ANALYSES OF WOODFUEL CONSUMPTION IN BAKERIES OF BAUCHI METROPOLIS, NIGERIA

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DECLARATION

I hereby declare that this dissertation "Analyses of Woodfuel Consumption in Bakeries of Bauchi Metropolis" and its subsequent preparation was carried out by Ahmed Aliyu (SPS/14/MGE/00024). All material consulted were duly acknowledged.

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CERTIFICATION

This is to certify that the research work on "Analysis of woodfuel consumption in bakeries of Bauchi metropolis" and the subsequent write up by Ahmed Aliyu (SPS/14/MGE/00024) was carried out under my supervision.

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APPROVAL PAGE

This dissertation has been examined and approved for the award of the Master of Science in Environmental Management.

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DEDICATION

I dedicate this dissertation to my beloved late parent, Alhaji Aliyu Zangina and Fatima Sani Abubakar, my first wife Hauwa'u Ibrahim Waziri and my beloved son Aliyu Ahmad Aliyu.

TABLE OF CONTENTS

LIST OF TABLES **PAGE**

LIST OF FIGURES **PAGE**

ABSTRACT

The study assesses the consumption pattern of woodfuel among bakeries in Bauchi metropolis with a view to provide information for sustainable management of the environment. The data were obtained through both primary and secondary sources. Questionnaires was designed to get the different types of energy used, factors influencing energy choice, cost and consumption pattern of different types of energy used by bakeries. One hundred copies of questionnaire were administered to the respondents of the bakeries identified. The totals of 40 bakeries were identified using snow-ball sampling method In Bauchi state, the rate of overdependence on woodfuel by owners of bakeries is a great concern. The findings show that Woodfuel and electricity were the main sources of energy used. Thirty eight (38) bakeries were using woodfuel while two (2) use electricity. This is due to availability and affordability of woodfuel (N55per bundle) than electricity (N29.8 per unit). It was found that the high cost is the main factor militating against the use of electricity for baking bread and hot-wet and cold- wet are the period with highly demand of energy for heating the ovens due to the dampness of the environment and also, are the season of high cost of woodfuel because, accessibility is difficult. It was recommended that government and stakeholders should subsidies other alternative source of energy like solar energy in order to reduce over dependency on woodfuel which affect the quality of environment, also modern oven that have chimney or other clean energy sources should be made available at subsidized rate, these may reduce the over dependency on forest resources as the only bank for woodfuel resources for the sustainability of the environment.

CHAPTER ONE

INTRODUCTION

1.0 **Background of the study**

Energy is an integral part of economic growth and a vehicle for social change. Any reduction in the optimal production of energy resources poses a threat to economic growth and social change (Earl, 1973). The food industry is one of the many energy-intensive industries that lack information on its energy conservation and conversion technologies (Wang, 2009). Economic growth and development of any nation rely greatly on its energy availability, management and conservation (Jesuleye, 1999). Energy efficiency practices and products would reduce cost of production and consequently results in lower selling prices of the products (Akinoso and Olatoye, 2013). Energy efficiencies in food processing facilities vary with end users and production lines. Procedural and behavioral changes that include avoiding wastages can save about 30% energy without capital investment (Fischer *et al*., 2007). Energy is widely regarded as a propelling force behind any economic activity and indeed industrial (bakery bread) production. Therefore, high grade energy resources would amplify the impact of technology and create tremendous economic growth. High grade resources can act as facilitator of technology while low grade resources can dampen the forcefulness of new technology. Hence, the scale of energy consumption per capita is an important indicator of economic modernization. In general, countries that have higher per capita energy consumption are more developed than those with low level of consumption Energy Information Administration (IEA, 2012).

The search for more energy resources today is of remarkable interest to the world. The progress in technology has led to the discovery of new energy sources, some of which are yet to be used world wide. Man's first sources of energy include wood, charcoal and other materials that are renewable, coming before he used wind and water. Wood has long been burnt for cooking and heating but is limited in supply (Sorensen, 1983)

Developing countries depend on woodfuel and charcoal to supply most of their energy. The Wold Fact Book (WFB 2008) stated that clean energy is the mainstay of Nigeria's economic growth and development. It plays a significant role in the nation's international diplomacy and it serves as a tradable commodity for earning the national income, which is used to support government development programs. It also serves as an input into the production of goods and services in the nation's industry, transport, agriculture, health and education sectors, as well as an instrument for politics, security and diplomacy.

The consumption of woodfuel and charcoal has however, posed enormous threats to the environment. The emission of carbon dioxide (CO_2) from burning wood results in the reduction of environmental quality. (Ellison and Waller, 1978), Bates, (1980) reported the following health problems associated with household and commercial energy emitting smoke as: Irritation of the eyes, nose, and throat; Sneezing, coughing, chest tightness, and breathing difficulties; Worsening of existing lung and heart problems, such as asthma, pneumonia; Increased risk of heart attack; Cancer and damage to the immune, neurological, reproductive, and respiratory systems; Severe injuries and to some extent death. Furthermore, the extraction of wood for woodfuel production has lead to the depletion of the tropical forest. This problem of depletion has been addressed a number of times without any proper attention being given to the out cry. Majority of the world's population seems careless about the importance attached to the preservation and conservation of

forest. Moreover, the use of woodfuel and charcoal produces gases with greenhouse effect on environment. However, the environment needs to be protected and conserved, therefore environment friendly equipment like solar, gas and electric devices have been developed to help in protecting and conserving the environment.

With the level of poverty in the country owner of bakers cannot afford to procure these equipments which are expensive, especially now with economic realities compelling the Nigerian government to remove subsidies on petroleum products, thereby commercializing the petroleum industry. Obueh (2007) reported that the deregulation policy of Nigerian government on petroleum products has affected availability, use and consumption pattern of energy. The cost of petroleum escalated and made them out of reach of most bakeries owner of in the country. Therefore, this has made most owners of bakeries to make use of the cheapest sources of energy which are woodfuel and charcoal (Umaru 1999).

There are a lot of works done on household energy consumption but, not much emphasis has been put on the destruction of woodfuel for consumption in bakeries and search for alternatives.
A move to cope with the pressure on forest and other energy resources as well as the emission of greenhouse gases as a result of using woodfuel, Nigerian bakeries and other developing countries can be achieved by developing other alternative energy source that would maintain the environment friendly (Umaru 1999).

1.1 Statement of The Research Problem

Bauchi state shares border with Yobe, Jigawa, Kano and Gombe states, where the impact of desert encroachment is severe. The over dependence on woodfuel by bakeries owner's in Nigeria and other developing countries has become an issue of great concern. It is enormously

contributing to the depletion of forest and eradication of plant and animal species, as well as the emission of greenhouse gases which affect the quality of the environment. Ewah (*2014)* examined the nature of woodfuel or biomass exploitation in different ecological zones of Nigeria and its impact on the integrity of the rainforest and savannah regions of Nigeria. The finding shows that, it can lead to climate change, desertification, global warming if exploitation of woodfuel and biomass continue taking place.

The woodfuel sector employs many men, women, and children in both rural and urban areas, offering both temporary and permanent employment opportunities. It is important economically because it offers an immediate source of income to the exploiters (Larinde and Kehinde, 2003). Malimbwi *et al*., (2001) reported that woodfuel constitutes a major source of energy in most countries, developing and developed countries. In most cases methods used to extract wood energy are not sustainable, leading to land degradation. Center for Tropical Agriculture (CTA 2007) reported that Africa lost over 9% of its trees between 1990 and 2005 and this represented half of global loss. Olusegun (2009) showed Nigeria consuming 262,783 metric tones of woodfuel annually compared with 7,210 tones for South Africa and 35,313 tones for Thailand. Most of the rural dwellers in Nigeria depend on wooldfue for their energy. woodfuel is used by more than 60 per cent Nigerians living the rural areas (Sambo, 2005).

In Bauchi state, the rate of overdependence on woodfuel by owner's of bakeries has become a great issue of concern also. The rate of woodfuel consumption is continuously increasing. If much care is not taken; there may be serious ecological problems in the area.

The daily inflow of trucks loaded with wood and forest materials into the city center is an indication of the alarming rate of deforestation which is a serious issue of worry considering the

impact of the activity to the social, economic and natural viability of the environment. Therefore, in order to achieve the aim of the study the following research questions will be answered:

(a) What are the locations of bakeries and the type of energy used by bakeries?

(b) What are the factors influencing the choice of energy used by bakeries in Bauchi metropolis?

(c) What are the cost of woodfuel and consumption pattern in the area?

1.2 AIM AND OBJECTIVES

The aim of this research is to examine the consumption pattern of woodfuel among bakeries in Bauchi metropolis with a view to providing information for sustainable management of environment, while the objectives are to:

(a) identify the bakeries and types of energy used in Bauchi metropolis.

(b) determine the factors influencing the energy choice by bakeries in Bauchi metropolis.

(c) determine the cost and consumption pattern of energy in bakeries in Bauchi metropolis.

1.3 SCOPE OF STUDY

The study focused on the woodfuel consumption pattern by bakeries, identification of the bakeries within the metropolis and the factors influencing the energy choice in the area. The study is limited to Bauchi metropolis.

1.4 STUDY AREA

Bauchi state was established in 1976 when the former North-Eastern State was broken up. The State occupies a total land area of 49,119 km² representing about 5.3% of Nigeria's total land mass and is located between Latitudes 9° 3' to 12° 3' north and Longitudes 8° 50' to 11° east (Alli *et al.,* 2001).

