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Biomass Consumption in Nigeria: Trends and Policy Issues

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Abstract: The purpose of this paper is to analyse the demand for and policy implications of consumption of biomass energy in Nigeria. Analysing the demand for biomass energy is important if these sources of energy are to be used efficiently and on a sustainable basis. The result shows that the biomass energy surpasses all other forms of energy in Nigeria during the last four decades despite Nigeria being a major producer of commercial energy globally. The study reveals that biomass played an important role as a source of energy in all the six geopolitical the regions as well as both rural and urban households and this would likely to remain so in the near future. Although the importance of biomass was declining in relative terms, in absolute terms its use appears to be increasing; suggesting there is high level of energy poverty in Nigeria. Factors identified as responsible for such phenomenon include poverty, inaccessibility to alternative energy sources and cultural factors. A correlation analysis conducted shows a highly positive relationship between biomass consumption and poverty levels as well as highly negative correlations between incomes and biomass consumption in all the six geopolitical regions in Nigeria. There is also regional bias in the consumption of biomass. A major conclusion drawn from the study is that due to health, environmental and socioeconomic consequences of biomass energy consumption, there is a need for deliberate policies to enhance efficiency and sustainability of biomass energy in Nigeria and make clean commercial energy more accessible and relatively cheaper.

Keywords: Biomass Consumption Health and Environment Nigeria

1.0 Introduction

Most studies of energy in Nigeria focus on Nigeria's position as a major world producer and exporter of crude oil and, increasingly, natural gas (in the form of LNG). To the extent that internal developments are discussed and analysed, the emphasis tends to be on supply – including supply disruptions, thefts and smuggling - and/or on the macroeconomic effects of oil revenues in a large and populous, resource dependent, middle-income country. However, there are some few studies on the use of commercial energy. By contrast, this paper is mainly concerned with the use of biomass energy within Nigeria itself.

A focus on the domestic use of biomass energy is justified, in part, because Nigeria is a large user of energy, and its use has been expanding rapidly. Thus the total use of energy (all sources, including traditional biomass) was more than 1080 thousand tons of oil equivalent (Ktoe) in 2011, and, reflecting population growth and urbanisation, it has been expanding rapidly – the use of energy has more than tripled since 1971 (an annual average rate of growth of 6% per annum). These figures refer to total consumption. The consumption of oil (and oil products including natural gas) is much lower – about 120Ktoe.

On a per capital basis, the picture is very different. Per capita consumption of energy is about 0.6 metric tonnes oil equivalent per year. Consumption of oil and oil products is about 0.07 toe per year. One of the striking 'stylised facts' about Nigeria is that per capita consumption of energy is relatively low and its per capita consumption of 'modern' commercial fuels (including electricity) is very low indeed, given that Nigeria is relatively industrialised and a major oil producer. The explanation is that traditional

bio fuels (bio mass) make up about 87% of energy use (2011 estimate). What is more, the proportion accounted for by bio mass has been roughly stable over the past 20 years (and rising over the last decade).

This immediately suggests a classification of issues. The first is about bio-fuel use. What accounts for the continuing dependence on bio fuels in Nigeria, and is this trend likely to continue? The second section tries to explain what are environment, health and socioeconomic implications for the continuous dominance of biofuels in the Nigeria's primary energy mix and finally, what are the issues raised for energy policy and planning for development? Sections 3 and 4 consider these two, very different, sets of issues, in turn. Finally section 5 makes concluding remarks.

In broad terms, the expansion of bio-fuels is due to population growth and the fact that firewood and charcoal are cheap relative to alternatives, such as bottled gas or kerosene or electricity. But it is not just a matter of price: the supply of alternatives is highly constrained as well as patchy and unreliable. This is especially true of electricity which is subject to frequent outages. What this means is that the normal progression, as development occurs, from the use of traditional bio mass for cooking to alternatives such as Kerosene, LPG and electricity (sometimes called the 'energy ladder') does not really operate in Nigeria. And it is more or less impossible to determine whether the root causes lie on the demand side, or on the supply side – i.e. in the lack of alternatives. What is clear is that 'fuel poverty' in the sense of lack of access to modern fuels for cooking, heating and lighting, is endemic - despite Nigeria's vast resources of oil and gas.

