Academic Scholars Publishing League (ASPL)
International Journal of Natural Resources & Environmental Studies
ISSN: 2360-915X | Volume 11, Issue 8 | August, 2023 | Pages 21 – 27
DOI: 2775136901182
arcnjournals@gmail.com

Energy needs to Sustain Domestic Water Supply with National Grid Power Source in Maiduguri Borno State, North East Nigeria

Baba Shehu Shettima
Shettimababashehu@yahoo.com
School of Environmental Studies
Department of Urban and Regional Planning
Ramat Polytechnic Maiduguri, Borno State
Felix Aromo Ilesanmi
aromofelix@ahoo.com
Faculty of Environmental Science
Department of Urban and Regional Planning
Modibbo Adama Universtiy, Yola, Adamawa State
Isiaka Adeyemi Abdul-Azeez
Azeezabu@yahoo.com
Faculty of Environmental Science
Department of Urban and Regional Planning
Modibbo Adama Universtiy, Yola, Adamawa State

Abstract: *This paper determined the water demand of the population in the study area, and computed the water demand and energy needed to sustain water supply. the computation was done with the population the study area obtained the national population commission and ISN 175 standard for daily water need per capita in high density residential areas. The result shows that the total daily energy required to abstract from the underground source are 1,537.50 kwh when using the national grid.*

Key words: *Energy, Sustainable, Domestic, Water supply*

1.0 Introduction

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. The aim of the paper is to compute the water need of the study area with

the view to determine the energy needed to sustain domestic water supply. It archived through the following objectives:

To determine the population of the area, to compute the water demand of the study area, to determine the energy needed to sustain water supply. The scope of the study covered four high densities low-income residential neighbourhoods in the four cardinal directions of Maiduguri these are Zajeri to the north, Kululuri to the south, old Maiduguri to the east and Ngomari to the west. These areas selected are not covered by the supplies from the Maiduguri water treatment plant. The study will also cover energy used by both public and commercial water supply in the selected areas. The estimation is covering only energy sources from the national grid Power Holding Company of Nigeria (YEDC).

2.0 Literature review

2.1 Nation grid power supply is a power grid network of electrical transmission lines connecting a number of generating stations to load over a wide area. It is designed to operate within certain limits of stability in line with voltage, current and frequency. The generating sources may be different however the most common energy used for national grid are the fossil fuel, hydro and nuclear energy with little contribution from renewable sources such as the solar energy. Nigeria has twenty-three (23) power generating plants connected to the national grid (Energypedia 2021). These plants are managed by generation companies, independent power providers, and Niger delta holding company. The supply to consumer is handled by the distribution companies and the cost is determine by the Nigerian electricity regulatory commission which connects the consumers and the discos (Naemeka 2014).

Sustainable Energy Supply, the United Nation (2020) saw in terms of three pillars these are the energy security, quality of life, and environmental sustainability. The energy security pillar deals with economic concepts of energy security from a national perspective. It includes accessibility to energy supplies including import, export and transits consideration. There is considerable social, economic, environmental and technological factors, which comes into play in this area. Some countries define energy security as energy independence, whereas others see energy security in a regional context, with a focus on interconnectivity and trade. A new perspective on energy security is to ensure that energy makes optimal contribution to a countries social, economic and environmental development.

Various researches in the field of energy have studied the challenges and solution to the problem of energy. Helen *et al* (2018) saw the challenges to energy supply in Africa as insufficient power generation capacity, difficulty in managing energy infrastructure, difficulty in attracting investment in power sector, challenges in serving lo income user and ambitus economic development that will demand more energy. They however proffered solution such the building of mini power grid that will isolate remote population and the use of natural gas, which is in abundance in most part of the continent.

Michael (2020) said the key challenges as expanding access to affordable, reliable and adequate energy supplies while addressing environmental impact at all levels, others challenges include crucial enabling roles for government, international organization, multi-level financial institution and civil societies. He proffered the following solutions accelerating the use of new renewable energy, widening the diffusion and use of other advanced technologies, mobilizing additional investment to sustainable energy and encouraging greater international cooperation.

Lorenz (2013) saw the challenge as dependency in fossil and nuclear energy resources, growing energy, price, climate change due to energy related carbon emission and the risk of nuclear disasters. He proposed the use of efficient and renewable sources such as the wind and solar energy because of their potentials.

2.2 Estimating water consumption per capita per day: In order to estimate the total water demand of a town or city, it is necessary to consider the quantity of water required to fulfill each of these demands. As such it is also indicated how the quantity of water required for each of these categories of water demand.