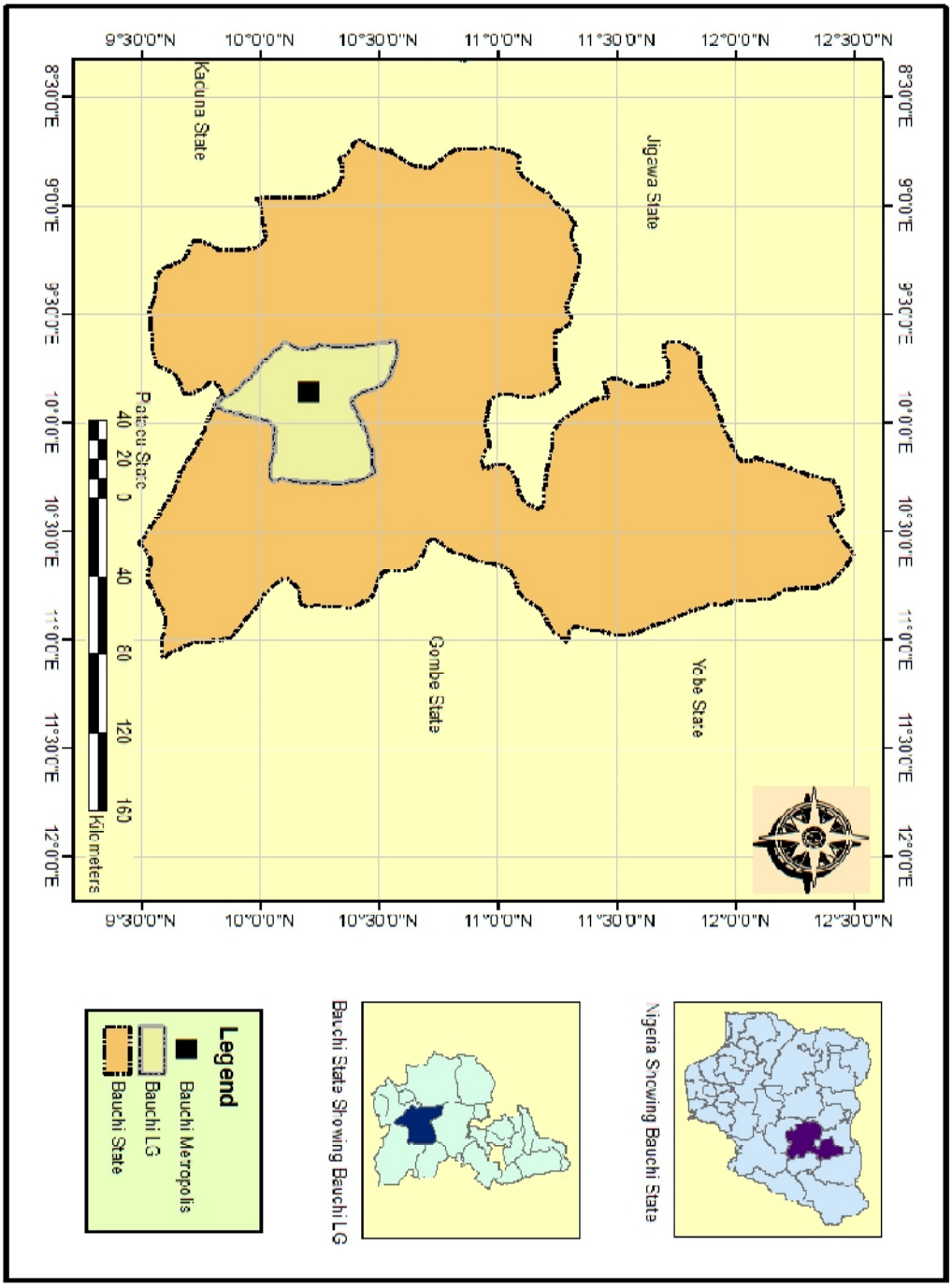
The state have the population of 4,653,066 out of this, 316,149 live in the metropolis, of which approximately 70% have access to electricity but not sufficient. There is a limited supply of the grid to the area and it would take decades to reach most of the area. It has become a matter of necessity for exploitation and establishment of other energy resources to complement and supplement the limited power generation and supply available in the metropolis (Alli *et al.,* 2001).

According to tradition, Bauchi was named after a hunter known as Baushe, who settled in the region before the arrival of Yakubu, the first traditional ruler of Bauchi emirate founded 1800-10 (Allis *et al,* 2001). In Hausa, the word Bauchi means the land of freedom and tourism. Bauchi and Adamawa were the two main sources of freedom and tourism for the Fulani empire of Sokoto (Alli *et al.,* 2001). Bauchi metropolis comprises of 12 wards including: Majidadi ''A'', Majidadi ''B'', Makama S/baki, Zugur, Liman/katagum, Mun/munsal, Dandango/yamrat, Birshi/miri, Kundum/durum, Kangyare/turwun, Galambi/gwaskwaram, Dan'iya/hardo and Dawaki.

The state is bordered by seven states, Kano and Jigawa to the north, Taraba and Plateau to the south, Gombe and Yobe to the east and Kaduna to the west. Bauchi state is one of the states in the northern part of Nigeria that span two distinctive vegetation zones, namely, the Sudan and Sahel savannahs. The Sudan savannah type of vegetation covers the southern part of the state. Here the vegetation gets richer and richer toward south, especially along water courses or rivers, but generally the vegetation is less uniform and grasses are shorter than what grows even further south, which is in the forest zone of the middle belt.

The Sahel type of vegetation, also known as semi desert vegetation, become manifest from the middle of the state as one moves from the state's south to its north. This type of vegetation

comprises isolated stands of thorny shrubs. On the other hand, the southwestern part of the state is mountainous as a result of the continuation of the Jos plateau while the northern part is generally sandy (Alli *et al.,* 2001). The vegetation types as described above are conditioned by climatic factors, which in turn determine the amount of rainfall received in the area. For instance, the rainfall in Bauchi state ranges between 1300mm per annum in the south and only 700mm per annum in the extreme north. Consequently rain start earlier in the southern part of the state, where it is heaviest and lasts longer. It starts in April with the highest recorded amount of 1300mm per annum. In contrast, the northern part of the state receives the rains late, usually around June or July and records the highest amount of 700mm per annum (Alli *et al,* 2001).



Source: Authors fieldwork and Department of Geography BUK (2018)

Figure1: Map of Bauchi Showing The Metropolis

CHAPTER TWO

LITERATURE REVIEW AND THEORETICAL FRAME WORK

2.0 **Introduction**

Woodfuel is a vital source of livelihood for a large proportion of the poor living in or close to the forest in most tropical countries. Wood harvesting for woodfuel is the third most important economic activity for the inhabitant of forest dependent area after farming and animal husbandry (food and agricultural organization 2008). There are diverse technical, environmental, social, cultural and economic reasons for choosing woodfuel as a source of energy (Horgan 2001). For many users, the choice depend on the availability and affordability of other energy options (Horgan, 2001).

The quest for rapid industrialization in the opinion of Hall and Reynolds, (2007) cannot be achieved without a strong and well developed energy resource base. That is, energy is a crucial element in the process of achieving sustainable economic development. Sorensen (1983) described Energy as a force multiplier that enhances man's ability to convert raw materials into useful products, providing varieties of useful services.

2.1 Sources of Energy

Energy sources are classified into two groups: (2.1.1) Renewable and (2.1.2) Non-renewable energy. Renewable energy is energy that can be replenished and include the following:-

2.1.1.1 Bio energy: Biomass can be converted directly into liquid fuels, called bio fuels. Because bio fuels are easy to transport and possess high energy density, they are favored to fuel vehicles and sometimes stationary power generation.

2.1.1.2 Hydropower: is the most mature and largest source of renewable energy.

2.1.1.3 Geothermal: Geothermal power plants access the underground steam or hot water from wells drilled a mile or more into the earth. The steam or hot water is piped up from the well to drive a conventional steam turbine, which powers an electric generator.

2.1.1.4 Solar Energy: Solar technologies tap directly into the infinite power of the sun and use that energy to produce heat, light, and power.

2.1.1.5 Wind Energy: Wind turbine technology may look simple: the wind spins turbine blades around a central hub; the hub is connected to a shaft, which powers a generator to make electricity. However, turbines are highly sophisticated power systems that capture the wind's energy by means of new blade designs or airfoils. Modern mechanical drive systems, combined with advanced generators, convert that energy into electricity.

2.1.2 Non-renewable energy: are essentially fossil fuel like petroleum oil, gas, nuclear and coal. According to Enger and Smith, (2004), the formation of fossil fuel take million of years and is finite in availability; they are formed as a result of accumulation of energy rich organic molecules produced by organism as a result of photosynthesis. Up to the 1960's, coal production was significant and dominated commercial energy supply. In 1990, coal share in total commercial energy consumption was less than one percent (Garba, 1999).

Five types of energy sources investigated (diesel, petrol, kerosene, wood and solar) by Sambo (1991) Show that woodfuel accounted for 95.8% while kerosene was 4.2%.

2.2 World Energy Consumption

The main source of world energy is from the sun. In 2012, the Environmental Impact Assessment (IEA) estimated that the world energy consumption was 155.505 terawatt-hours (Thw), out of this, approximately 22% is consumed in north America, 5% consumed in south and central America, 23% consumed in Europe and Eurasia, only 3% consumed in Africa and 40% consumed Asia as stated by U.S Energy Information Administration, (2009).This showed that the amount of energy consumed varies from one country to another country. Energy is a basic necessity of life for meeting domestic, social and industrial needs. Adequate and regular energy supply for industrial and domestic purposes are prerequisites for keeping socio-economic life moving. Ojinnaka, (2008) argued that the consumption of energy tracks with the national product. Hence, the scale of energy consumption per capita is an important indicator of economic modernization. In general, countries that have higher per capita energy consumption are more developed than those with low level of consumption. Enger and Smith, (2004) stated that the industrialized nations use energy equally within three sectors i.e. residential, transportation and industrial as against the predominant use of energy for residential purpose (cooking and heating) by less developed countries. They further reported that the amount of energy required for commercial and residential use varies from country to country.

Making energy available to all and sundry in a particular society is a measure of level of economic development of that particular society. For example, in advanced economies like UK, USA and France, their populations have access to cheap and affordable energy supply because they are technologically advanced. The necessary energy infrastructures are available while the costs of energy are affordable by the majority of the people (Enger and Smith, 2004). There are divers technical, environmental, social, cultural and economic reasons for choosing woodfuel as

a source of energy (Horgan 2001). For many users, the choice depends on the availability and affordability of other energy options (Horgan 2001).

