability of energy from KEDC, and
ii. level of activities in the university.

As can be seen from Tables 1 to 6, the pattern of electricity consumption is not uniform; there are variations from month to month. These variations are always due tothe two broad factors outlined above.

3.1 Availability of Energy from KEDC

Nigeria has not tapped fully into the huge energy generation potentials as highlighted in the introduction of this article. 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 KEDC is another pivotal factor that determines the availability of power supply. When there is 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 reduce availability and consumption.

3.2 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 travelled, 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.

1) Year 2018

From Figure 1 the University electrical energy consumption pattern for year 2018 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 KEDC. 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 400,000 kWhr per month. In December when all activities are at the lowest ebb due to vacation, there was a drop in consumption to 267,000 kWhr. A month average of 323,600 kWhr was noticed in year 2018.

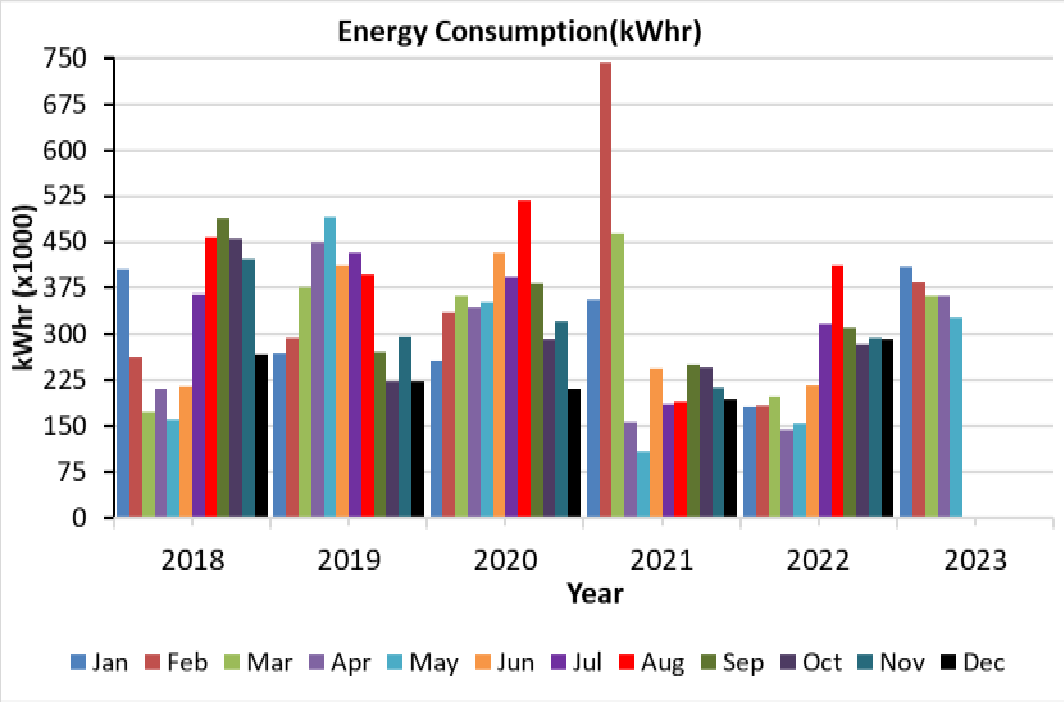

Figure 1: Electrical energy consumption pattern from KEDC

2) Year 2019

The electrical energy consumption pattern for year 2019 is similar to that of 2018 except there was a general drop in availability throughout the year. The highest consumption was noticed in April and May (448,400 kWhr) and (491,300 kWhr) 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 344,467 kWhr. Again, in December a drop was noticed to 222,300 kWhr due to vacation.

3) Year 2020

The pattern for 2020 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 350,167 kWhr was recorded.

4) Year 2021

The highest ever consumption was recorded in 2021, 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 favourable. A monthly average of 279,517 kWhr was obtained which indicate an overall drop compared to the previous year.

5) Year 2022

There is a steady decline in the average consumption per month in 2022 and this is a reflection of the degeneration of the supply system from the main source of power. The average monthly consumption was 249,066 kWhr a drop from that of the previous year.

6) Year 2023

The pattern for 2023 up to May shows a bit of appreciation in consumption. The average monthly consumption so far is

369,60 kWhr. 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. Figures 2 and 3 show annual and month average electrical energy consumption pattern for energy supply from Kaduna Electricity Distribution Company (KEDC).

