FEDERAL UNIVERSITY OF TECHNOLOGY
MINNA, NIGER STATE, NIGERIA

SCHOOL OF ENVIRONMENTAL TECHNOLOGY
INTERNATIONAL CONFERENCE (SETIC) 2018

# CONFERENCE Proceedings

# CONTEMPORARY ISSUES AND SUSTAINABLE PRACTICES IN THE BUILT ENVIRONMENT


EDITORS:
Asimiyu M. JUNAID
Olatunde F. ADEDAYO
Richard A. JIMOH
Luqman O. OYEWOBI

# School of Environmental Technology International Conference (SETIC) 2018

**10-12 APRIL 2018**

**Federal University of Technology Minna, Niger State, Nigeria**

# CONFERENCE PROCEEDINGS

**Volume 1**

**Editors**
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# Conference Proceedings of the School of Environmental Technology International Conference (SETIC) 2018

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10th – 12th APRIL 2018
School of Environmental Technology,
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# FOREWORD

The organising committee of the 2nd School of Environmental Technology International Conference is pleased to welcome you to Federal University of Technology Minna, Niger State Nigeria.

The conference provides an international forum for researchers and professionals in the built and allied professions to address fundamental problems, challenges and prospects that affect the Built Environment as it relates to Contemporary Issues and Sustainable Practices in the Built Environment. The conference is a platform where recognised best practices, theories and concepts are shared and discussed amongst academics, practitioners and researchers. The scope and papers are quite broad but have been organised around the sub-themes listed below:

- Architectural Education and ICT
- Building Information Modeling
- Construction Ethics
- Energy efficiency and Conservation
- Environmental Conservation
- Facility Management
- Green Construction and Efficiency
- Health and Safety Issues
- Information Technology and Building Maintenance
- Information Technology and Construction
- Information Technology and Design
- Innovative Infrastructure Development
- Resilient Housing Development
- Smart Cities Development
- Social Integration in Cities
- Sustainable Building Materials Development
- Sustainable City Growth
- Sustainable Cost Management
- Sustainable Property Taxation
- Sustainable Architectural Design
- Sustainable Urban Transportation Systems
- Theory and Practices for Cost Effectiveness in Construction Industry
- Urban Ecology Management
- Urban Land Access
- Disasters, Resilient Cities and Business Continuity

We hope you enjoy your time at our conference, and that you have the opportunities to exchange ideas and share knowledge, as well as participate in productive discussions with the like-minded researchers and practitioners in the built environment and academia.

**Local Organising Committee**
**School of Environmental Technology International Conference (SETIC) 2018**
**APRIL 2018**

# ACKNOWLEDGEMENTS

We have tried to build on the success of the maiden of SETIC held in 2016 which came with good feedbacks and memories. The success of the 2nd School of Environmental Technology International Conference holding at the Main Campus of the Federal University of Technology Minna, Nigeria is predicated on the support and goodwill from Vice-Chancellor of Federal University of Technology, Dean School of Environmental Technology and many other highly motivated people.

I sincerely wish to appreciate you for attending this Second edition of SETIC and to warmly welcome you to the city of Minna the capital of the *POWER STATE.* It is a great honour to have you in the beautiful campus of Federal University of Technology Minna, Nigeria. I am aware of the great sacrifices made by many of you to be present in this occasion and I will definitely not overlook the long distances some of you have had to cover to get to the conference venue. We genuinely appreciate all your efforts. It is our singular hope and desire that this 2nd edition of the conference (SETIC 2018) meets your expectations and gives you unquantifiable experience and tremendous developmental networking opportunities for a life fulfilling career.

We are grateful for the presence of the Vice Chancellor of the Federal University of Technology Minna Professor Abdullahi Bala whose leadership and distinguished academic career has served as inspiration and encouragement to many academics within and outside Nigeria. His desire to continue on the path of greatness for this Humble University of ours has seen the University become a destination for International conferences, Public lectures, Book Development, Presentations and Seminars that meet International standards. We are happy to have you as the Chief host to declare the conference open and deliver the welcome address.

We are grateful to the former Dean of School of Environmental Technology, Federal University of Technology Prof A.M. Junaid and the Ag. Dean of School of Environmental Technology Prof. S.N. Zubairu for providing the healthy platform, academic backing, management and guidance for the organisation of the conference. You increased the level of challenge from 2016 and provided the required resources, direction, energy and strategies for achieving its success, it is a great honour of having the opportunity to work closely with you and learning never to give up.

I wish to thank also all the special guests particularly leaders of the Industry, Built Environment and Academia.

A special thanks goes to the Bursar of Federal University of Technology, Mrs. Hajara Kuso for the timely responses to all our requests regarding the financial aspects of access to funds for the conference.

SETIC is beginning at the foundation this year and for this I wish to thank all those who have supported us through various forms of participation. Specifically I wish to thank the delegates and the partners for contributing significantly to the conferences. I wish to thank Prof. S.N. Zubairu Prof. A.M. Junaid, Prof. O. O. Morenikeji and Prof. Y.A Sanusi, who all genuinely and consistently monitored the progress of the conference preparations. My desire in 2016 was for SETIC to become a constant feature in the calendar of the University and global conference listings, am a happy person today seeing this desire fulfilled with the SETIC 2018 edition.

