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Analysis of Expenditure on Energy for Domestic Water Supply in Maiduguri Borno State, Nigeria

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Abstract: *The research is on the analysis of expenditure on energy for domestic water supply in Maiduguri it is Aimed at examine the expenditure on energy for domestic water supply in Maiduguri with the view to identifying the sustainable energy source.: The Aim was archived through the following objectives: identify the locations of the sources water, identify the energy sources determine the expenditure and to proposed the most economical energy source to sustain water supply. the study is covering the two major actors in the public water which are government (public) and commercial (private) the source of water supply are the boreholes in four selected high density residential areas of Maiduguri based on the four cardinal directions. The outcome of the research showed the exact locations of the water sources, the types energy used for abstracting water and the daily and monthly expenditures. it is expected that from the research the most economical energy source can be determined.*

Keywords: *Energy, Water supply, Expenditure.*

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1.0 Introduction

Water is very essential commodity in the residential sector. The world health organization defines the average water requirement for human survival to be 0.0025m³ per capita per day. The residential areas in north America and Japan use 0.35m³ of water per capita per day. Similarly, Europe consumes approximately 0.2m³ per capita per day. As against 0.01-0.02m³ per capita per day in sub–Saharan Africa (Pappally A. and lienhard V. 2012).

In providing water which is an essential element, energy is required both at production, treatment and distribution stages, Processing of water for consumption from both underground and surface source requires some form of energy, expenditure which may be from the national grid or isolated sources. Energy is a major contributor to the cost of processing water and treatment of wastewater. The cost represents over 30% of the annual operational and maintenance expense in a typical water treatment plant (Kate *et al* 2017). Energy and water resources are highly connected

in cities Water agencies use energy to acquire, extract, pump, treat, and discharge water supply to the end user, while residents need energy to heat water in building (Erick *et al,* 2020).

Energy is of primary importance for water management and development, the water infrastructure solely relies on energy throughout its value chain for instance groundwater extraction, transportation, purification, distillation, distribution, collection and waste water management and treatment. Energy does not only play an important role in the functioning of water infrastructure, but also in the optimal cost (United Nation Department of Economic and Social Affairs, 2019). Drinking water requires special treatment to be potable and useable by the general public, treatment that requires a certain amount of energy. The cost of producing drinking water should not burden all beneficiaries however, this cost should reflect the real cost of producing water, which is used as an economic good, and more importantly the ability of the community to pay the cost should be assessed (Spiru et al, 2022). Source pumping can have a highly variable energy intensity depending on the heights required to lift water, particularly for ground water extraction

In the United Kingdom water sector consume 3% of the electricity the country produces (for pumping, water treatment and management) and generate 1% carbon dioxide emission. Not only is the water sector energy intensive, but against a backdrop of global demographic growth in the coming decades, water is set to become an even rare resources, so the challenge is clear, how can the sector energy efficiency be improved whilst also securing a universal water supply, (Veolia 2019). Power supply is an important aspect in the supply and distribution of water in fact the two are in separable, electricity is required in the pumping of water from their source to the consumer, when the source is the ground water power is required to pump water from the ground to the reservoir before its finally released into the distribution network. This shows strong connection exist between energy supply and sustainable water supply Water- Energy relationship is an important element for urban planning and management. The aim of this paper is to examine the expenditure on energy for domestic water supply in Maiduguri, it was archived through the following objectives: To identify the locations of the boreholes, to identify the energy sources, and to determine the expenditure on energy.

The geographical scope of the study are four selected low-income residential areas of Maiduguri, which are Zajeri to the north, Kululuri to the south, old Maiduguri to the east and Ngomari to the west see figures 2-5 the energy source is the fossil fuel and that from the national grid Yola Electricity Distribution Company (YEDC).