There are other features of the biomass sector in Nigeria, which add to its complexity. The first is that there is a strong regional dimension. The proportion of biomass used is

generally higher in the North than the South - which, not surprisingly, correlates with relative incomes. Second, the use of biomass is not, by any means, confined to rural areas. Firewood and charcoal are extensively used for cooking in urban areas as well. Third, though most biomass is used in the residential sector, a surprisingly high proportion is used in small scale industry. The lack of reliable alternatives is likely to be an important part of the explanation for the continued use of the traditional fuels in small scale industry.

An important question is whether Nigeria's heavy dependence on biomass 'matters'. There are several reasons for concern. The first is essentially about local pollution and health. As discussed in the next section, the health costs stemming from the use of biomass in the home for cooking are generally thought to be large (especially for women and children). Thus there would be substantial benefits from switching to cleaner and more efficient fuels. Second, though firewood is often 'free' there are opportunity costs to take into account. Especially as forest resources get depleted, as is happening in many areas, the distances travelled and the time taken to collect firewood get larger. (Again, it is mainly women and children who are affected). This relates to another issue – the sustainability of forest resources. Whilst firewood and other kinds of biomass are, in essence, a low carbon (renewable) source of energy, this is only true if the stocks (e.g. of forest cover) are sustainable. As further discussed below, the issues of pollution, efficiency and sustainability interact in complex ways. Arguably, however, the policy issues are relatively straightforward (which is not to argue that their implementation would be easy).

The discussion of the various issues surrounding the demand and supply of biomass energy in Nigeria throws up a number of very important policy issues and indicates areas where policy could be improved. Because the problems interact (especially due to

the huge deficit in infrastructure) it is easy to call for a holistic approach, or at least a coherent set of plans, or a 'road map'.

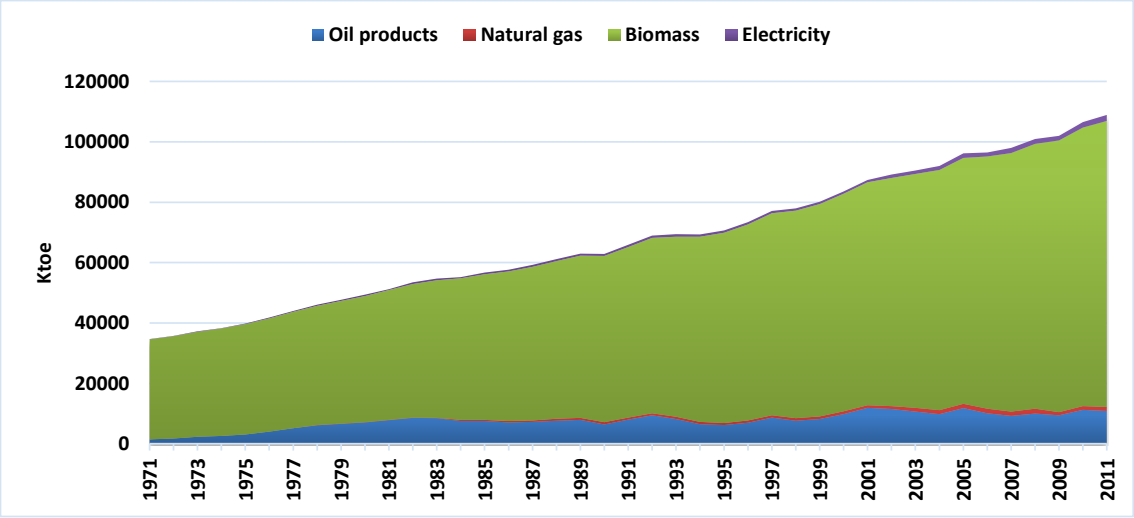
2.0: Analysis of trends and pattern of Traditional Biomass Consumption