Delegates to SETIC 2018 are from different academic and research institutions that are spread across different countries. This offers participants a wonderful opportunity for exchange of cultural, social and academic ideas during the conference periods. It is also an opportunity to create awareness about programmes and events at the participants' individual institutions. I encourage you all to make good use of the networking opportunities that are available.

In this 2nd edition we received 258 abstract submissions because we had a wide distribution outlet as compared to the 1st edition which is an indication of growth. Using a rapid review system we accepted a total of 209 abstracts and the authors were communicated on what issues they were to examine while developing the full papers based on their titles and aim of the paper. Two hundred (200) full papers were received and reviewed. We sent back the reviewed papers and reviewers comments forms to each of the prospective authors to assist

in the preparation of the revised papers. It was after this rigorous and time consuming process that we were able to accept 172 papers for presentation at the conference. It gives me great joy therefore to congratulate all the authors whose papers made it to the conference. It is my sincere believe that the presentation of the different ideas in your paper would go a long way in improving the knowledge of the participants and also generate meaningful discussions over the tea beaks, lunch and beyond.

I wish to express my utmost gratitude to each of the Seventy-three (73) reviewers for a wonderful job done well and for tolerating our deadlines and Oliver Twist syndrome. It is your dedication and expertise that has ensured that the conference is a success.

Special thanks to all our keynote speakers, Arc. Umaru Aliyu, (ficiArb, fnia, ppnia) (*President, Architects Registration Council of Nigeria (ARCON)*, Prof. Stella N. Zubairu (*Former Dean Postgraduate School, Federal University of Technology Minna*), Dr. Julius A. Fapohunda, (*Editor-in-Chief: International Journal of Sustainable Energy Development & Leader: Sustainable Building and Urban Growth Research Unit, Cape Peninsula University of Technology).*

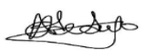
It is important to appreciate the roles and efforts of the following people for their selfless and very significant contributions made towards the successful organization of the conference: Oyetola Stephen, Alonge Olubunmi, Lynda Odine, Adedokun John, Idowu Oqua, Bamidele Eunice and Muhina Lami (for being available to run around at very short notice),

The organisation of this conference would not have been this easy without dedicated individuals offering to serve. My heartfelt gratitude goes to Dr. Taibat Lawanson, Dr. R.A. Jimoh, Dr. L.O. Oyewobi, Dr. N.I. Popoola, Dr. Lekan Sanni, Dr. I.B. Muhammad, Dr. A.A. Shittu and Dr. A. Saka for their unflinching support all through the process.

It is our sincere hope that this conference will serve as a forum for the advancement of research in the urban sphere towards achieving a sustainable environment. It is our sincere believe that academics and professionals in practices will continually participate in this forum.

Worthy thanks goes to the members of the Local Organising Committee for the tireless effort. The success of the conference goes to these wonderful people. You have made SETIC 2018 to ROCK.

Once again I wish to thank you all for creating time out of your busy schedule to attend this conference. Please do enjoy your stay at Federal University of Technology Minna, and the city as a whole. Ensure that you make use of the different fora created throughout the conference to build new relationships for the future and strengthen existing relationships. I look forward to seeing you all in future.



Olatunde Folaranmi ADEDAYO
SETIC 2018 LOC Chairperson
APRIL 2018

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# DETERMINANTS OF HOUSEHOLDS DOMESTIC COOKING ENERGY CHOICE AND TECHNOLOGY IN MINNA, NIGER STATE NIGERIA

***Ohadugha, C. B.; Sanusi, Y.A; Morenikeji, O.O; Zubairu, M. and Olaide, A.**
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Domestic energy poverty occasioned by acute shortages and frequent price fluctuation have compelled urban households to various cooking energy options. Reliance on modern energy for cooking especially electricity is questionable because of its epileptic nature, cost and inadequate infrastructure. Inaccessibility of modern domestic energy supply is among the research problems in the study area. The study is justified as a result of the irregularities in terms of availability and affordability of modern domestic cooking energy in Minna metropolis, the capital of Niger State. The main objective is to analyse households' energy characteristics in order to discern the factors influencing households cooking fuel choices in Minna. The study hinges on energy access and poverty concepts from literature. Multistage sampling method involving delineation of the study area into 28 neighbourhoods was adopted. Descriptive statistics was employed in the analysis using SPSS. With kerosene being the prevalent domestic cooking energy type among electricity, gas, charcoal and fuel wood used with variety of cooking technologies, the study revealed that the major determinants of households' fuel choice are affordability (29.5%) and availability (26.3%). The study concludes that the choice of cooking energy among the households is pattern less as all options at their disposal based on affordability and availability are explored. Besides promoting access to electric power being a very important dimension to consider in enhancing households' access to energy, the study recommends improving modern energy supply, households' income and education.