Malimbwi and Mugasha, (2001) reported that Woodfuel constitutes a major source of energy in most countries, both developing and developed countries. In most cases methods used to extract wood energy are not sustainable, leading to land degradation. Lawrence Berkeley National Laboratory, The Office of Management and Budget (OMB) and the Department of Energy (DOE) (2008) have initiated a joint effort to examine the issue of consumer welfare impacts of appliance energy efficiency standards, and to extend and discuss enhancements to the methodology by which these impacts are defined and estimated in the regulatory process.

Wang, (2009) Observed that Energy derived from fossil fuels (oil, coal, and natural gas) has come to play a very central role in the U.S. economy and in American lifestyles, not to mention in the production, processing, and distribution of food. Most of what is currently known about energy use in the U.S. food system is a direct result of the "energy crisis" of the early 1970s.

Mead, (2005) claimed that fuelwood harvesting in developing countries is so important that it rivals other sources of industrial energy such as electricity, principally among poor people in rural areas. Salim and Ullsten, (1999) repotted that 58% of the energy supply in Africa comes from woodfuel and charcoal and this percentage in Latin America and Asia, though lower, is 15% and 11% respectively, and thus cannot be neglected as a potential source of ecosystem disturbance.

Developed nations rely on electricity, gas and solar energy for meeting their domestic energy needs. Serious intensification of technological advancement effort has led to the identification, exploitation and utilization of other energy sources in most of the technologically advanced countries. As a result, various energy sources such as nuclear, wind, solar among others are

developed and utilized for the generation of energy. Globally, more than 2 billion people depend on woodfuel for meeting their energy needs (Adetunji *et al.*, 2007).

Woodfuel is a source of energy derived by burning wood materials like logs and twigs and is common among the rural dwellers. It is a traditional source of energy, which has remained the major source of fuel for over half of the world's population (FAO, 2001). According to the UNDP, (2002) the share of various energy sources in the total primary energy supply in Nigeria are made up of oil, 10.4%; gas, 6%; hydro electric power, 0.6%; and commercial renewable energy, 83%. The greater portion of the commercial renewable energy is wood, while other agricultural wastes constitute the remaining smaller portion. The over-dependence on woodfuel for energy is chiefly because of its relatively low prices and ease of accessibility (Adedayo, 2005). Other reasons are constraints in the supply of the conventional fuels and the growing population with a larger segment still falling below incomes that cannot afford the cost of conventional fuels (Adedayo, 2005).

There are diverse technical, environmental, social, cultural and economic reasons for choosing woodfuel as a source of energy. For many users the choice depends on the availability and affordability of other energy options. These factors make woodfuel use a site- and situation-specific energy option (Horgan, 2001). In the past, wood harvesting in developing countries was mainly for domestic consumption, and it was mostly women who gather the dried branches and trunks of trees and shrubs for woodfuel (Awah, 1995). Today, the situation has changed, as increased commercialization of the sector has led to the widespread harvest of both dead and live branches and trunks by men and women (Awah, 1995). Woodfuel is harvested, processed, marketed and consumed exclusively by forest dependent communities, moving from collectors through wholesalers and retailers to consumers. Woodfuel is forest product with little

sophistication in length of processing and marketing, the products reach the final consumers more or less directly (Malimbwi and Mugasha, 2001)

The woodfuel sector employs many men, women, and children in both rural and urban areas, offering both temporary and permanent employment opportunities. It is important economically because it offers an immediate source of income to the exploiters (Larinde and Kehinde, 2003). Woodfuel is obtained by splitting logs and big branches into halves and smaller pieces. Most of the wood harvested in the villages for household use are harvested by women and younger children and transported on head, animal, truck and bicycle. Furthermore, Agroforestry today (1993) showed that about 25% of the global warming effect is attributed to the clearing of tropical rainforest at the rate of 17 million hectare per annum. Also, Center for Tropical Agriculture (CTA 2007) reported that Africa lost over 9% of its trees between 1990 and 2005 and this represented half of global loss. Bigger losers in this regard are countries like Angola, Cameroon, Democratic Republic of Congo, Nigeria, Sudan, Tanzania, Zambia and Zimbabwe. The use of woodfuel has been on the increase due to increase in cost and scarcity of alternative sources, particularly Kerosene (Paul, 2008).

Woodfuel is not only used in poor and rural households. In many towns and metropolitan areas, woodfuel is widely used either as main, substitute or supplementary fuel by low-, middle- and high-income groups. The over-dependence on woodfuel for energy is chiefly because of its relatively low prices and ease of accessibility (Adedayo, 2005). Other reasons are constraints in the supply of the conventional fuels and the growing population with a larger segment still falling below incomes that cannot afford the cost of conventional fuels (Adedayo, 2005). In South Asia where there is a large poor population, poverty is the most significant parameter that drives extensive traditional use of woodfuel and residues. Akinbami, (1997) also indicated that a

comparison between the historical consumption and supply patterns reveals that the demand for wood (especially woodfuel) outstrips the natural regeneration of the forestry stock.

2.2.1 Energy Consumption in Africa

Yahaya, (2002) stated that the poorer a country is, the greater its dependence on woodfuel. Almost all African countries rely on woodfuel for meeting their domestic energy needs (Sambo, 2005). Mead, (2005) and FAO, (2001) claimed that woodfuel harvesting in developing countries is so important that it rivals other sources of industrial energy such as electricity, principally among poor people in rural areas. Malimbwi *et al.,* (2001) reported that Woodfuel constitutes a major source of energy in most countries, both developing and developed countries. In most cases methods used to extract wood energy are not sustainable, leading to land degradation.

In addition, woodfuel had a share of between 60 and 86 per cent of African energy consumption, except South Africa. In most of the countries in Sub Sahara Africa, woodfuel accounts for 80 to 90 per cent of residential energy consumption. World Bank, (2000) reported that in sub-Saharan African countries, especially Nigeria, woodfuel is the dominant source of energy for cooking and other activities. Energy Commission Ghana, (2006) stated that woodfuels provide the bulk of the energy needs for most informal enterprises such as bread-baking, processing of oil-palm, brewing of local drinks, tobacco curing, traditional textiles (tie and dye, batik), traditional soap making and fish smoking.

2.2.2 Energy Consumption in Nigeria

Oni, (2014) argues that Nigeria, a country estimated to have a population of over 170 million people has varying temperatures, natural and physical features within its 923.78 thousand sq. km land mass. The country lies within a high sunshine belt and thus, has enormous solar energy and

other solar related potentials. The resources in the North of the country in particular, provide a more viable potential for photovoltaic use, with insulation of up to 7 kWh/ m2/day. Average sunshine hours in Nigeria, are estimated at 12hrs per day. Hence, the country does have rich potentials for renewable energy (solar power production in particular). Given Nigeria's solar potentials, solar thermal applications, for which technologies already exist in the country, include solar cooking, solar water heating for industries, hospitals and households, solar evaporative cooling, solar crop drying, solar incubators and solar chick brooding (Oni, 2014). Akinboro *et al.,* (2012) explains that solar energy, an energy obtained from the sun, is the world's most abundant and cheapest source of energy available from nature. It is free and automatically renewable everyday. Solar energy is available in two forms, namely Solar Thermal and Sola PV. Solar thermal is the direct application of solar energy to produce heat (Akinboro, *et al.,* 2012). Solar PV is the conversion of solar radiation to electricity using solar cell. The surprise, thus, remains how Nigeria is not a solar energy giant. This takes Nigerians to the major challenges to energy security (Akinboro *et al.,* 2012).

Wang, (2009) investigates the relationship between energy consumption and the Nigerian economy from the period of 1970 to 2005. The energy sources used to test for this relationship were crude oil, electricity and coal. By applying the co-integration technique, the results derived infer that there exists a positive relationship between current period energy consumption and economic growth. With the exception of coal which was positive, a negative relationship was noted for lagged values of energy consumption and economic growth. The implication of the study is that increased energy consumption is a strong determinant of economic growth having an implicit effect in lagged periods and both an implicit and explicit effect on the present period in Nigeria.

Akinoso and Olatoye, (2013) carried out a research on energy consumption and economic growth which shows that in the long run, total energy consumption had a similar movement with economic growth except for coal consumption. Fescher *et al*., (2007) carried out a research on ‘‘domestic energy needs and natural resources conservation: the case of woodfuel consumption in Nigeria’’, the role and challenges associated with the use of woodfuel in Nigeria. Desk research on energy utilization, rate of deforestation and alternative sources of energy provided shows that there is a serious problem confronting the environment. Cline-Cole (1987) carried out a research on woodfuel Consumption, Population Dynamics and Deforestation in Africa which shows that, there is existence of a linear relationship between population growth, woodfuel consumption and rates of woodfuel-induced deforestation. That woodfuel-induced deforestation approximates ripples spreading outward from urban consuming centers, and that land conversion to agriculture always reduces woodfuel supplies-to close vicinities.

According to Oyedepo, (2012) energy plays the most vital role in the economic growth, progress, and development, as well as poverty eradication and security of any nation. Uninterrupted energy supply is a vital issue for all countries today. Future economic growth crucially depends on the long-term availability of energy from sources that are affordable, accessible, and environment friendly (Oyedepo, 2012). The energy crisis, which has engulfed Nigeria for almost two decades, has been enormous and has largely contributed to the incidence of poverty by paralyzing industrial and commercial activities during this period. The Council for Renewable Energy of Nigeria estimates that power outages brought about a loss of 126 billion naira (US$ 984.38 million) annually (Oyedepo, 2012).