The dynamics of energy consumption in Nigeria during the last four decades shows a sort of paradox of poverty in the mist of plenty; Nigeria being a major exporter of hydrocarbon continues to rely heavily on traditional biomass for its energy needs. Over the years, the use of biomass has been a source of many problems; ranging from environmental degradation, through deforestation and land erosion, to health hazards as well as socioeconomic problems for children and their mothers. The predominance of biomass in energy consumption mix can be attributed to some factors, including economic factors such as poverty and inaccessibility and high cost of modern fuel as well as socio-cultural factors, culture of individuals and the population size. Notwithstanding those challenges; biomass, both solid and biofuels have a great potentials for the Nigerian economy. Presumably, if the fuels are sustainably and efficiently used, then it has great potentials as a source of clean energy for household, electricity generation, transportation and small scale industries. Therefore, its wide range of uses that provides potential of a win-win development path for the environment, socioeconomic development and energy security in Nigeria. Bioenergy must be viewed not as the single replacement for oil, but as one element in a wider portfolio of renewable sources of energy.

Biomass production as a means of rural empowerment through employment and incomes for the rural population and to some extent, as a complement to hydrocarbons in exports and foreign exchange earnings are incontestable. The major challenge is policy failure and lack of political will from the government; there are so many African

countries that pursued some policies and programs to promote domestic use of biofuels and attracted millions of foreign direct investments from Europe, America and pacific for production of biofuels. This section will analyse those factors and their implication as well as policy options for Nigeria.

Figure 1: Share of Energy Consumption by Fuels

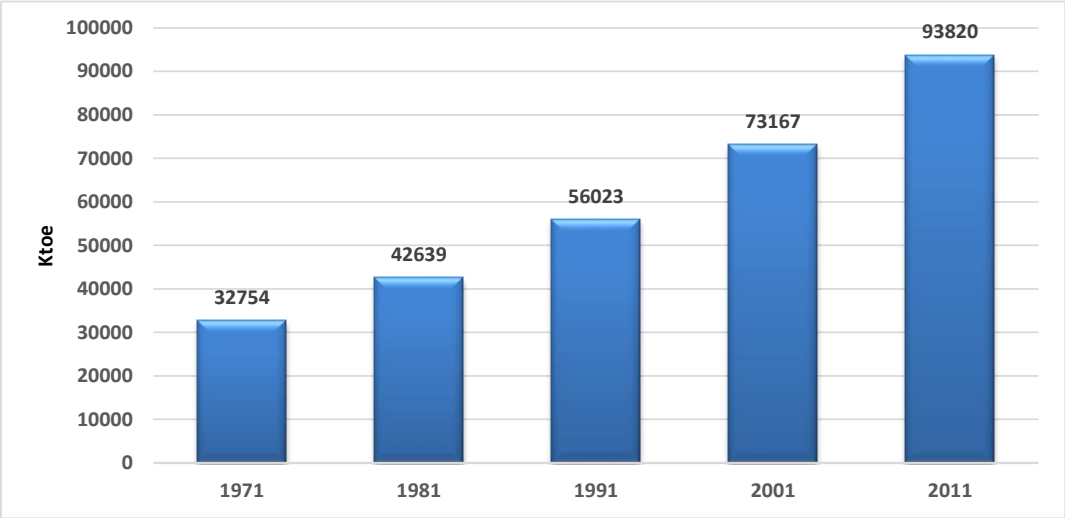


Source: Energy Balances of non-OECD countries, IEA, 2013

Biomass remains the most dominant energy for both household sector and small scale rural industries and commercial outlets in Nigeria; over the years its use continues to increase. In Nigeria, about 95 percentage share of biomass in energy mix represents its use to meet off-grid heating, cooking needs and cottage industrial needs; such as for processing cassava, oil seeds, local bakeries, blacksmiths, brewing and other activities that are closely related to household and small scale commercial activities such as restaurants in both rural and urban areas. Similarly, some households in the urban areas have also long been dependent on biomass from rural areas for some part of their domestic fuel needs.