Water is used for various purposes and the rate of consumption depends upon the purpose for examples water consumption for domestic use (drinking, cooking, cleaning washing, bathing, flushing toilets etc.) requires about 100 liters per head per day, while in commercial places (hotels, cinema halls bakeries, parlours) the use is estimated at 45 liters per head per day. Public places such as the (schools, parks, hospitals rail station etc.) needs about 30 liters per head per day (Rao, 2004). This however varies depending upon factors such as climate, duration of water supply, standard of living, drainage system, method and extent of charging the consumer and pressure available in distribution mains. Water consumption is usually more in the morning hours (5-9 am) and evening (5-8 pm). It varies hourly, daily and seasonally.

Below is a table of average daily water consumption for High Income Residential areas in India based on IS:175-1993 standard under normal condition.

Table 1 Adopted from water demand for town or city: 5 types

S/No	Activity	Consumption in liters per day
1	Drinking	5
2	Cooking	5
3	Bathing	75
4	Washing of cloth	25
5	Washing of utensils	15
6	Washing and cleaning of house and residence	15
7	Lawn watering and gardening	15
8	Flushing of water closets	45
9	Total	200

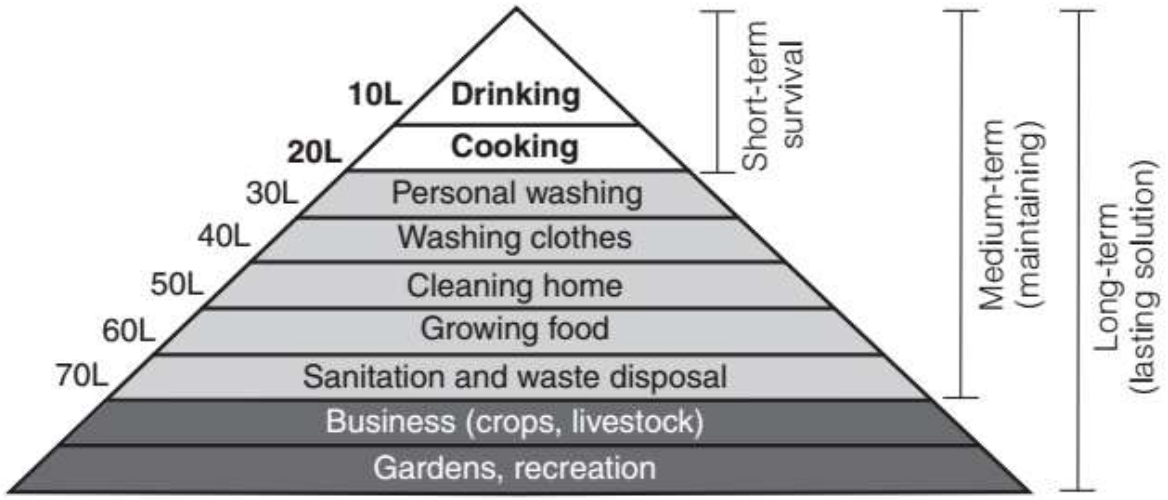
For low Income Residential areas based on IS:175-1993 standard under normal condition

Table 2 Adopted from water demand for town or city: 5 types.

S/NO	Activity	Consumption in liters per day
1	Drinking	5
2	Cooking	5
3	Bathing	55
4	Washing of cloth	20
5	Washing of utensils	10
6	Washing and cleaning of house and residence	10
7	Lawn watering and gardening	10
8	Flushing of water closets	30
9	Total	135

The World Health Orgainsation (WHO) made an attempt in the past to define minmum water quantity required in emerngencies. In 2004, a cluster of relief agencies developed the document entilled sphere humanitarrian charters and minimum standard in disaster response which sets standards. For the minmum level of services for water supply, it states that all people should " have safe and equitable access to sufficient quantity of water for drinking, cooking and personal and domestic hygiene and that public water points should be suffienctly close to households to enable useof the minimum water requirement" (WHO 2013)

Fig 1: Hierarchy of water requirement (after Maslow's Hierarchy of needs)



2.2 ***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 3: Attributes of energy sources for water supply

S/no.	Energy resources	Positive attributes	Negative attributes
1		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 Methodology

The population of the study was obtained from the national population commission, per capita water demand was obtained from IS:175-1993 standard water demand under normal condition. Quantity of energy to abstract water in Kwh and fossil fuel was obtained American society of automobile engineers standard. Calculation was done with the use simple arithmetic (multiplication).