The food industry is one of the energy-intensive industries and lacks information on energy conservation and conversion technologies (Wang, 2009). Economic growth and development of

any nation relies greatly on energy availability, management and conservation (Jesuleye, 1999). Energy efficiency practices and products will reduce cost of production and consequently results in lower selling prices of the products (Akinoso and Olatoye, 2013). Energy efficiencies in food processing facilities vary with end users and production lines. Procedural and behavioral changes that include avoiding wastages can save about 30% energy without capital investment (Fischer *et al*., 2007). Energy efficiency and environmental protection have attracted increasing attention in the food industry. Effective energy utilization and energy source management in food processing facilities are desirable for reducing processing costs, conserving non-renewable energy resources, and reducing environmental impact. In recent time, there has been a greater awareness of the energy problems facing the world than at any other period in history (Wang, 2009). It is now widely accepted that the current rate of energy generation and supply cannot match the rapid growth in energy consumption rate (Aiyedun *et al*., 2008). The importance of energy in sustained economic development is a well accepted fact. Energy of different forms and quantity are required to carry out each unit operation involved in bread production. These include liquid fuel, woodfuel, and manual (human) energies. Profiling energy utilization data and developing energy conservation processing methods will improve sustainability in the food processing industry (Mohammed *et al*., 2010).

Jekayinfa, (2008) observed economic evaluation and energy requirements of bread baking operations in south western Nigeria and reported that most of the processes of bread baking in Nigeria largely involve manual material handling, which continues to represent a major loss source in the work place. The manual operations, besides being uncomfortable, are characterized by low output and unhygienic products. Available literature on estimation of energy input in food processing include some reported work on energy utilization in food industry such as bread

baking, (Jekayinfa, 2008); cassava products processing operations, (Jekayinfa, 2008); palm-kernel oil processing operations, (Jekayinfa and Bamgboye, 2004); bread making processes (Le-bail *et al*., 2010), sugar production factory (Abubakar *et al*., 2002) and cashew nut processing mills (Taru *et al*., 2010). The estimated total energy consumption in Nigeria in 2009 was about 4.6 EJ or 111 million tone of electricity (MTOE) (IEA, 2012). Close to 60% (that is, 80 million) Nigerians are not connected to the national electricity grid. There is also frequent power outages that can last up to 20 h daily in places connected to the grid (Akande and Olorunfemi, 2009).

Woodfuel has assumed a major role as domestic energy source in Nigeria as a result of several factors such as poor state of the economy, inadequate infrastructure and lack of good political will. Among all these problems, the poor state of Nigerian economy is the most significant problem confronting majority of the people (Sambo, 2005). The poor condition of Nigerian economy which manifests in form of widespread poverty has several implications on the people. In the first instance, poverty is a social disease that affects large section of the Nigerian populace with numerous impacts on the socioeconomic well being of the people. Secondly, poverty is a multi-dimensional social malady that cut across the several ways of life of the people such as feeding habits, style of dressing and overall living standards including their choice of energy. About 70.8 per cent Nigerians are poor, living below US$1.00/day (Mabogunje, 2005). Furthermore, he added that chronic poverty in urban areas is seen as much more complex and visible than the problems of acute need in rural areas of Nigeria. This condition forces majority of the poor to depend on woodfuel for energy since they could not afford other energy sources like kerosene, gas and coal regularly. The rural poor for example, only need to travel for a short distance from their home, to collect woodfuel for meeting their domestic energy needs without any financial implication. More importantly, many people have resulted into cutting, collection

and gathering of woodfuel as employment opportunity and means of livelihood. This situation is very common in most of the rural areas in Nigeria where jobless youths and adult (male and female) have adopted gathering of woodfuel as a major employment to complement their farming and other petty trading activities. Electricity is therefore needed for economic growth, national development and improved standard of living (Sambo, 2006).

Ekanade and Orimoogunje, (2012); Asifat (2012) and Specht *et al*., (2015) have established that people's dependence on woodfuel as primary source of energy is increasingly popular in developing countries such as Nigeria. This is as a result of rapid population growth and rise in fuel price of kerosene and natural gas. Asifat, (2012) opined that many people cannot afford to use fossil fuels and, more importantly, the erratic nature of electricity in Nigeria has increased the use of woodfuel.

Price signals are the best route to optimal energy use. Optimal is defined within the confines of economic models. The translation to policy arguments has been that the price of energy should reflect the cost of delivering it, e.g., production costs and the value of environmental externalities of that production. People, in turn, should react to changes in price. This theory is intended to operate on the margin. (EIA, 2012). Ewah (*2014)* examined the form and content of woodfuel or biomass exploitation in different ecological zones in Nigeria and its impact on the integrity of the rainforest and savannah region in Nigeria that can cause environmental challenges such as climate change desertification global warming and floods as some of the major effects and contributions of woodfuel and charcoal to environmental degradation.

Montalembert and Clement (2003) reported that woodfuel meets about 90% of energy need in South of Sahara Africa and Latin America. woodfuel is used by over 70% of Nigerians living in the rural areas. Nigeria consumes over 50 million tones of woodfuel annually, a rate which

exceeds the replenishment rate through various afforestation programs. Sourcing woodfuel for domestic and commercial uses is a major cause of desertification in the arid-zone states and erosion in the southern part of the country. The rate of deforestation is about 350,000 ha/year, which is equivalent to 3.6% of the present area of forests and woodlands whereas reforestation is only at about 10% of the deforestation rate (August, 2000).

The low amount of electricity produced and the electricity grid problems contribute to the low per capita consumption (≈100 kWh) of electricity in Nigeria in comparison to consumption of over 10,000 kWh in developed countries (FGN, 2006).

Apart from oil and gas, other energy sources such as electricity, wood and coal also play significant roles in meeting energy demands in the country. However, among all these energy sources, only woodfuel is mostly available and utilized almost everywhere in the country for meeting domestic energy needs. Other energy sources are scarce, most especially in the rural and urban areas where woodfuel is their major energy carrier (Sambo, 2006). Adetunji *et al.* (2007) opined that energy option of any country is influenced by national economic condition, individual level of income, technological advancement, the state of energy infrastructure as well as the rate of population growth. The Nigerian energy sector is not well developed based on the fact that despite abundance various energy sources in the country, majority of the people are yet to have access to affordable and reliable energy. Iwayemi (2008) opined that Nigerian energy sector is probably one of the most inefficient in meeting the energy needs of its people. This is most evident in persistent disequilibrium in the market for electricity and petroleum products, especially kerosene and premium motor spirit (PMS). This has resulted in the use and overdependence on woodfuel which has led to deforestation and attendant degradation of the environment and worsening desertification (Babanyara and Saleh, 2010).

The type of biomass resource available in Nigeria varies with climatic region in the country. For example the rain forest zone will generate the highest quantity of woody biomass while savannah zones will generate more crop residues (Olaoye, 2011). Olusegun (2009) showed Nigeria consuming 262,783 metric tones of woodfuel compared with 7,210 tones for South Africa and 35,313 tones for Thailand. Most of the rural dwellers in Nigeria depend on wooldfuel for their energy. woodfuel is used by more than 60 per cent Nigerians living the rural areas (Sambo, 2005).

The use of woodfuel is currently gaining more popularity among the medium and high income earners in urban centers such as Kaduna, Kano, Lokoja, Bauchi, Ibadan, Sokoto, Ilorin, Makurdi, Jalingo and Minna among others due to the scarcity and cost of kerosene which officially was suppose to be sold for fifty naira (₦50:00) only per liter, but sells for as high as one hundred and thirty naira (₦ 130: 00) only per liter in most filling stations and one hundred and eighty naira (₦ 180: 00) or more at black market in Abuja and coupled with the epileptic electricity supply (Sambo, 2006). Bread baking operations especially those involving baking (in oven) stage are accomplished by the use of thermal energy and the heat for baking is derived from different fuel sources. Fuels are materials consumed by burning to generate energy suitable for human needs (Rajput, 2001). The major sources of energy used for bread baking in Nigeria are woodfuel, gas and electricity, which at the moment are not only scarce but costly (Rajput 2001). This is due to Epileptic nature of electricity supply from the national grid on the one hand and shortage in supplies of petroleum products and the continuous disappearance of natural forest on the other hand. In most bakeries in Nigeria, manual bread-baking operations which are carried out under hot environmental conditions involve the use of rudimentary tools, and therefore have a lot to do with muscles which are energy sapping. The health of the bakers may be endangered due to large

amount of poisonous exhaust gases they inhale as a result of incomplete combustion. In addition, there is lack of adequate energy infrastructure and adequate energy supply. This further compounds the problems of energy availability. Overall, most of the developing nations do not have access to cheap, reliable and environment friendly energy (Rajput, 2001).

Similar works on energy requirements consideration of food and agricultural processing operations have been reported in literature. Baruah and Bhattacharya, (1996) studied the utilization pattern of human and fuel energy in tea plantation in India. Aiyelari *et al.,* (1981) evaluated the power requirements in gari (cassava) frying in Nigeria. Cleland *et al.,* (1998) proposed the application of multiple linear regressions to analysis of data from food factory energy surveys. Cundiff and Dodd (1981) developed mathematical models that could estimate energy requirements for forced air tobacco curing. Chang *et al.,* (1996) conducted a study to develop an energy model and a computer simulation model which could assess the requirements of electricity, fuel and labor for handling, drying, storage, and milling processes of rice processing complex in Korea. Jekayinfa and Bamgboye (2004) conducted a study to determine the efficiency and pattern of energy usage in some selected cashew nut and palm-kernel oil processing mills in Nigeria.

Energy is the mainstay of Nigeria's economic growth and development (The World Fact Book (2008). It plays a significant role in the nation's international diplomacy and it serves as a tradable commodity for earning the national income, which is used to support government development programs. It also serves as an input into the production of goods and services in the nation's industry, transport, agriculture, health and education sectors, as well as an instrument for politics, security and diplomacy (The World Fact Book, 2008).

One major energy problem confronting developing countries like Nigeria is that majority of their people lack access to energy sources and therefore mostly depended on woodfuel for most of their energy needs. Most of the rural dwellers in Nigeria depend on woodfuel for their energy. Woodfuel is used by more than 60 per cent Nigerians living the rural areas (Sambo, 2005). Apart from domestic energy purposes, woodfuel is also used in other sector of the economy such as cottage industries. For example, in most of the bakery industry, woodfuel is used for providing heat for baking bread. More importantly, woodfuel is used mostly in cooking large quantity of several food items used in social occasions in the country. Nigerians consume over 50 million metric tons of woodfuel annually, a rate, which exceeds the replenishment rate through various a forestation programs (Sambo, 2006).