Biomass resources available in the country include fuelwood, charcoal, agricultural waste and crop residue, sawdust and wood shavings, animal dung/poultry droppings, industrial effluents/municipal solid waste. However, fuelwood and charcoal constitute the bulk of the biomass energy consumption; particularly in residential sector. Virtually, all the six regions of Nigeria use biomass; particularly for household activities, however, there is a great divergence between the magnitude and patterns of biomass use among various regions of the country.

Figure 2: Trends in Biomass Consumption in Thousands Metric Tons

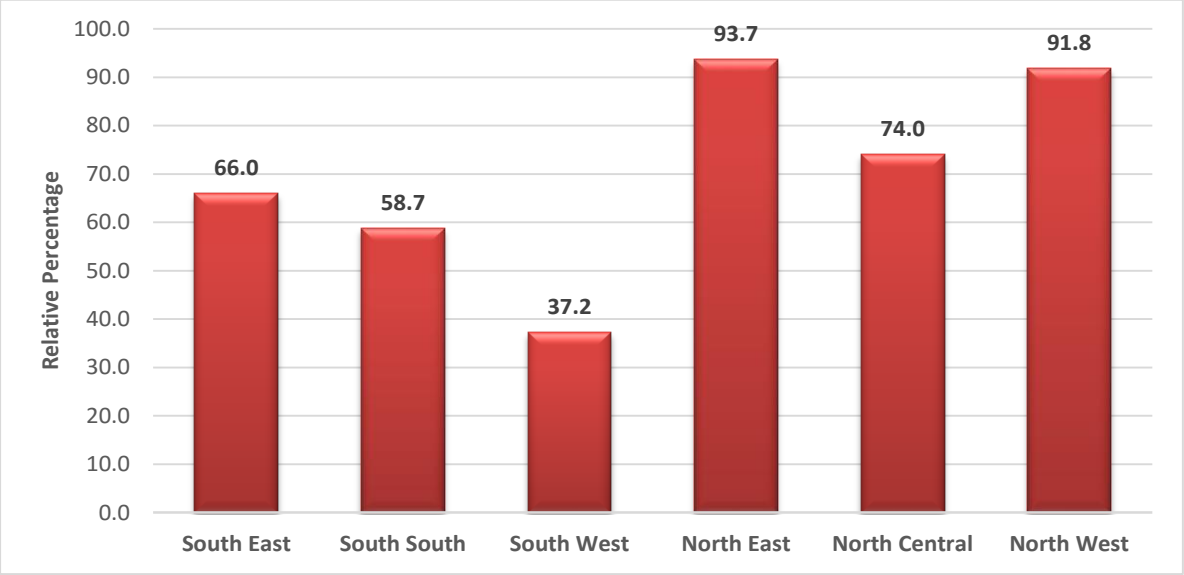


Source: Energy Balances of non-OECD countries, IEA, 2013

From Figure 2, the biomass consumption in Nigeria has been increasing unprecedentedly; it increased by about 300% from 32754ktoe in 1971 to 93820ktoe in 2011. One question that may be asked about the trend and proportion of traditional biomass in the Nigeria's energy mix is that, whether Nigeria is descending from energy ladder or climbing to the top of it. Today, as this trends shows, more Nigerians are either stagnating or descending down the energy ladder, despite the acclaimed robust growth in incomes by the successive governments. Interestingly, empirical evidence

from other developing countries including some African countries, such as South Africa suggest that with increasing income people generally move up towards the top of the energy ladder from firewood to charcoal or kerosene and then to liquefied petroleum gas (LPG), natural gas, or electricity for cooking (Alam and others 1975; Barnes & Qian 1992; Leach 1986, 1988; Jones 1988; Reddy &Reddy 1983; Natarajan 1985).