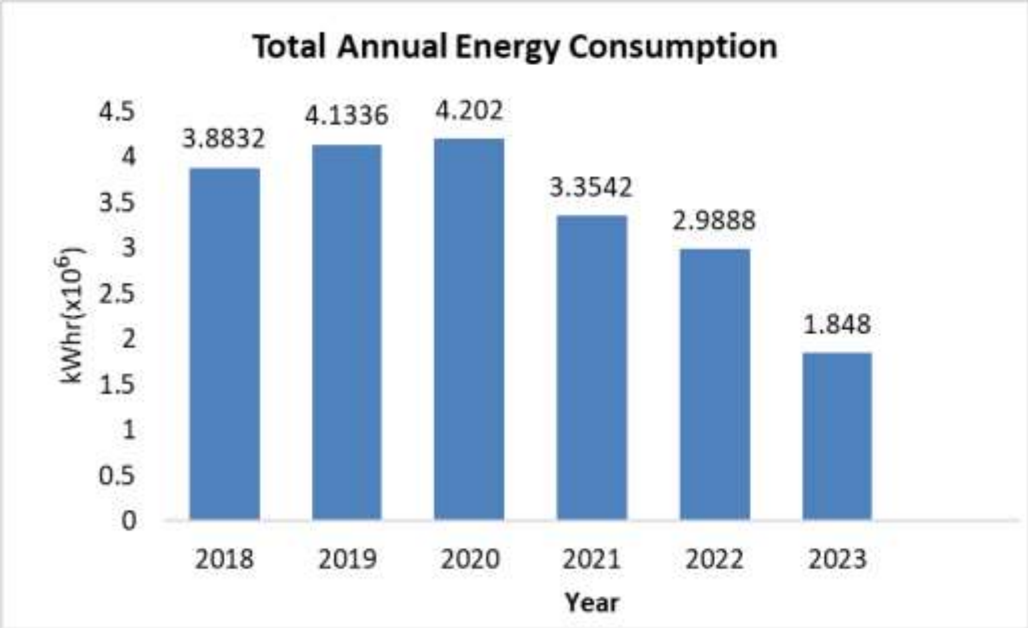

Figure 2: Annual electrical energy consumption pattern from KEDC

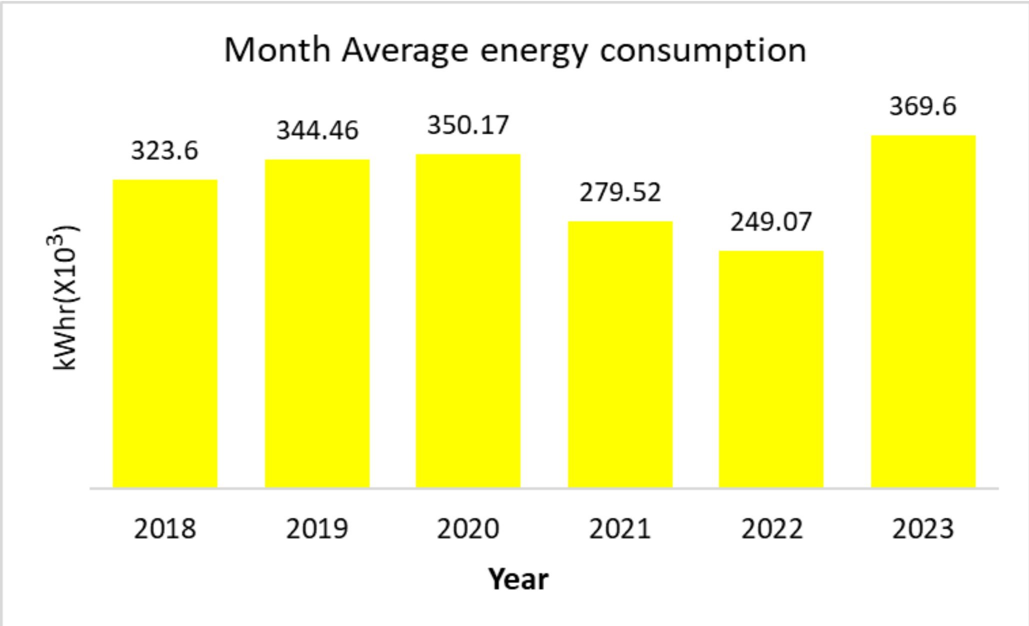

Figure 3: Month average electrical energy consumption from KEDC

3.3 Electrical Energy Consumed from Generators
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 x 400x150 = 10,200,000 Whr = 10,200 kWhr per month.

250KVA Senate building generator
Average Load/Month =100A

Voltage = 400V
Average Hours Run per Month = 150 hours Energy = IVT
Energy Consumed/Month =100 x 400 x150 = 6,000 kWhr per month.

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

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

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

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

169KVA LODGES GENERATOR
Average Load/Month =30A Voltage = 400V
Average Hours Run per Month = 150 hours Energy = IVT
Energy Consumed/Month = 30 x 400 x 150
= 1,800 kWhr per month.
500KVA WATER WORKS GENERATOR Average Load/Month = 80A, Voltage = 400V
Average Hours Run per Month = 150 hours Energy = IVT
Energy Consumed/Month = 80 x 400 x 150 = 4,800 kWhr per month.
There are two 500 KVA Generators in Water works.
Therefore, energy consumed per month = 4,800 x 2= 9,600 kWhr per month

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 x 400 x 150 = 900 kWhr per month.