2.3.3 Energy Consumption in Northern Nigeria

Available records show that in northern Nigeria, the fuel consumption rate was given as 23.3 million cubic meters per year (Anderson and Abakah, 1990). As Gbadegesin (1995), has rightly observed the gradual removal of subsidy on petroleum products has heightened the problems of environmental degradation in Nigeria. Simonyan and Fasina (2013) reported that energy from biomass can potentially be an alternative approach to solving the country's electricity problem. Their estimation shows that Nigeria is capable of producing 2.01 EJ (47.97 Millions tones of energy (MTOE)) from the 168.49 million tones of agricultural residues and wastes that can potentially be generated in a year. Converting the huge quantities of biomass resources to electricity will increase the energy supply, energy mix and balance of Nigeria.

Taru *et al.,* (2010) evaluated woodfuel marketing in Adamawa State and observed that the felling of trees for woodfuel (energy) consumption cuts across most rural and urban communities in

sub-Saharan Africa. This activity denies the existence of forest trees and wood is burnt to produce carbon dioxide which is linked to climate change.

There are 19 states in Northern Nigeria and the Federal Capital Territory (FCT). Of this number, ten (10) states are already affected by desertification. The affected states include Bauchi, Gombe, Borno, Yobe, Jigawa, Kano, Katsina, Zamfara, Sokoto and Kebbi (Ayuba and Dami (2011). Acconding to Okoye and Ezeonyejiaku, (2010) Although the magnitude of this environmental hazard is not equal, as one moves further north, it becomes more severe. Therefore, the frontline states of northern Nigeria (Sokoto, Kebbi, Zamfara, Jigawa, Borno, Katsina and Kebbi) experience severe desertification, while Bauchi, Gombe and Kano experience moderate desertification. Gbadegesin, (1995) revealed a high dependence of Fakai district of Sokoto state and Oshogbo in Oshun state of Nigeria on woodfuel and kerosene with consumption of households in twelve villages to the range of 105.7–195.0kg and 2.50–12.73 liters respectively while in Bauchi State of Nigeria, fire wood was found to be the dominant fuel source, contributing between 52.45% and 88.62% of the household and commercial budget (Ewah, 2014). Jekayinfa *et al.,* (2007) investigated the link between real incomes, inflation and woodfuel consumption. His regression analysis indicates that the quantity of woodfuel consumed is negatively correlated to real incomes and positively related to inflation levels.

2.3.4 Energy Consumption in the Urban and Rural Areas

In the opinion of Ubueh, (2007) forests contribute directly and indirectly to rural household livelihoods through the generation of income and employment from the sale and exchange of gathered and unprocessed non-timber forest products such as woodfuel. Kerosene and gas are not readily available due to inadequate supply in most Nigerian rural areas. Studies have shown that in Nigeria, harvesting of woodfuel contributes to deforestation at a rate of about 400,000 hectares

per year. If this trend continues, the country's forest resources could be completely depleted by 2020 (Alli *et al.,* 2001 and Obueh, 2007).

Babanyara *et al.,* (2010) in their work Urbanization and the Choice of Woodfuel as a Source of Energy in Nigeria found out that the factors causing woodfuel demand in urban areas include, Rural-urban migration, Urbanization, Poverty, Hikes in prices of kerosene and cooking gas amongst others. Lawrence (1998) reported in her work ''Socio-economic Analysis of Woodfuel Production and Utilization in Communities'' found that the raw materials for the processing and production of woodfuel found in almost all the five (5) communities selected for the study came from the natural forest People do not plant their own wood (trees) to use them as fuel for either domestic and/or commercial purposes.

Falola, (1998) in his work investigated woodfuel consumption in urban Kano, the rural urban trade in firewood, the ecology of wood fuel, and the management of wood resources in the hinterland. Reported that several factors account for the preservation of trees in Areas close to the urban centre. First, rising prices of firewood, together with subsidized petrol costs have made the increased distance acceptable to merchants. Second, resistance to wood cutting by the local farmers has stabilized off take within the local hinterland. The rural dwellers, whose needs are often basic, depend to a large extent on the traditional sources of energy for their domestic energy requirements, while the majority of the urban dwellers depend on traditional energy sources and fossil fuels. However, the high level of poverty and other socio-economic problems inhibit both the rural and urban dwellers from having access to adequate and reliable sources of energy for domestic purposes.

In terms of energy availability, there are various ample energy sources in Nigeria such as wind, solar, hydro, coal, oil and gas etc, which if properly managed will alleviate energy problems of

the people most especially for domestic consumption. Obviously, Nigeria is naturally endowed with oil and gas and depends on it for her economic development. For example, oil accounts for 80.5 per cent of national revenue. These two energy sources are the major export commodities that provide foreign exchange for the country. Oil and gas also play major role in meeting energy needs of the various sectors of the nation's economy. For example, gas, petrol, diesel and kerosene provide energy for wide industrial and domestic application (CBN, 2007). The use of woodfuel has been on the increase due to increase in cost and scarcity of alternative sources, particularly Kerosene (Paul, 2008).

2.4 Environmental and Health Perspective

Concern for the alarming rate of environmental degradation globally, has been a topical issue to government and key layers in the field of environmental science in recent times. Wood harvesting for woodfuel is the third most important economic activity for the inhabitants of forest dependent area, after farming and animal husbandry. Consequences of large scale deforestation and environmental pollution are manifesting in the form of soil erosion, land degradation, loss of bio-diversity and local climate change resulting from global warming (FAO, 2001). Doig (1999) predicted that although not seen on a daily basis, over a number of years, the impacts of global warming will be felt in different part of the world. Some authorities claim that recent natural disasters around the world have been due, partly, to global warming whose main effect is rising global temperatures, thereby increasing drought in some places and creating floods in others. Bates, (1999) argued that every time fuel is burnt, greenhouse gasses, which are the main cause of global warming, are released to pollute and damage the ozone. The reduction of pollutants could be of more benefit than the overall control of the effect of the green house gases of the environment, because people health are more directly affected by the emission of this damaging

pollutants than those emitted away from home in places like power plant, industries and others (Bates, 1999).

Efficiency and conservation are the two routes to reduced emissions. Separation of technology and behavior have contributed to a narrow view of the role of people in determining energy use. People are seen to "save energy" through undertaking a limited set of behaviors, namely, purchasing efficiency incrementally or undertaking conservation actions. The latter actions have been primarily defined as management or curtailment done with the intention of saving energy or money. This view misses much of what is important on how people and society do affects energy use, e.g., the size and type of dwellings and their location, indirect energy use, and so on, as may also misunderstand why people manage energy as they do. Have research and policy focused too much on small stuff while bigger opportunities have gotten away (Shove, 2003).

Neira, (2006) quoting the World Health Organization (WHO) gave a figure of 1.5 million death, mostly among children and women per year, as a result of indoor air pollution. He added that the World Health Organization (WHO) in 1997 reported that the greatest burden of air pollution exposure occurs in the kitchen and in some commercial areas of the developing world. Bates 1980) reported the following health problems associated with household and commercial energy emitting smoke (a) Irritation of the eyes, nose, and throat (b) Sneezing, coughing, chest tightness, and breathing difficulties (c) Worsening of existing lung and heart problems, such as asthma, pneumonia, (d) Increased risk of heart attack (e) Cancer and damage to the immune, neurological, reproductive, and respiratory systems (f) Severe injuries and to some extent death. Agro-forestry today (1993) showed that about 25% of the global warming effect is attributed to the clearing of tropical rainforest at the rate of 17 million hectare per annum. Also, CTA (2007) reported that Africa lost over 9% of its trees between 1990 and 2005 and this represented half of

global loss. Bigger losers in this regard are countries like Angola, Cameroon, Democratic Republic of Congo, Nigeria, Sudan, Tanzania, Zambia and Zimbabwe.

2.5 Motivating Factors for Energy Consumption

:**(a) Education and Seasonality:** Survey of the energy use in northern Nigeria by Silvinconsult, (1991) identified that any commercial center that have little or no formal education (western education) consume more energy than those with background of formal education.

(b) Cultural Beliefs and Energy Consumption: Nierkik, (1998) reported that electricity was initially rejected in west and of South Africa, because people believe that the coming of electricity will chase away their ancestral sprits.

(c) Socio-economic, Demand and Supply Factor: According to Sepp, (1999) availability of different energy sources, different user's habits, available technology, energy price in relation to the household and commercial mean income, will determine the consumption pattern. The author sited example woodfuel and charcoal consumption as being directly related to their availability.

(d) Urban Rural Energy Dichotomy: Khennans, (1998) asserted that urban areas are responsible for the bulk of household energy consumption especially the conventional energy (electricity, petroleum products) and is also true for traditional form of energy such biomass. Biomass fuel not only provides energy for poor rural population but also to people with higher incomes.

Gana *et al.,* (2008) stated that, in Bauchi State of Nigeria; Kerosene is irregularly supplied and costly, hence, firewood and charcoal are the major alternative sources of energy. Woodfuel is also a source of income to many, hence, it is not only sold in the rural areas, but also in urban

areas using trucks. Those who engage in this business at times employ the services of men to cut down trees and allow them to dry before they are sold. This has been contributing to desertification in Nigeria.

(e) Government Policy: Obueh, (2007) reported that the deregulation policy of Nigerian government on petroleum products has affected availability, use and consumption pattern of energy. Before 2003, kerosene was sold at ₦35, to day it sold ₦100 per liter.

(f) Energy Population Dynamic: Rapid growing of world population has impact on energy consumption. (UNDP, 2002) The implication of foregoing scenario is increased demand for energy for more people and at a very alarming close interval of years. Sepp, (1999) summarized the world population growth thus: ‘’It took the world population millions of years to reach the first billion, then 123 years to the third, 14 years to the fourth, and 13 years to the fifth billion’’.