**Keywords:** Poverty, Cooking energy, Choice, Availability, Affordability

## INTRODUCTION

The choice of households' energy in urban areas is majorly determined by pressure and its consequences as one of the effects of population and urbanization. Urbanization, a common characteristic of developing countries usually alters both production and consumption structures which affects energy access and usage among urban households (Karekezi, Kimani and Onguru, 2008). It mounts pressure on the modern urban services, facilities and energy, including electricity, refined petroleum products and this leads to acute shortages and price fluctuations because many poor urban households particularly will be lacking access to modern energy carriers (energy poverty). National Bureau of Statistics (NBS, 2011) observed that because of the poverty level that is high, urbanization influences the quest for cheaper energy in Nigeria.

Energy poverty sets in because of inadequate energy infrastructure for modern energy delivery resulting from population pressure on the few infrastructure and inability of households to pay for the desired energy resulting from price fluctuations of the few available energy types. Domestic energy poverty is the in-affordability and inaccessibility of households to modern energy forms. Bouravoski and Herrero (2016) are of the view that domestic energy poverty is a situation that varies from area to area where a household cannot afford or lack access to their daily basic energy needs and services.

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**Hamma-Adama.** (2018). **BUILDING INFORMATION MODELLING: A TOOL FOR DIFFUSION OF INFORMATION IN NIGERIA.** Contemporary Issues and Sustainable Practices in the Built Environment. School of Environmental Technology Conference,
SETIC, 2018

The commonest domestic energy needs in Minna includes energy for lighting, cooking, preservation and communication. Morenikeji *et al.* (2006) concludes that most urban dwellers resort to dependence on biomass (wood fuel) for cooking because of the inconsistencies in accessing modern energy carriers.

Minna with population density of 56 persons per square kilometre is one of the growing cities in Nigeria which is as a result of increasing developmental projects when it became the capital of Niger state (Abd'razack *et al.*, 2012). In Minna, fuel wood is one of the cheap energy forms utilized domestically and this is as a result of its availability and affordability. Immigrants from rural areas that are already used to biomass energy use aggravate the wood fuel utilization situation.

Falling out of subsidy removal in 2012 and recently 2016 in Nigeria, the increased the prices of modern energy, compelled households in Minna to cheap energy utilisation (especially traditional wood fuel) in the face of the energy price hike. The National Population Commission (NPC 2006) observed that out of 729,964 households in Niger state, 571,254 households representing 78.3% depend on firewood as their main domestic cooking energy. Morenikeji *et al.* (2006) also observed the high dependence on fuel wood by Minna residents (74.45%) for cooking especially the poor who constituted higher percentage.

Domestic energy poverty occasioned by acute shortages and frequent price fluctuation have compelled households especially those in low and medium income categories, to resort to energy stacking. This multiple domestic cooking fuel use is determined by choice factors which are as a result of energy poverty and the eventual energy types relied on are wood fuels (biomass). The studies on environmental and economic implications of fuel wood trade and use conducted by Morenikeji *et al.* (2006) revealed that wood fuel business in Minna, Niger State is lucrative though it impacts negatively on the environment. The economic aspect of urban biomass trade and consumption differ from the rural situation because of the magnitude of dependence, even by poor households, on fuels bought and responsiveness to market mechanisms. The study therefore seeks to determine the factors influencing the prevalent wood fuel utilisation in the study area

Energy poverty which is an expression of lack of energy especially electricity to a great extent determines the livelihood of electricity dependent households. Access to modern energy facilitates households' energy services such as cooking, preservation, lighting, communication, etc. Households' energy poverty status is worsened by the inaccessibility to modern energy which play major roles in urban households' domestic and economic activities. In terms of cooking, urban households resort to various domestic cooking energy sources to meet up with their cooking needs. Some rely on pollutant emitting energy types with or without knowledge of the implications hence justifying the need for the study. Therefore the study aims to analyse household energy characteristics in order to discern the rationale for households cooking energy choice in Minna.

# METHODOLOGY

## Study area

The Study area is Minna metropolis; the capital of Niger State and is the headquarters of Chanchaga Local Government Area (Niger State Statistical Year Book, 2011). It lies between Latitude 9º 33' and 9º 40' North of the Equator and Longitudes 6º 29' and 6º 35' East of the Greenwich Meridian on a geological base of an undifferentiated basement complex of mainly gneiss and magnetite (Max Lock, 1979).