2.0 literature review

2.1 ***Sustainable Energy*** is related to the provision of adequate reliable and affordable energy in conformity with social and environmental requirement. (Evangelos *et al,* 2019). Assessing energy sustainability is important since energy is key factor of all economies, however, energy generation imposes large pressure on the environment is mostly based on limited resources, which may be from the following sources:

a. ***Solar power*** is the conversion of energy from sunlight into electricity, either directly using photovoltaic (PV), indirectly using concentrated solar power or a combination. Concentrated solar

power system uses lens or mirror and solar tracking system to focus a large area of sunlight with small beam.

b. Wind is the air in motion; the uneven heating of the earth's surface causes it by the sun. Today, energy is mainly use to generate electricity. A wind turbine is used to harness the kinetic energy in wind to generate energy. A typical wind machine consists of blade, generator, cable and tower. The blade is connected to drive sharp that turns an electric generator to produce electricity (Awogbemi and Komolafe, 2011).

c. Hydro power supply this form of energy generation is through use water as the name implies it mostly suitable in areas where the amount of water received from the rain fall is high and there exist a flowing river which can be dam so that a turbine station can be put in place to generate energy, it can be small, medium or large plants depending on the amount of energy it generates. It has lowest cost and the longest plant life compared when with other large-scale power generating plant. (Lejeune and Hui, 2012).

d. Nuclear power this form of energy is generated using uranium as the major raw material, it has grown in importance since its inception just after the World War II and no supplies some 7% of primary energy. Its advantage includes non-emission of greenhouse gases and the abundance of its major raw material the uranium.

e. Fossil fuel energy is currently the world's primary energy source. Formed from organic materials over the course of millions of years. This includes the coal, oil and natural gas.

Table 2.1: Attributes of energy sources for water supply

S/no.	Energy resources	Positive attributes	Negative attributes
1	Hydro power station	Clean and cheap to set run	Expensive to set up and output could be affected by drought
2	Solar cells	Clean and cheap to set run	Not always sunny and output does not always weight initial cost to set up.
3	Wind turbine	Clean and cheap to set run	Expensive to set up and wind does not always blow
4	Nuclear power	Reliable	Will run out and produce dangerous waste that is hard to dispose off
5	Fossil fuel	Reliable	Create pollution

Source: Adopted from 2019 Energy sustainability: Definition and Assessment Model

3.0 Materials and Methods

The present Maiduguri is a fusion of Maiduguri village and Yerwa. Later wards like Gamboru, Gwange, Bulumkutu and others to mention a few came up (Max Lock, 1976). Maiduguri the capital of Borno is located in the northeastern part of Nigeria as shown in Figure 1; it lies on latitude 11°. 05¹ North and longitude 13º.05¹ East. It is largely surrounded by Jere local government and Konduga local government, which make up part of the greater Maiduguri (Figure 2). The town

covers a total land area of 543 sqkm and a population of 540,016 with a growth rate of 3.5% and a density of 1,878 people per sqm (2006 national population census). This makes it the largest city in the northeastern part of the country.