2.6 Theoretical Framework

Some of the theories guiding bakery energy study are: fuel choice theories (energy ladder fuel stacking), fuelwood gap theory and energy Conservation theory (Value-belief-Norms theory) and linear stage theory (Rostow, 1960).

The Rostorw’s stages of growth model are the most well-known example of the linear stages growth model. He identified five stages through which developing countries had to pass to reach an advance economic status: (a) traditional society (b) precondition for take-off (c) take-off (d) Drive to maturity (e) Age of high mass consumption. This work is also similar to energy ladder. The energy ladder is a commonly used concept in models of energy choice in developing country. This model contains three rungs that represent three categories of fuels- namely, primitive, transition and advance fuel (Rostow, 1960). The first stage (primitive) is mark by

universal reliance on biomass such as woodfuel. In the second stage bakeries move to charcoal, gas. In the third phase, bakeries switch to LPG, natural gas or electricity.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

The methodology adopted for this research such as research design, sources of data, sampling techniques, data collection techniques, and data analysis and presentation were presented in this chapter.

3.1 Sources of Data

The data were obtained through both primary and secondary sources. The primary sources are the data generated from questionnaire and Global Position System (GPS), while secondary sources data was collected from review of relevant literature such as books, and journals.

3.2 Research Design

The research design adopted is field surveys, where information on the type of energy used, factors influencing the energy choice, cost of alternative energy and consumption pattern of woodfuel among bakeries were derived using questionnaire and GPS was used for taking the coordinate of the bakeries.

3.3 Sampling Techniques

Forty (40) bakeries were identified using snow-balling sampling method. This is because the precise location of the bakeries is unknown. In each bakery identified, the respondent directed the researcher to the next bakery. Questionnaire was administered to the respondent in each bakery.

3.4 Data Collection Techniques

The questionnaire was administered to the identified respondents. The coordinate of each bakeries identified was recoded using Global Position System (GPS) in order to determine the spatial distribution of bakeries in the area.

3.5 Data Analysis and Presentation

The data obtained from the questionnaire was analysed using descriptive statistics of frequency, Percentage (%) and mean while the result was displayed Tabular forms.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.0 **Introduction**

The data collected on the identified bakeries include the demographic characteristics of the respondents, type of energy used, location, factors influencing the energy choices, cost and consumption pattern of woodfuel were analyzed and presented in this chapter.

4.1 Demographic Characteristics of The Respondents

The demographic characteristics of the respondents, are sex, religion, nationality, geo-political regions, level of education were and presented in Table 4.1

Table 4.1 Demographic Characteristics of The Respondents

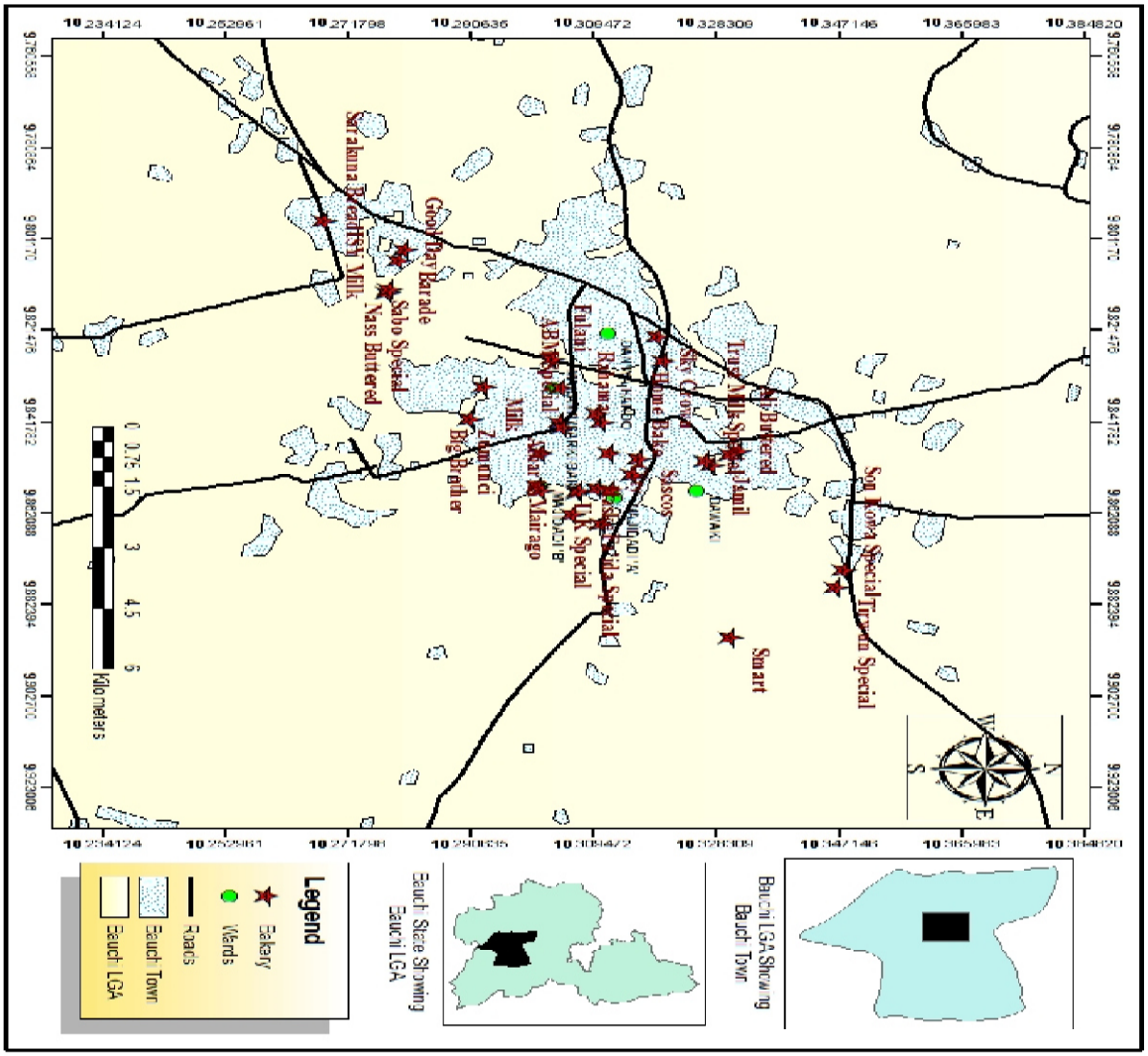
Socio-economic characteristics	Number of Respondent	Percentage (%)
	Gender	
Male	40	100
female	00	00.00
	Religion	
Islam	39	97.5
Christianity	01	02.5
	Nationality	
Nigerian	39	97.5
Non-Nigerian	01	02.5
	Geo-political region	
North-East	39	97.5
Other Part of Nigeria	01	02.5
	Level of education	
Primary	24	60.00
Secondary	05	12.50
Tertiary	04	10.00
Islamic education	07	17.50

Source: Field Survey (2017)

The result revealed those males are the owner of Bauchi metropolis bakeries. From this research also, it is seen that 100% of the respondents are men, this shows that female are not engaged in bakery bread business in Bauchi metropolis. Low patronage of female in business may probably due to either culture or religion of people in Bauchi especially Muslim. In terms of religion, as typical of northern Nigeria, where majority of the population are Muslims, it is also seen here that 97. 50% of the respondents are Muslims, while only 2.2 % are Christians, mostly live in Yalwan-Tudu. From Table 4.1 it is seen that out of the 40 respondents, only one (1) respondent is non-Nigerian and he is living behind Baban-Shadda shop along Kobi Street. This therefore indicates that bakeries in Bauchi are mainly dominated by people of Bauchi. In term of geopolical region, (39) of the respondents are indigenes of the state (Bauchi), while only (01) from other part (Jos). This is no doubt as the work was conducted in Bauchi. Probably visitors are not interested in any place where there is no standard market (Adam, 1995)**.** In term of education, result shows that persons with primary and secondary education represent about 72.50% of the total respondents interviewed. The persons with primary and secondary certificate have knowledge but not enough as those with tertiary education on how to maintain the environment. This argument is also in agreement with a work of Gwandu (1990), which stated that level of education determines the opportunity for better income and the use of alternative energy sources. Also goes inline with the work of Sepp (1999), who noted that any commercial center that have little or no formal education (western education) consume more energy than those with background of formal education. Those with tertiary education represent only 10.00%, while person with Islamic education represent 17.50% respectively.

4.1.2 Spatial Distribution of Bakeries

The distribution of bakeries in Bauchi metropolis identified was mapped out as presented in figure 2.



Source: Authors fieldwork and Department of Geography BUK (2018)

Figure 2: Bauchi Metropolis Showing Locations of Bakeries

Figure 2: shows that, Bauchi metropolis bakeries were located around Railway area while, others are located aroung Kobi, Sabuwar-Kasuwa, wunti, Kofar Idi, Central Market and Babangida square. Best of the spatial distribution of the bakeries presented in (figure2) indicates that north-eastern part of the metropolis have higher concentration of bakeries which may probably be attributed to high population around the area and the area is also closed to the railline station where business activities are dominated.

4.2.1 Types of Energy Sources Used

The types of energy sources used in bakeries activities in Bauchi metropolis were identified as woodfuel and electricity. Woodfuel is the major energy used in bakeries.

Table 4.2 Types of Energy Sources Used

Types of energy	Number of bakeries	Percentage (%)
Woodfuel	38	95.00
Electricity	2	05.00
Total	40	100%

Source: Field Survey (2017)

Table 4.2 indicated that out of forty bakeries, thirty eight (95.00%) used woodfuel while only two (05.00%) used electricity. This implies that woodfuel are the major sources of energy for bakery activities, this is probably attributed the availability and affordability of the woodfuel in the area. This is supported by Sepp (1999) who reported that low patronage of electricity is probably due to high cost and inadequate of electricity.