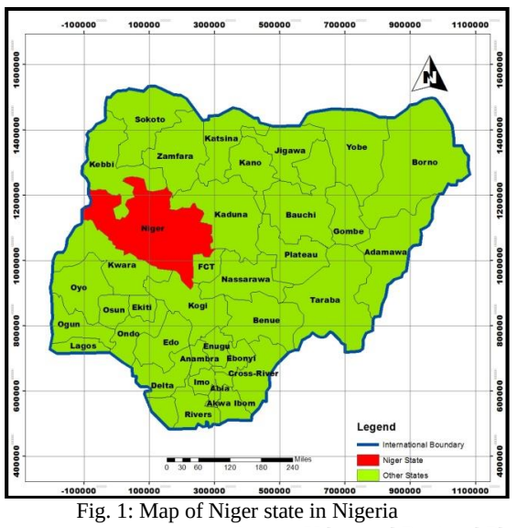


Fig. 1: Map of Niger state in Nigeria

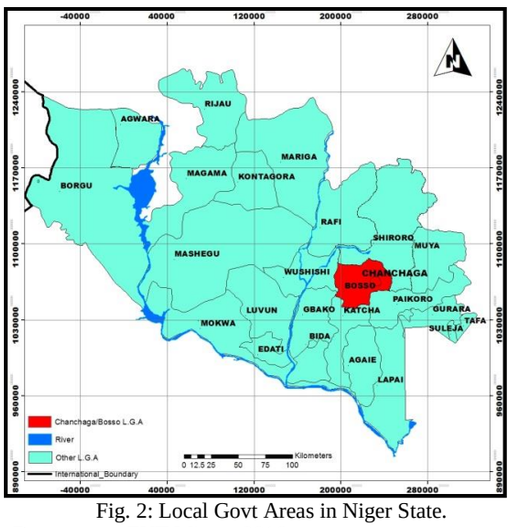


Fig. 2: Local Govt Areas in Niger State.

Source: Urban and Regional Planning Department, FUT Minna, 2016.

With the creation of the Federal Capital Territory, Minna has become enhanced in all her developments as more people are attracted to the town.

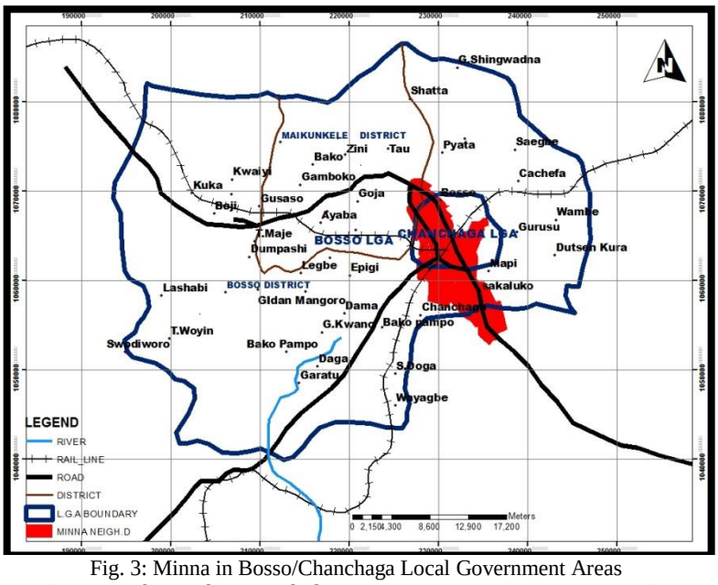


Fig. 3: Minna in Bosso/Chanchaga Local Government Areas

Source: Urban and Regional Planning Department, FUT Minna, 2016.

Being the state with the largest land mass of about 76, 469.903 Square Kilometres (about 10% of the total land area of Nigeria) out of which about 85% is arable (Niger State Statistical Year Book, 2011), the majority of the populace in the State (85%) are farmers while others constituting (15%) are involved in vocations such as white collar jobs, business, craft and arts. This suggests availability of wood fuels (charcoal, fuel wood, etc) which influences its dependence as cooking energy alternative.

## Conceptual Framework and Literature Review

The choice of domestic cooking energy can be linked to households' economic status. Some varieties of choices in energy carrier are at the disposal of the wealthier people where many go for more efficient, cleaner and modern energy sources. Both relatively and often absolutely, the energy expenditure of the poor generally outweighs that of the rich as they hardly offset the upfront cash for devices that increases fuel use efficiency or facilitate changing from local to modern energy (Clancy *et al.*, (2002). The poor people now have very limited options, an energy poverty situation. Biomass fuels will for some time most likely remain the major heat processing and cooking fuels since electricity is more expensive for such applications in almost all situations.

Energy poverty which implies the lack of access (in terms of availability and affordability) to modern energy sources breeds reliance and dependence on inefficient and cheap energy sources used for energy dependent domestic activities. Part of the United Nation's Sustainable Energy for All (SE4All) Initiative objectives is achieving access to modern energy universally with greater efficiency in energy and increased renewable energy use. Energy access jointly is defined by Masud *et al.* (2007) as the provision of quality and

reliable modern energy supplies optimally sufficient when and as needed, as well as the individual's power to pay for such supplies quantitatively and qualitatively necessary for their day to day use. Access to energy entails the availability of adequate and timely energy as well as that being reliable, qualitative, affordable, legal, convenient and safe, for all the household, community and productive services requiring energy (ESMAP, 2014). It implies ensuring the ability of the end users to procure (Al-amin, 2014) and efficiently use these services at a reasonable price for their various needs with consideration to their respective budgetary constraints (Masud *et al.,* 2007).