Figure 3: Percentage of Households Dependent on Firewood for Cooking by Regions in Nigeria



Source: Annual Abstract of Statistics, 2011, National Bureau of Statistics

One interesting aspect of biomass use in Nigeria is its regional dimension; from Figure 3, it is clear that the consumption of biomass in the North and South is uneven. From the Figure, in Northern Nigeria, household's reliance on biomass ranges from 74% in the North Central to 92% and 94%, respectively in North East and North West. Ironically, the Northern States is the most wood deficient in the country where deforestation and desertification are most prevalent and threatening the lives of the inhabitants in the area, but they have the highest percentage of biomass usage than any

other region. As a result of wood deficit, sometime the North has to rely on the Southern Nigeria for supply of charcoal.

Contrary, South West is more cosmopolitan and it has the lowest rate of biomass usage in the country. Although there is relatively moderate rate of biomass usage in South East and Southern South when compared with the South West, the prevalence is not as high as the case of Northern Nigeria. It is important to note that in all the six geopolitical regions, firewood is not only a source of energy for rural areas, it is also energy of choice for some urban households; therefore, it is not unusual in a typical house in cities you find two kitchens; one in the main building with gas or electric cooking facilities and a small one at the backyard that uses firewood and cooking is mostly done using three-stone or simple traditional stoves(both are neither healthy, efficient nor environment friendly).

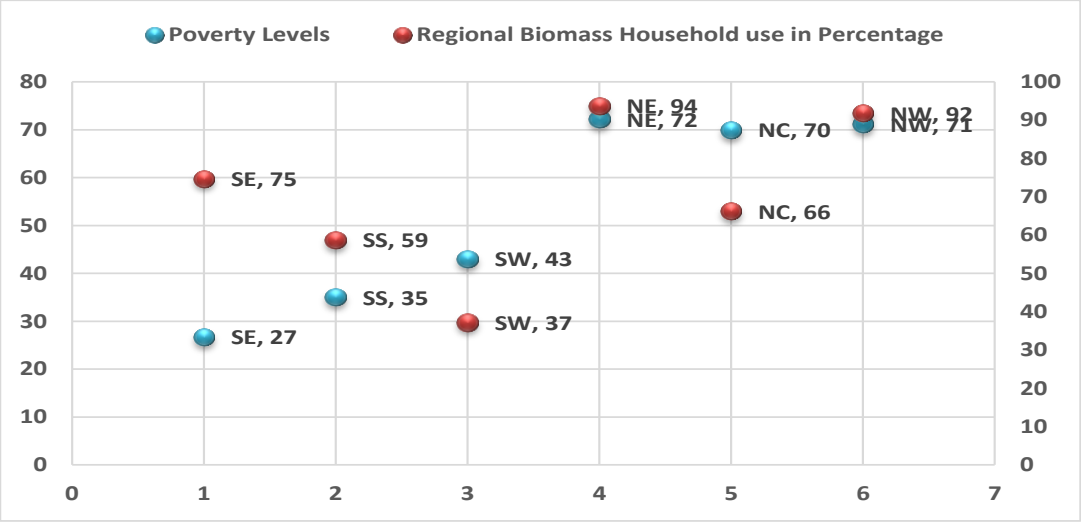
3.0 Drivers of Biomass Use in Nigeria

3.1. Poverty

Population is certainly the primary reason for the increase in energy needs. However, use of biomass for cooking and heating activities in Nigeria is also influence by economic factors, particularly, poverty levels. Per capita income levels and increasing use of modern fuels are unequivocally correlated. Empirical evidence shows that when a country's per capita income is less than $300 (in US dollars), typically 90% or more of the population uses fuelwood and dung for cooking, however, once incomes have exceeded $1000 per capita, most people switch to modern fuels, and substitution is nearly complete. According to World Bank report on poverty in 2012, over 70% of Nigerians are living below $2.0 per day (below internationally accepted minimum poverty line). Practically, they may not afford to switch from using traditional biomass