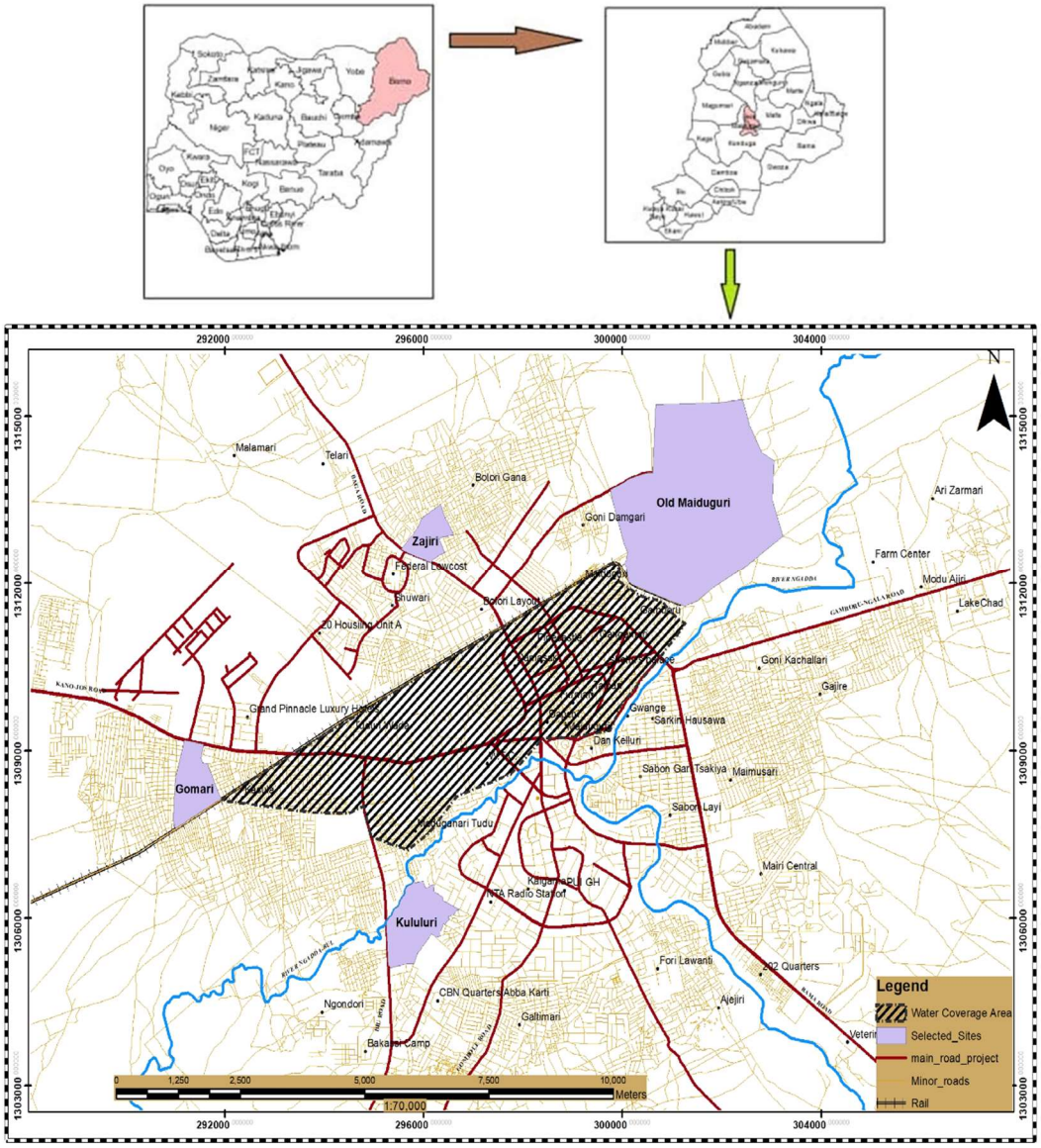

Figure 1, Maps showing at National, State and Local levels
Source: GIS lab. Ramat Polytechnic Maiduguri (2023)

3.1 Data collection and Analysis

In the production of maps boundary data for Maiduguri and wards of Maiduguri were collected from the office of the surveyor general of the federation (OSFOF) data and global administrative boundary (GADM) data repositories. Data on street network was obtained from open street map (OSM). Data for boreholes; locations was collected using Mobile topographer, a simple android application installed in mobile phones with an active data to obtain the coordinates of the sources of water supply in the study areas.

Simple descriptive statistics (range, frequency etc) was used in analyzing the data collected from the representative of the inhabitant of the study area. This is because it enables the presentation of data in way that is more meaningful, it allows simple interpretation of the data, it also offers methods to summarize a collection of data in numerical or graphical form and finally it helps in identifying further ideal of research. The data collected was coded entered into Statistical Package for Social Sciences (SPSS) version 22-spread sheet for the statistical analysis. The data collected from the government agency charge with the responsibility of providing water and that of the borehole owners was analyzed using SPSS Version 26 and presented in table.