In order to meet various purposes especially at the household levels, energy is very imperative at all times. Life tends not to be easy and possible with inadequate and irregular energy supply for domestic needs. Momodu (2013) suggested that availability and affordability are two major factors that determine the energy for domestic purposes. It implies that handy and affordable energy must be at the people's door steps especially the poor. Household activities are supported by energy through fundamental and basic needs provision such as a temperature for comfortable living, cooked food, illumination and appliances use, sewerage, preservation, education and information/communication aids and transport (Nnaji *et al.,* 2010; Oyedepo, 2012). In the developing countries, the commonly and widely used domestic energy resources includes electricity, LPG, kerosene, charcoal and fuel wood. In the rural areas of Africa and Nigeria in particular, endemic poverty among households and inaccessibility to basic social services has led to reckless exploitation of natural resources (Akwa *et al*., 2008). Among all the energy sources, however, fuel wood is mostly available and is utilized virtually everywhere in Nigeria for meeting households' energy needs.

However, as a measure of economic development level of a particular society, energy must be available to all in that specific society. Momodu (2013) gave an example of advanced economies of France, United Kingdom and USA where the greatest percentage of their population accesses cost effective and affordable energy supply as a result of their technology advancement. Unlike in a developing country like Nigeria, large proportion of its populace has low purchasing power and necessary energy infrastructures are not in place suggesting inaccessibility to choice energy sources by majority of the people (Momodu, 2013).

In Nigeria, commercial energy accounts for a negligible fraction of total energy consumption different from what is obtainable from most industrialised countries. A large percentage of energy consumption is supplied by the "traditional" and "non-commercial" sources such as charcoal, fuel wood, vegetable wastes and dung. Momodu (2013) observed that generally, cheap, reliable and environmentally benign energy sources are not accessed by most of the undeveloped nations.

In Nigeria, a developing country with about 180 million people, the rural dwellers, with their often basic needs, depend largely on the local energy sources for their domestic energy needs unlike the bulk of the urban dwellers that are dependent on both traditional sources of energy and fossil fuels. In terms of energy existence, Nigeria has ample energy sources at her disposal such as wind, solar, hydro, coal, oil and gas, used especially for domestic consumption. In addition, the household use requiring large amount of domestic energy however relies mostly on fuel wood and partly on electricity and kerosene in many countries in the world.

The inadequacy in generating electric power likewise poor distribution network in the country has subjected a large chunk of the citizenry to fuel wood use for their domestic needs. Sambo (2005) asserted that for cooking especially, household sector depends maximally on fuel wood and minimally on electricity and kerosene in many countries. Like any form of energy, Sanusi (2008) stated that the presence of electricity is important for productive services, for development of most community services and preservation of the environment, particularly forest resources that could be used for cooking in the absence of accessible and dependable electricity supply. Most discouraging is the supply and distribution of petroleum products in Nigeria. Kerosene is inaccessible to many for their domestic needs in terms of purchasing power. Where it is available, it is sold at exorbitant prices. Inadequate and poor condition especially, of energy infrastructure truncates regular supply of electric energy to the people.

Energy poverty is defined as households' inability to satisfy basic costs of energy for warming and illuminating their homes and cooking food adequately. It also can be defined

as the availability of insufficient options for reliable, affordable, qualitative, safe (Bekele, Workneh, Negatu & Getachew, 2015) and favourable environmental energy services to support both human and economic development (Reddy, 2004). Affordability refers to prices of choice energy in relation to household income and also incorporates flexibility which implies the ability to pay for needed energy against being compelled to pay what is available for sale (Al-amin, 2014).

In the light of inaccessibility to electricity, energy poverty situation is worsened when energy expenditure (economy, health) is high. Energy expenditure increases with income although the rate is less proportional, (World Energy Outlook - W.E.O., 2002). As poor households continue spending larger part of their income on energy, it gets to a point where they begin to be conservative on their energy consumption. Accordingly, W.E.O, (2004) stated that economic energy poverty is at a level when households' energy expenditure is more than 10% of the disposable income, excluding transportation costs. Khandker, Barnes & Samad, (2010) stated that frequently mentioned in the literature is threshold point of 10% of total income as poor households common expenditures level. The idea is that for energy, households who are cowed to spend up to 10% of their cash earnings are short of other basic needs for life sustenance.

In developing countries like Nigeria, Bamiro and Ogunjobi (2015) observed the share of energy expenditure to be 23% indicating high level of domestic energy poverty. Electricity (36%) and kerosene (30%) are the two most important fuels in proportioning total energy expenditure. While it may be true to say that the poor always access low services, it is also clear that the middle income or even the high income people can also suffer service deficiency (Sanusi, 2008). By this position, he concluded that deficiency in service provision may be explained by inadequacy of governance system rather than the income of the people.

Inadequacy in modern energy supply likewise shielding from deregulation, facilitates the prices of energy sources to often rise above the poor's ability. The Federal Government of Nigeria (FGN) upward deregulation of the petroleum products prices, consequently compelled people to adopt cheaper energy source. Equally falling out of government's insensitivity to the predicaments of the masses, infrastructures were and are still vandalized in Nigeria to date thus leading to artificial scarcity of energy with its consequences (Momodu, 2013). According to Abd'razack *et al.* (2012), economic dead end and global economic meltdown have also affected households greatly and this has altered both their ability to provide shelter and energy use and services adequately. In the same vein, Bruce *et al.* (2011) suggest the importance of not relying on economic growth and other poverty alleviation measures as the basic means of improving poor households energy choices.