4.0 Results and findings

In estimating the energy, the study started with determining the daily water requirement of the selected study areas using the standard of 135liters per capita per day of IS 175-1993 standard under normal condition. (Table 1).

Several approach to estimating energy used for water supply has been done by researcher' Lin, Chung and Ming (2015) based their estimation of energy on stages of water supply which are water abstraction, treatment and distribution in changeling water supply system with distribution taking 50% of the total energy usages. Kelly and Michel based research on energy used to supply water United States on land uses bases with residential, commercial and industrial land uses as focus of study. Maryam, Malia and Waleed (2018) based their estimation on stage of water supply in the kingdom of Bahrain with water production taking 97%, transmission taking 2.1% and distribution 0.9% however the source of water supply is from the sea.

3.1 Estimated energy needs from the National grid for Kukuluri settlement

Population of Kukuluri = 9,104

Water requirement per capita per day = 135 liters

Daily water requirement per day - 9,104 × 135 liters = 1,229,040 liters of water

Daily water requirement in cubic liters = 1,229,040 liters of water ÷1000 liters = 1, 229.04 cubic the energy required to produce one cubic liters of water in kwh = 0.29kwh

Energy required to produce required = 1, 229.04 cubic× 0.29kwh = **356.42kwh**

Estimating energy needs in monetary terms: 356.42kwh × ₦69.43k = ₦24,746:24k

3.2 Estimated energy needs from the National grid for Zajeri settlement

Population of kukuluri = 18,968
Water requirement per capita per day = 135 liters
Daily water requirement per day - 18,968 × 135 liters = 2,560,680 liters of water
Daily water requirement in cubic liters = 2,560,680 liters of water ÷1000 liters = 2,560.68 cubic the energy required to produce one cubic liters of water in kwh = 0.29kwh
Energy required to produce required = 2,560.68 cubic× 0.29kwh = **742.60kwh**
Estimating energy needs in monetary terms: 742.60kwh × ₦ 69:43k = ₦$51,558:718k/day$

3.3 Estimated energy needs from the National grid for Old Maiduguri settlement

Population of Old Maiduguri = 39,272
Water requirement per capita per day = 135 liters
Daily water requirement per day – 39,272 × 135 liters =5,301,720 liters of water
Daily water requirement in cubic liters =5,301,720 liters of water ÷1000 liters = 5,301.72 cubic the energy required to produce one cubic liters of water in kwh = 0.29kwh
Energy required to produce required = 5,301.72 cubic× 0.29kwh = **1,537.50 kwh**
Estimating energy needs in monetary terms: 1,537.50 kwh × ₦69:43k = **₦106,332:05k**

3.4 Estimated energy needs from the National grid for Gomari settlement

Population of Gomari = 26,744
Water requirement per capita per day = 135 liters
Daily water requirement per day – 26,744 × 135 liters =3,610,440 liters of water
Daily water requirement in cubic liters =3,610,440 liters of water ÷1000 liters = 3,610.44 cubic the energy required to produce one cubic liters of water in kwh = 0.29kwh
Energy required to produce required =3,610.44 cubic× 0.29kwh = **1,047.02 kwh**
Estimating energy needs in monetary terms: 1,047.02 kwh × ₦$69:43k$ = **₦72,694:60k**

Table 4. shows daily estimated energy needs for the four selected study location in kilowatt per hour. This estimation is however based on 135 per capita per day.

S/NO.	Settlements	Estimated energy in Kwh	Cost in (₦)
1	Kukuluri	356.42 kwh	**₦24,746:24**
2	Zajeri	742.60 kwh	**₦51,558:70**
3	Old Maiduguri	1,537.50 kwh	**₦106,332:00**
4	Gomari	1,047.02 kwh	**₦72,694:60**
Total	**4**	1,537.50 kwh	**₦106,332:00**

Source: Field survey 2021

5.0 Recommendation

Planning is one sure way of archiving sustainable provision of water supply and one key stochastic component is the energy which is needed to abstract or process water from the various in order to ensure the steady supply the needed energy has to computed based on the available type of energy. This study has focused on one of the major energy types used in the study area and detailed amount required is presented in table 4 above. The same can be used for settlements with similar characteristics.

6.0 Conclusion

In conclusion the providers of energy to sustain water supply are presented with cost implications in terms of energy needs and the likely cost based on the prevailing unit cost of energy, this will in no small way in ensure sustainable water supply in Maiduguri.

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