4.0 Findings

A total 68 bore holes was identified in the four selected study locations which are old Maiduguri, Zajeri, Gomari and Kukuluri settlements (Fig 2-4).

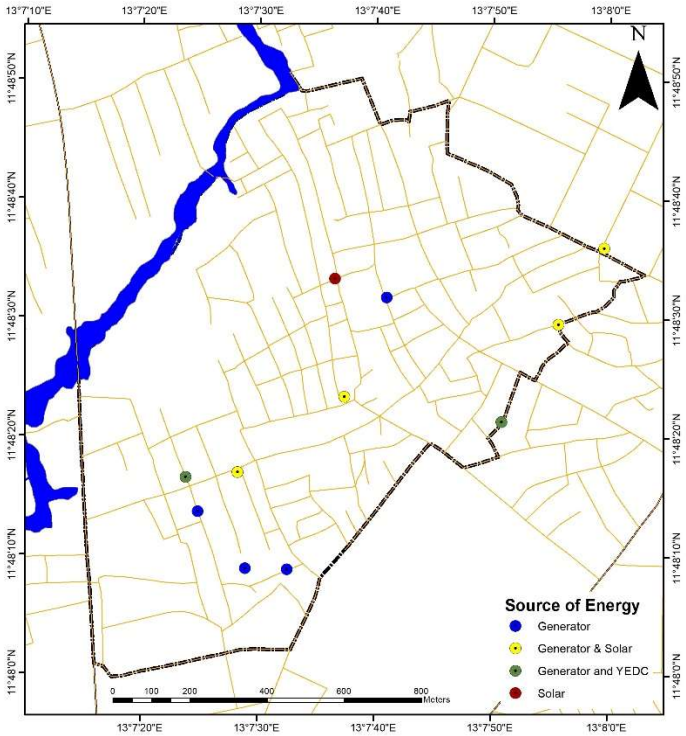

Figure 2 Map of kululuri showing boreholes location and ownership

Source: GIS lab. Ramat Polytechnic Maiduguri (2022)

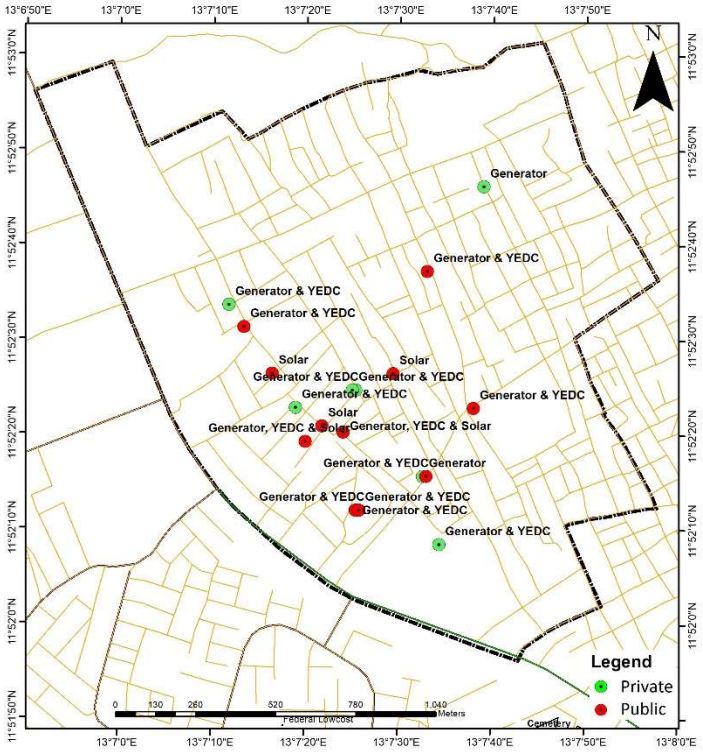

Figure 2 Map of Zajeri showing boreholes location and ownership

Source: GIS lab. Ramat Polytechnic Maiduguri (2022)