This state of the economy has jeopardised households in their daily energy use in trying to attend to needs. Rural populace and households' with low income cannot afford the supposed major sources of cooking energy which are Kerosene and LPG. As a consequence, the domestic energy consumption pattern by households in Nigeria changed and has great adverse impact on the socio-economic characteristics of the poor. The relationship of poverty and energy can be described with reference to the quality and quantity of energy used. In general, most poor households use biomass fuels because of affordability and they do not have sophisticated energy appliances such as gas and electric cookers (Ogwumike, *et al.*, 2014). It also has environmental effect as biomass consumption has been on the increase for households cooking energy used day in day out.

Households domestic energy choice and consumption as indicated by researches substantiate the energy ladder suggesting the consumption of cheap and less conventional energy such as biomass, of quick price and quality (kerosene) than costlier and highly convenient energy types such as LPG and electricity while moving up the income ladder and or habits change overtime (Sathaye & Meyer 1990; Smith, 1994; UNCHS, 1991). However, as inflation rate has altered the situation, households rely on biomass to beat its effect. In the past, petroleum products pump price increase in the early 2012 has decreased kerosene patronage among the middle and low income groups (Sathaye and Meyer, 1990) for increased and high charcoal consumption. The major factors influencing the use of any kind of energy by urban households include availability and affordability of the energy, cultural preference and income. Despite being established that there are differences in the urban and rural households energy consumption, between high and low income group; within a region, country and among countries (Takama *et al*., 2011), households energy consumption pattern are as a result of the aforementioned factors. Also

the level of urbanization, lifestyle and economic development influences the use and differences (Dzioubinski and Chipman, 1999).

As the modern energy supply is unstable and unreliable likewise the demand of fuel wood which is soaring in both urban and rural setting as poor man's basic energy source, households are at risk of daily energy use for their need. The supposed alternative cooking energy source of electricity and LPG becomes unreachable to many households. This influences the variation in the choice and pattern of households' domestic energy consumption which could be for various reasons in Minna.

## Data Collection and Method of Analysis

Multi-stage sampling technique involving delineation of the study area into 28 urban neighbourhoods was adopted. Within each neighbourhood, stratification using roads system was done and within each stratum, random sampling was conducted. Four hundred (400) copies of the research instrument were distributed to household heads in the sampled buildings as shown in Figure 4 based on the proportion of the individual neighbourhood's population that make up the total neighbourhoods population using Adams *et al.* (2007) sample size formula, $n_o = Z^2_{a/2} \frac{p(1-p)}{d^2}$.

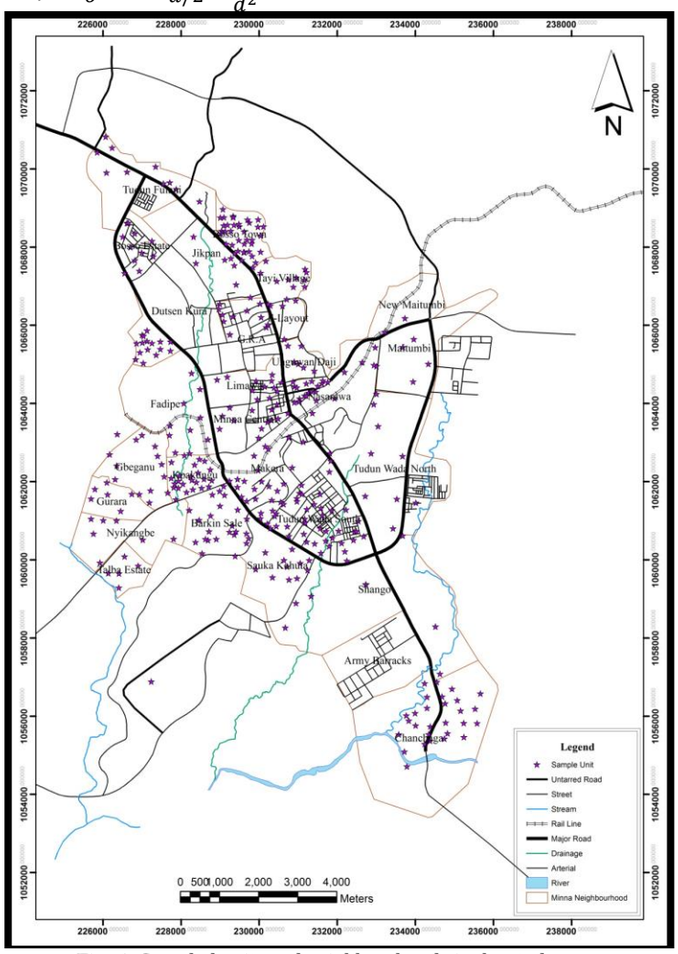


Fig. 4: Sampled units and neighbourhoods in the study area
Source: Author's field work, 2016.