250KVA AMINA GENERATOR
Average Load/Month = 50A Voltage = 400V
Average Hours Run per Month = 150 hours Energy = IVT
Energy Consumed/Month = 50 x 400 x 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.

3.4 Percentage of Power from Generators

If the above power is superimposed on the KEDC power supply then, the percentage of power consumption from generators is as shown;

137, 677.79/323,600 x 100 = 42.6 % in 2018.
137,677.79/344,467 x 100 = 40 % in 2019.
137,677.79/350,167 x 100 = 39 % in 2020.
137,677.79/279,517 x 100 = 49.3 % in 2021.
137,677.79/249,067 x 100 = 55.27% in 2022.
137,677.79/369,600 x 100 = 37.3 % as at May 2023.

If the generator and KEDC supply area added in other to determine percentage of total power privately generated, then;

Total power consumed in 2018 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 2018 was privately generated.

Total power consumed in 2019 is; 137,677.79 + 344,467 = 482,144.79 kWhr
137,677.79/482,144.79 x 100 = 28.6 %
28.6 % of total energy consumed in 2019 was privately generated.

Total power consumed in 2020 is; 137,677.79 + 350,167 = 487,844.79 kWhr
137,677.79/487,844.79 x 100 = 28.22 %.
28.22 % of total energy consumed in 2020 was privately generated.

Total power consumed in 2021 is; 137,677.79 + 279,517 = 417,194.79 kWhr
137,677.79/417,194 x 100 = 33%
33 % of total energy consumed in 2021 was privately generated.

Total power consumed in 2022 is; 137,677.79 + 249,067 = 386,744.79 kWhr
137,677.79/386,744.79 x 100 = 35.60 %
35.60 % of total energy consumed in 2022 was privately generated.

Total power consumed in 2023 is; 137,677.79 + 369,600 = 507,277.79 kWhr
137,677.79/507,277.79 x 100 = 27.14 %
27.14 % of total energy consumed in 2023 was privately generated.

3.5 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 2022 is given by:

$$P = E/PL \times 100/95 \tag{1}$$

Energy consumed E = Energy consumption from KEDC + Energy Consumption from Generators.
Energy consumption from KEDC = 2,988,800 kWhr

Energy consumption from generator for the year =137,677.79Kwhr x 12 =1,652,133.5 kWhr
Energy consumed E = 4,640,933.5 kWhr
ABU staff and student population PL as at 2022 = 39833 {source: MIS}
Therefore per capita energy consumption P for 2022 from equation (1) is = 4,640,933.5/39833 x100/95 =122.64Kwhr.

3.6 Energy Consumption Forecast

If by 2025, 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 x 100/95

Energy required to power ABU for a population of 50,000 by 2025 will be = 5,825400Kwhr per annum using E = P x 50,000 x 100/95. Where E is the energy required.

Population figures can be inputted into this formula to generate energy requirement in others universities.

4. CONCLUSION

In this study, the electrical energy consumption pattern of ABU Samaru Zaria was investigated for a period of five years. The monthly and annual energy consumption pattern was established: 323.6×10^3 kWhr, 3.8832×10^6 MWhr for 2018; 344.46×10^3 kWhr, 4.1336×10^6 kWhr for 2019; 350.17×10^3 kWhr, 4.202×10^6 kWhr for 2020; 279.5×10^3 kWhr, 3.3542×10^6 kWhr for 2021; 249.07×10^3 kWhr, 2.9888×10^6 kWhr for 2022 and 369.6×10^3 kWhr, 1.848×10^6 kWhr for up to May 2023 respectively. The study found that due to frequent disruption in public electricity supply the University installed 7.74 MW capacity diesel and petrol generators to complement the shortfall in public power supply. The complementary power supply constituted 42.6% of monthly energy consumption in 2018, 40% in 2019, 39% in 2020, 49.3% in 2021, 55.27% in

2022 and 37.3% as at May, 2023. From the consumption pattern established in this work, a forecast of 5,825.4 MWhr of electricity was computed for the year 2025 representing a monthly consumption of 485.45 MWhr. Based on the results and the need for the University to adopt a clear-cut energy policy, the following recommendations are made:

i. 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.
ii. University to negotiate large-user tariff regime with KEDC, this will save cost for her.
iii. University to request for a dedicated power line subject to less fluctuation.
iv. University to replace inefficient diesel generators with more fuel-efficient generators.
v. To utilize the abundant biogas from poultry wastes and cows dungs to generate electricity using appropriate technology.

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