4.2.2 Factors Influencing Energy Choice for Bakeries production

The factors influencing energy choices were identify as cheap, availability, accessible, better test, less risk, normally used to it, efficient are presented in Table 4.3

Table 4.3 Factors Influencing Energy Choice For Bakeries Production

Factors	Type of energy	
	Woodfuel	Electricity
Cheap	57.50%	00.00%
Availability	17.00%	12.00%
Accessibilty	2.00%	77.50%
Better test	0.00%	08.00%
Normally used to it	19.50%	00.00%
Efficient	4.00%	02.50%
Total	100%	100%

Source: Field Survey (2017)

From Table 4.3 It is seen that 57.50% preferred to use woodfuel as a source of energy for baking because it is cheaper. Average bundle of woodfuel which weigh about 3.30 kg, with 6 pieces cost about ₦55. On other hand, 77.50% bakeries that use electricity as the source of energy for baking of bread prefer it due to their location close to the blue line (accessibility), because they made an agreement with the power staff and were connected to the relatively stable blue line (a 33kv electricity line which is meant for industries in the state), thereby having a near constant power supply. This agrees with the work of Sepp (1999) who noted that cheapness, availability of different energy sources, different energy user's habits, available technology, energy price in relation to the household and commercial mean income, will determine the consumption pattern. From the result, bakeries that use woodfuel preferred it due to its cheapness; the reason is that

Bauchi state span two distinctive vegetation zone: guinea and sudan savannahs where there exist trees, therefore woodfuel is available and cheaper compared with other sources of energy while electric bakeries preferred best on the accessibility with blue line.

4.2.3 Factors Militating Against The Use of Alternative Energy Sources

The factors militating against the use of alternative energy were identify as high cost of energy, unavailability, and low income are presented in Table 4.4

Table 4.4 Factors Militating Against The Use of Alternative Energy Sources

Reasons	Frequency	Percentage (%)
High cost of energy	32	84.22
Unavailability	01	2.63
Low income	05	13.15
Total	38	100%

Source: Field Survey (2017)

From Table 4.4, the result shows that, (84.22%) of the woodfuel bakeries were unable to switch to other source of energy due to its high cost, 13.15% cannot afford the other source of energy due to their low income while, 2.63% due to unavailability and insufficiency. In regard to this result, Paul, (2008) reported that the use of woodfuel has been on the increase due to increase in cost and scarcity of alternative source. Also sepp, (1999) reported that energy price in relation to the household and commercial mean income, will determine the consumption pattern.

4.2.4 Average Cost of Woodfuel (kg) and Electricity Unit (kwh)

The cost of woodfuel and electricity which are the only source of energy used for baking bread in Bauchi metropolis was presented in Table 4.5

Table 4.5 Average Cost of Woodfuel (kg) and Electricity Unit (kwh)

Energy Type	Unit of Measure	Average Cost (₦)
Woodfuel	Bundle (kg)	55.00
Electricity	Unit (kwh)	29.80

Source: Field Survey 2017

Table 4.5 presented that the average cost of a bundle of woodfuel wich weigh about 3.30kg with 6 pieces cost (₦55.00) is much less compared with the average cost of a unit (kwh) of electricity (29.80₦). Based on the result, one bundle of woodfuel is equal to 2 unit (kwh) of electricity interms of price. In regard to this result, Paul, (2008) reported that the use of woodfuel has been on the increase due to increase in cost and scarcity of alternative source. Similarly Adedayo (2005) repotted that the over dependence on woodfuel for energy is cheaper because of its relative low price and ease of accessibility.

4.2.5 Temporal Analysis of Energy

The temporal energy consumption is: hot-wet, hot-dry, cold-dry and cold-wet and were presented in Table 4.6

Table 4.6 Temporal Analysis of Seasons

Temporal Analysis of Seasons	Frequency	Percentage (%)
Hot-wet	17	42.50
Hot-dry	02	05.00
Cold-dry	06	15.00
Cold-wet	15	37.50
Total	40	100.00%

Source: Field Survey (2017)

Table 4.6 based on the data collected from the field, the result shows that, 42.50% energy is consumed during the hot-wet season, followed by cold-wet 37.50, the consumption of bread is higher at theses period due to cold and a lot of woodfuel is needed for production and for heating the oven due to dampness of the environment. While during the hot-dry and cold-dry only 20.00% energy are consumed, the temperature is higher and there is market for bread but not much as during hot-wet and cold-wet seasons. You can see that season is the main factor that determining energy consumption pattern, also within the season there are factors that determining energy consumption changes such as: Market flow of bake, Market day of neighboring village, working of other bakeries,

4.2.6 Factors Responsible for Energy Consumption Changes within the Season

The factors responsible for energy consumption within the season such are: market flow of bake, market day of neiboring village, and working of other bakeries, were presented in Table 4.7

Table 4.7 Factors Responsible for Energy Consumption Changes within the Season

Season for Changing	Number of Bakeries	Percentage (%)
Market flow of bake	10	25.00
Market day of neighboring village	25	62.50
Working of other bakeries	5	12.50
Total	40	100%

Source: Field Survey (2017)

From the Table 4.7 it is shown that within the season, market of neiboring village (62.50%) is the main factor that changes the consumption of bread, the higher the consumption the greater the production. Increase in level of production will lead to more energy consumed (Ronald, 1976).

4.2.7 Determinant Factor Shaping the Woodfuel Cost

Factors that determine woodfuel cost are: season, cost of transportation, location of bakeries are the factor that determine the woodfuel cost and were presented in Table 4.8

Table 4.8 Determinant Factor Shaping the Woodfuel Cost

Determinant Factor of Woodfuel Cost	Frequency	Percentage (%)
Season	36	90.00
Change in transportation cost	2	05.00
Location of the bakeries	1	02.50
Others (specify)	1	02.50
Total	40	100%

Source: Field Survey (2017)

Table 4.8 Respondents views; season (90.00%) is the main determinant factor of woodfuel cost. The reason is because, the roads to the forests are muddy and not motorable therefore, a lot of woodfuel is stored for this period to be used. Ronald, (1976) said that, some times the price of good is determined by how this good is demanded in the society. Added that the higher the demand the greater the price.

4.2.8 Average weight (kg) of Flour Consumed Daily

The weight of flour consumed in bakeries is depend on the level of production starting from 01-300kg are considered as small scale bakeries, 301-900kg are considered as medium scale bakeries while, 901kg and above are considered as big scale bakeries (Umaru 1999), the categories were presented in Table 4.9

Table 4.9 Average Number of Flour weight (kg) Consumed Daily per Bakery in Bauchi Metropolis

Scale (weight/kg) of daily production	Frequency	percentage (%)
01-300	23	57.50
301-900	15	37.50
901-1bove	02	05.00
Total	40	100%

Source: Field Survey (2017)

Table 4.9 presents the bakeries in Bauchi metropolis that used different weights of flour daily. Out of the forty (40) numbers of bakeries visited, 23 of them used 01-300kg of flour daily considered as small scale bakeries, 15 used 301-900kg of flour daily considered as medium scale bakeries, while 05 used 901-above kg daily which considered as big scale industries. This shows that about 57.50% of the bakeries in Bauchi metropolis are engage in small scale production. Other bakeries in the area which used 301-900kg daily have 37.50% considered as medium scale bakeries while, the least (05%) are only bakeries that used 901-above kg of flour daily. Therefore the result from the discussion presented revealed that daily production in Bauchi metropolis is less compared with the production in the neighboring state (Jos) metropolis which big scale bakeries dominated the production capacity (Umaru 1999).

4.2.9 Differences Between Average Quantity of Woodfuel and Electricity Consumed for Baking 50kg of Flour

The differences between the bundle of woodfuel which weigh 3.3kg, with six (6) pieces and unit (kwh) of electricity for baking a 50kg of flour were evaluated and presented in Table 4.10

Table 4.10 Differences Between Average Quantity of Woodfuel and Electricity Consumed for Baking 50kg of Flour

Energy	Type	price (₦)	Average Quantity	Total(₦)
Woodfuel	Bundle (kg)	55	05	275.00
Electricity	unit (kwh)	29.8	15	447.00

Source: Field Survey (2017)

Table 4.10 presented that five (5) bundle of woodfuel is needed to bake 50kg of flour while, 15 unit(kwh) of electricity is needed to bake one bag of flour. From all indications, woodfuel is cheapest compared with other energy source in Bauchi metropolis. As cited by Adetunji *et al.,* (2007) opined that energy option of any country is influyenced by national economic condition, individual level of income, tecnological advancement, the state of energy infrastructure as well as the rate of population growth. The Nigerian energy sector is not well developed based on the fact that despite abundance various energy sources in the country, majority of the people have yet to have access to affordable and reliable energy (Iwayemi, 2008).

4.2.10 Average Cost of nergy Used For Baking

The average cost of energy (woodfuel and electricity) Were presented in Table 4.10

Table 4.11 Average Cost of Energy Used For Baking

Frequency	Woodfuel ₦	Electricity ₦
Daily	1650	2682
Weekly	11550	18774
Monthly	346500	563220
Yearly	4158000	6758640

Source: Author's Field Survey March (2017)

Table 4.10 revealed that the cost of electricity use for baking is found to be higher than woodfuel, this is probably the reason most of the respondents prepared to use woodfuel because of its less price and availability compared to other energy source. Horgan, (2001) reported that for many users, the choice depend on the availability and affordability. Similarly, with the level of poverty in the country bakeries owner's cannot afford to procure these equipments which are expensive, especially now with economic realities compelling the Nigerian government to remove subsidies on energy products, thereby commercializing the energy industry. Obueh, (2007) reported that the deregulation policy of Nigerian government on energy products has affected availability, use and consumption pattern of it. The cost of energy escalated and made them out of reach of most bakeries owner in the country. Therefore, this has made most owners of bakeries to make use of the cheapest sources of energy which are woodfuel and charcoal (Umaru 1999).