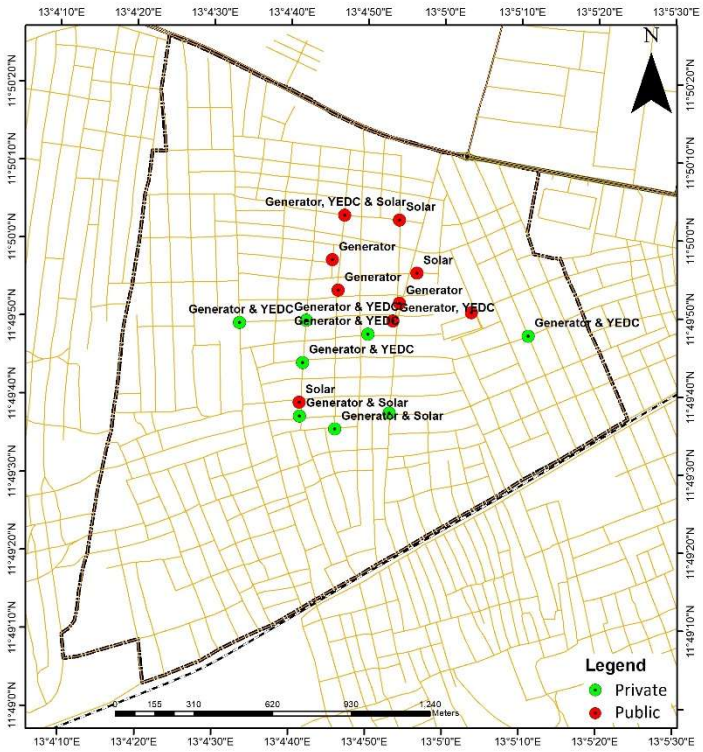

Figure 2 Map of old Maiduguri showing boreholes location and ownership

Source: GIS lab. Ramat Polytechnic Maiduguri (2022)

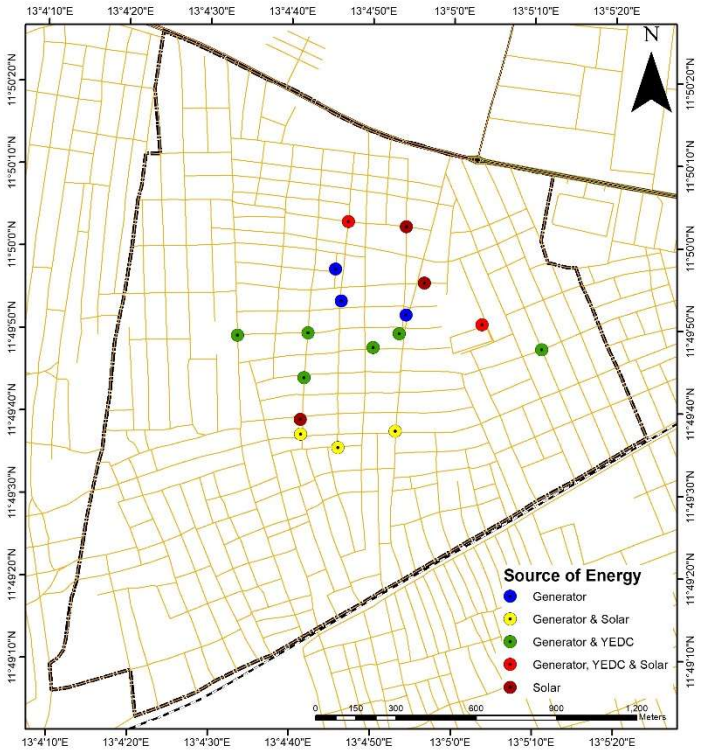

Figure 2 Map of Gomari showing boreholes location and ownership

Source: GIS lab. Ramat Polytechnic Maiduguri (2022)

The data collected for energy sources shows the combination of the National grid Yola electricity Distribution Cpmpany (YEDC) and fossil fuel (generators) take the highest percentage with 58.8% followed by solar and fossil fuel (generator) with 14.7% and 13.2% respectively and the lowest source of energy are from National grid (YEDC) and fossil fuel / solar with 2.9 and 1.5% respectively.