Questionnaire, digital camera and hand-held GPS instrument were used as primary data collection instruments for Minna households' energy characteristics. Descriptive statistics using tables was employed in determining households' domestic primary cooking energy choices.

## RESULTS

The elements of household energy characteristics examined are the various types of primary cooking energy forms and the technology used. The factors influencing the choice of energy type used and the proportion of households' monthly income spent on the primary cooking energy types are also examined.

## Primary energy types

Contextually, primary domestic energy used for cooking refers to the preferred cooking energy options at the households' disposal. The primary domestic cooking energy options observed in the study area are electricity, gas, kerosene, charcoal and fuel wood. These are used with variety of cooking technologies.

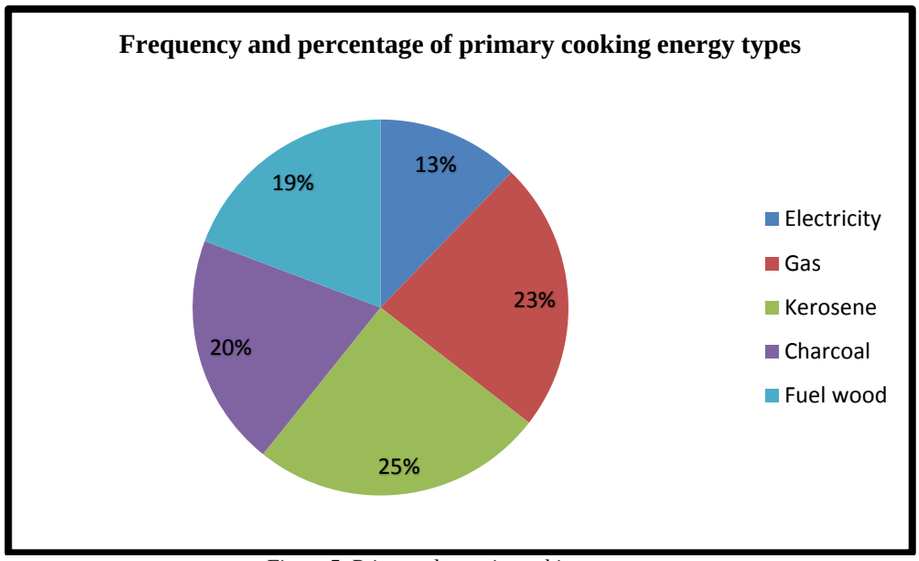


Figure 5: Primary domestic cooking energy
Source: Author's field work, 2016.

The households' primary cooking energy types in the study area are illustrated in Figure 5. It portrays that kerosene is the energy type mostly used for cooking representing 25% of the households in the study area. This is closely followed by gas which represents 23%, charcoal and fuel wood users each represent 20% and 19% respectively while electricity is 13%.

## Primary cooking energy technology

This study revealed the primary cooking technologies that households in the study area use to include gas and electric appliances, kerosene pressure stove (Plate I), local charcoal efficient stove (Plate II) and fuel wood efficient (Plate III).


Plate I: Kerosene pressure stove

Plate II: Charcoal efficient stove

Plate III: wood efficient stove

Source: Author's field work, 2016.

The study also discovered the inefficient versions in the technology of the adopted cooking coping fuels in the wake of energy poverty. These include the Nigerian conventionally fabricated iron charcoal stove called *'Abacha stove'* in local parlance (Plate IV) and iron or stone wood stoves (Plates V and VI).

Plate IV: Iron charcoal stove (*Abacha stove*)

Plate V: Iron wood stove

Plate VI: Stone wood stove

Source: Author's field work, 2016.

Equally used by the households are local versions of efficient charcoal and wood stoves as depicted in Plates VII and VIII.

Plate VII: Local charcoal efficient stove

Plate VIII: Local wood efficient stove

Source: Author's field work, 2016.

## Factors for the choice of primary cooking energy

Accounting for the choice of primary cooking energy, Table 1 shows the reasons households adduced to the choice of a particular primary cooking energy.

**Table 1: Factors for the choice of primary cooking energy type**

| Energy type | Cheap | Available | Easy to use | Durable | Safe | Cultural Preference | Clean energy | Low uptake cost | Fast | Household size | Others |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Electricity | 12 | 17 | 13 | 0 | 0 | 0 | 7 | 0 | 1 | 0 | 0 |
| Gas | 7 | 22 | 8 | 9 | 2 | 0 | 24 | 0 | 21 | 0 | 0 |
| Kerosene | 20 | 28 | 37 | 2 | 6 | 0 | 0 | 1 | 5 | 0 | 1 |
| Charcoal | 41 | 16 | 12 | 3 | 0 | 1 | 0 | 3 | 4 | 0 | 0 |
| Fuel wood | 38 | 22 | 8 | 1 | 0 | 5 | 0 | 0 | 1 | 1 | 1 |
| **Total** | **118** | **105** | **78** | **15** | **8** | **6** | **31** | **4** | **32** | **1** | **2** |
| **Percentage** | **29.5** | **26.25** | **19.5** | **3.75** | **2** | **1.5** | **7.75** | **1** | **8** | **0.25** | **0.5** |

Source: Author's field work, 2016.