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY OF FINDINGS

Woodfuel and electricity are the only energy used in bakeries of metropolis. The low cost of woodfuel is the major factor influencing the choose of the woodfuel as major energy source and the high cost of other alternative energy is the main factor militating against the use of alternative energy. Meaning that, Five (5) bundle of woodfuel wich cost two hundred and seventy five naira (₦275) can bake fifty (50kg) of flour while fifteen (15) unit (kwh) of electricity wich cost four hundred and forty seven naira (₦447) can bake 50kg of flour. Hot-wet and cold-wet are period with highly demand of bakeries product which required more woodfuel for the activitiest in the area and for heating the oven due to the dampness of the environment. Withing the season, Market day of neiboring village account for sixty two percent (62%) consumption of bread. It was discovered that the small scale bakeries dominated (57.50%) among the metropolis bakeries. Finally, best on the map provided, railway area have higher concentration of bakeries.

5.2 CONCLUSION

The bakeries in Bauchi metropolis are sparsely distibuted in the area and depend wholy on woodfuel for energy due to its cheapness and availabilty and high cost of other alternative is the factor militating against the use of other energy around the area. The consumption pattern of woodfuel is seasonal because of the demand of the bakeries products depend also on the season of the year. It was concluded that the small scale bakeries dominated (57.50%) among the metropolis bakeries.

5.3 RECOMMENDATIONS

Based on the findings, the following recommendations were suggested in the area.

1- Government should provide a bar land for bakers to plant trees before they finish cutting one side another side has grown. This will maintain the ecology of the environment.

2- Government should also subsidies the electricity price for bakeries to reduce over dependency on woodfuel.

3- Government and stakeholders should provide modern facilities in affordable price or loan through corporative to harness other alternative energy such as solar energy in order to reduce the over dependency on woodfuel which reduces the quality of environment.

4- The stakeholders should establish or construct more bakeries particularly around Wunti, Central market, new and old GRA and Babangida square because of the availability of electricity in the area, therefore, electricity can be used to reduce the pressure on woodfuel as a source of energy to bakeries located around the area.

5- Where falling of trees is necessary use of axe should be adopted because it enables the pad lopped to regenerate naturally but machine should be avoided because pad lopped die completely.

6- Policy should be enacted on the use of environmental friendly oven design (with chimney) and compliance should be monitored by the government. Therefore, the chimney will reduced the carbon emission to atmosphere and the carbon be used as a raw-materials for carbon paper and ink.

7- Public awareness should be given to bakers about the implication of massive deforestation and the emission of carbon in to the atmosphere.

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APPENDIX

Department of Geography,
Faculty of Earth and
Environmental Sciences,
Bayero University, Kano.

Dear Respondent,

QUESTIONNAIRE ON CONSUMPTION OF WOODFUEL IN BAKEREIES IN BAUCHI METROPOLIS

I am an M.Sc. student of the Department of Geography, Faculty of Earth and Environmental Sciences, Bayero University Kano. I am carrying out a research on Consumption of Woodfuel in Bakeries in Bauchi Metropolis. I would be grateful if you provide answer to the questions below. The information provided would be used strictly for academic purpose only.

Please fill in or tick where appropriate.

A BIO-DATA SECTION

(1) Name of Bakery _____

(2) The co-ordinate of the bakery_____

(3) Location of bakery (ward) _____

(4) Bakery type (a) Local building { } (b) Modern building { }

(5) Name of Respondent_____

(6) Post of Respondent_____

(7) Level of education of the respondent (a) Primary { } (b) Secondary { } (c) Tertiary { } (d) local Islamic Education { } (e) None { } (f) Others { } specify_____

(8) Sex (a) Male { } (b) Female { }

(9) Religion (a) Islam { } (b) Christianity { } (c) Others specify_____

(10) Geo-Political Region (for Nigerian only) (a) North-West{ } (b) North-East{ } (c) North-Central{ } (d) South-East{ } (e) South-West{ } (f) South-south{ }

(11) Nationality (a) Nigerian { } (b) Non-Nigerian { }

BAKERY ENERGY CONSUMPTION PATTERN

(1) What type(s) of energy do you use currently in your Bakery? (a) Woodfuel { } (b) Electricity { } (c) Gas { } (d) Others (specify) _____

(2)Where do you mostly buy it from_____?

(3) Is it your preferred choice?

(a) Yes { } (b) No { }

(4) If yes, what is the advantage derived from its selection? (a) It is csheaper { } (b) Its commonly available { } (c) It is efficient { } (d) Safety { } (e) Give a better taste of bread { } (f) is closer { } (g) Less risk { } (h) Normally used to it than other sources { } (i) others (specify) _____

(5) If NO, what is your preferred choice? (a) Woodfuel { } (b) Electricity { } (c) Gas { }

(6) What is constraining you from using the preferred choice?

(a)Start-up cost { } (b) High cost of energy { } (c) unavailability { } (d) Level of production { } (e) Low income { } (f) Others Specify_____

(7) Do you encounter any problem using this type of energy (presently used)?

(a) Yes { } (b) No { }

(8) If Yes, what is (are) the problem(s)? _____

(9) Is the rate of energy consumption changing?

(a) Yes { } (b) N0 { }

(10) If yes, what is the reason for the change?

(a) Market flow of bake { } (b) Market day of neighboring village { }

`(c) Working of other bakeries { } (d) others (specify) _____

(11) If no, why is it stable? _____

(12) If you use woodfuel for baking, what size of woodfuel bundle do you normally use? (a)Small { } (b) Medium { } (c) Big { } (d) others { } specify_____

(13) What is the average weight of a bundle of woodfuel? _____

(14) What is the average cost (N) of woodfuel bundle? _____

(15) How many bundles(s) of woodfuel do you consume?

Daily _____ weekly_____

Monthly_____ yearly_____

(16) How many average bundle(s) of woodfuel is needed to bake a bag of flour? _____

(17) What is the determinant factor of woodfuel cost?

(a) Nature of woodfuel (specify) _____

(b) Season { } (c) Change in transportation cost { } (d) Location of the bakery { }

(e) Others (specify) _____

(18) If you use other form of energy that is non-woodfuel, please give an estimated quantity of energy consumed

Daily _____ weekly_____

Monthly_____ Yearly_____

(19) How many bags of flour do you consume?

Daily _____ Weekly_____

Monthly_____ Yearly_____

(20) How is the waste (ashes) generated from woodfuel burning disposed? _____

(21) How is the smoke generated from woodfuel managed? _____

(22) What is your advice on how to reduce the amount of energy consumed at bakery? _____

(23) What is your advice to government and the general public on how to ensure a cleaner source of baking energy for all bakeries? _____

Table 5.1 Co-Odinates of Identified Bakeries For This Work

Name Of Bakery	latitude	longitude
Haske bread	$10^0$18’56.1”N	$9^0$51’13.2”E
Dan-Bauchi Special Bread	$10^0$18’17.1”N	$9^0$50’03.9”E
Sarakuna Bread	$10^0$16’05.7”N	$9^0$47’50.0”E
Rahama Bread	$10^0$18’39.1”N	$9^0$50’31.6”E
Sabo Special Bread	$10^0$16’41.4”N	$9^0$48’44.8”E
Milk Bread	$10^0$17’34.2”N	$9^0$50’003”E
Jamil Bread	$10^0$19’39.6”N	$9^0$51’05.6”E
Shukura Bread	$10^0$18’56.1”N	$9^0$51’13.2”E
Dadin-kowa Bread	$10^0$18’44.5”N	$9^0$51’25.6”E
Big Brother Bread	$10^0$17’26.0”N	$9^0$50’28.6”E
Shawwal Special Bread	$10^0$19’50.2”N	$9^0$50’57.1”E
Trust Milk Special Bread	$10^0$19’36.5”N	$9^0$51’02.1”E
Rahama Special Bread	$10^0$18’36.5”N	$9^0$51’24.6”E
Ali Buttered	$10^0$19’54.6”N	$9^0$50’54.6”E
City Bread	$10^0$18’43.2”N	$9^0$50’56.6”E
Fa’ida Special Bread	$10^0$18’38.8”N	$9^0$51’52.5”E
Al’ansri	$10^0$18’05.2”N	$9^0$50’56.3”E
ABM Special Bread	$10^0$18’16.1”N	$9^0$50’31.6”E
Hamdala Ramat	$10^0$18’22.7”N	$9^0$51’44.8”E
Nass Buttered	$10^0$16’41.0”N	$9^0$48’48.0”E
U.K Special Bread	$10^0$18’26.0”N	$9^0$51’26.5”E
Home Bake	$10^0$19’12.9”N	$9^0$49’42.4”E
Good Day	$10^0$16’49.8”N	$9^0$48’13.4”E
Maizakara	$10^0$18’05.2”N	$9^0$50’56.3”E
Fulani	$10^0$18’11.8”N	$9^0$49’41.0”E
Walima Special Bread	$10^0$18’36.5”N	$9^0$50’24.6”E
Oxford Sweet Special Bread	$10^0$19’50.2”N	$9^0$50’57.1”E
Smart	$10^0$19’50.2”N	$9^0$53’23.7”E
Mairago	$10^0$18’04.1”N	$9^0$51’23.2”E
Manna Buttered	$10^0$18’56.1”N	$9^0$51’13.2”E
Albarka	$10^0$18’17.8”N	$9^0$50’35.7”E
Alfijir Special Bread	$10^0$18’26.3”N	$9^0$51’27.6”E
U.S and A.B	$10^0$18’05.2”N	$9^0$51’26.5”E
Zumunci	$10^0$17’26.0”N	$9^0$50’28.6”E
ISY Milk	$10^0$16’05.7”N	$9^0$47’50.0”E
Sky Crown	$10^0$19’09.9”N	$9^0$49’23.1”E
Barade	$10^0$16’46.3”N	$9^0$48’21.8”E
Sascos	$10^0$18’59.8”N	$9^0$51’00.6”E
Tirwun Special Bread	$10^0$20’48.6”N	$9^0$52’43.0”E
Son Kowa Special Bread	$10^0$20’52.4”N	$9^0$52’30.0”E

Source: Field Survey (2017)