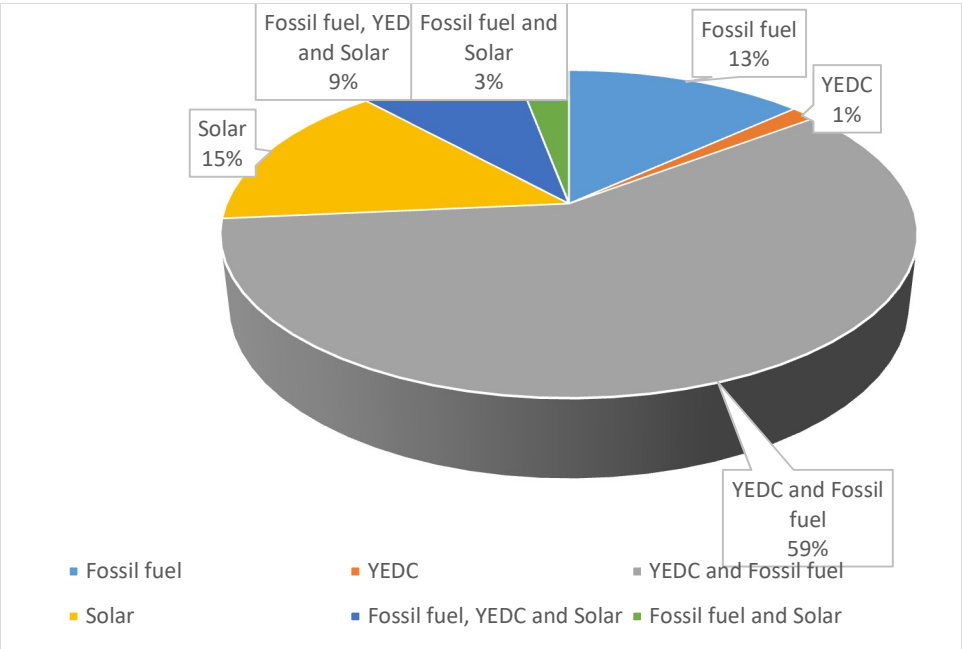

Figure: 7 Source of energy for the bore hole
Source field survey 2023

4.1 Expenditure on fossil fuel

Table 4.1 Indicates that 27.3 % of the boreholes spend between 1000-1500 naira on fossil fuel another 27.3% spend 3000-3500 daily on fossil and another 27.3% spend 4000 and above on fossil fuel daily.

Amount in Naira	Frequency	Percentage
1000 – 1500	15	27.3
2000 – 2500	10	18.2
3000 – 3500	15	27.3
4000 - and above	15	27.3
Total	55	100

Source field survey 2023

4.2 Expenditure on National grid Yola Electricity Distribution Company (YEDC)

Table 4.2 shows that 38% of the boreholes spend 4000 naira on YEDC bill monthly, 30% spend between 3000-3500 naira and 26% spend 2000-2500 monthly as bill for energy used.

Amount in Naira	Frequency	Percentage
1000-1500	1	2.2
2000-2500	13	28.3
3000-3500	15	32.6
4000 and above	17	37.0
Total	46	100

Source field survey 2023

5.0 Conclusion

Expenditure for domestic water supply in Maiduguri have been reviewed for the major source of water supply which is the ground water source (boreholes) and the two major sources energy used in the selected study areas. The study found that its more economical to use the energy from the national grid supplied by Yola electricity distribution company YEDC than the use fossil fuel.

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