## DISCUSSION

In spite of electricity being a clean energy type, the research discovered that 14.3% of the households using it as their primary cooking energy adopt it because it is a clean energy type. The remaining households who use it for its availability, cheapness and being easy to use are represented by 32.7%, 24.5% and 26.5% respectively. This implies that 85.7% of the households using electricity for cooking are least aware of it being a clean energy type which influenced their choice of other cooking energy types.

Similarly, LPG as a clean energy is adopted as primary cooking energy by 25.8% of the households. Some other LPG using households represented by 23.7% and 22.6% use it because it is available and fast respectively while 18.3% adduced their reason to the choice of LPG because it is easy to use. The survey indicates that 7.5% of the households use it because it is affordable. The findings suggest that as much as 74.2% of the LPG using households do not use it because it is a clean energy form.

Apart from kerosene being the most used cooking energy fuel in general, it is '*unclean*' and the most sought among the low level energy sources which include charcoal and fuel wood. Its choice by the 25% of the households as their primary cooking energy type is because it is easy to use against charcoal and fuel wood users who adopt them because of affordability and availability respectively.

From Table 1, it can be deduced that the major determinants of cooking fuel choice by households are affordability (29.5%) and availability (26.3%) as a fallout of domestic cooking energy poverty. The least factor as observed is household size which accounts for 0.25% determinant of cooking energy choice.

The implication of the choice of kerosene, charcoal and fuel wood is the occurrence of carbon monoxide emissions.

The mean monthly income and expenditure of the primary cooking energy types of the households are summarised in Table 2. It shows that the average income and energy expenditure across the energy types are ₦125331.7 and ₦2460.08 respectively.

**Table 2: Summary of Households' Mean Monthly Income and Energy Expenditure**

| Energy type | No. of Households | Household Income | Energy expenditure |
|---|---|---|---|
| **Electricity** | 49 | 153040.8 | 2382 |
| **Gas** | 93 | 174112.7 | 3152.3 |
| **Kerosene** | 101 | 101543 | 2593.9 |
| **Charcoal** | 80 | 81252.6 | 1647.5 |
| **Fuel wood** | 77 | 116709.5 | 2524.7 |
| **Average** | | **125331.7** | **2460.08** |

Source: Author's field work, 2016.

In the light of the above, Table 3 represents the percentages of households' income spent on cooking energy in the study area. It shows that the greatest percentage (36.5%) of households in the study area spends 2% of the monthly income on their respective primary cooking energy. The households spending about 1% of their monthly income on cooking energy is represented by 22.3%. The households that spend no proportion of their monthly income represented by 2.5% are those using fuel wood that they source elsewhere other than purchasing.

**Table 3: Percentage of Households' Income spent on Cooking Energy**

| Cooking energy type | No. of Hshds | Percentage of income spent on cooking energy | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 % | 1 % | 2% | 3 % | 4 % | 5 % | 6% | 7 % | 8 % | 10 % | 11 % | 12 % | 16 % | 21 % | 23 % |
| Gas | 93 | | 23 | 49 | 9 | 5 | 3 | 3 | 1 | | | | | | | |
| Charcoal | 80 | | 24 | 27 | 12 | 7 | 7 | | 1 | | | 2 | | | | |
| Fuel wood | 77 | 10 | 4 | 12 | 8 | 14 | 13 | 12 | | | | | | 1 | | 3 |
| Kerosene | 101 | | 18 | 49 | | 9 | 4 | 14 | 3 | 1 | 1 | 1 | | | 1 | |
| Electricity | 49 | | 20 | 9 | 9 | 7 | 2 | | 1 | | | | 1 | | | |
| **Total** | **400** | **10** | **89** | **146** | **38** | **42** | **29** | **29** | **6** | **1** | **1** | **3** | **1** | **1** | **1** | **3** |

Source: Author's field work, 2016.

## CONCLUSIONS AND RECOMMENDATIONS

The major determinants of cooking fuel choice by households in the study area are affordability and availability. Equally, the choice of cooking energy do not have a definite pattern among the households as all options at their disposal based on affordability and availability are explored. Besides promoting access to electricity being a very important dimension to consider in enhancing households' access to energy, the findings suggest the importance of enhancing households' income, education, gas and kerosene supply. Eventually and in trying to meet up with domestic cooking energy demand, the choice of traditional energy sources as coping strategies in the absence of modern energy is relied on. The study concludes that poor access to regular and efficient modern energy supply is the main rationale for diverse energy choices in Minna metropolis.

Improvement in modern energy access especially electricity in terms of availability and affordability and enlightening energy consumers to be more proactive in improving and adopting sustainable energy use are basic recommendations emanating from the study. Accessing modern cooking energy types by making them available and very affordable in the study area will positively alter the choice and use of various cooking energy types. Also, encouraging efficient cooking energy choice is recommended to meet up with reduction of the negative effects of using inefficient domestic cooking energy needs in the face of unreliable and inconsistent modern energy supply.

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