to modern commercial energies. In fact, it has been suggested that the extensive use of biomass in traditional and inefficient ways and the limited availability of modern fuels are manifestations of poverty. Based on the figure, we can classify Northern Nigeria as both energy and income poor in relation to South West and Southern-South. On the other hand, Southern Nigeria is relatively, energy poor but in terms of income they are relatively rich. The high use of biomass in that area is likely to be the problem of easy accessibility to modern energy.

Fig 4: Relationships between Biomass and Poverty Levels by Regions (in percentages)



Source: Annual Abstract of Statistics, 2011, National Bureau of Statistics, Nigeria

3.2. Availability and Cost

Additional economic factors responsible for the dominance of the consumption of biomass in rural and poor urban households in Nigeria are because alternative energy sources are scarce and sometimes inaccessible to rural population. For the poor urban and peri-urban modern energy tend to be far too expensive and often unreliable. The rising cost and unreliability of kerosene (and perhaps gas and electricity) had increased

the demand for wood as the main source of household cooking fuel. Moreover, commercial energy like electricity and LPG requires initial capital stock such as kerosene stove and electric and gas fired cookers which are very expensive and sometimes, the supply of their fuels are not reliable. Similarly, Nigeria, though with huge natural gas resources, lacks a well-developed infrastructure for natural gas even in big cities like Abuja, Lagos or Port Harcourt.

Past efforts of the Nigerian government to reduce firewood consumption have so far been unsuccessful due to both repeated shortages of cooking gas and kerosene and their relatively high price. Similarly, rural electrification program and the proposed gas-pipeline master plan are not forthcoming. In rural areas, fuelwood is a "free" good; households collect bushwood and dead branches of trees from neighbouring commons and, although they may have to go ever further afield as nearby wood is used up, the distance is rarely so great that they prefer to pay someone for it. Most people in rural Nigeria are aware of the negative environmental effects of felling trees and are willing to adopt fuelwood substitutes. However, household choices of fuel were affected mainly by affordability and availability. One case was the period of December 1993 to January 1994 when the supply of kerosene was grossly inadequate in Northern Nigeria. Households resorted to buying diesel oil (which was readily available by then), which was treated crudely and used in place of kerosene as cooking fuel.

3.3. Cultural Factors

Although it appeared that economic and demographic factors (such as poverty and population) and availability of biomass are major factors in determining its popularity. However, apart from those, other factors also matter for fuel choice; in some areas, uptake of modern fuels such as LPG often goes hand-in-hand with continued wood usage. In this case subsidies on modern fuels like LPG to discourage biomass use may

not necessarily induce households to abandon wood fuel to bring about the intended results. The fundamental reason why some households stick on traditional fuels is due to cultural factors, such as perception and the sizes of households. Traditional cooking techniques and taste preferences might make people prefer wood fuel, even in situations where wood fuel is as expensive as the available alternatives. Many Hausa-Fulani household in Northern Nigeria always prefer to use wood sometimes with clay pots in traditional three stone fire-wood cooking stoves in cooking, believing the food would be testier than the one cooked with aluminium pots in a kerosene stoves, which they believe have some unpleasant odour.

In a typical nomadic Fulani household, milk is always boiled in clay pot and cattle dung, which they perceived to be testier with nice aroma. To some extent, some husbands' loath eating food that was cooked by kerosene stoves, therefore, their wives always ensure that the meal is always cooked using fire wood. The people avoid buying kerosene if possible; they want firewood. *Any food cooked on kerosene does not taste as good as if it is cooked on firewood*. The *tuwo (or nyiri)* tastes much better when it is cooked on wood, and in some villages, old men will not eat food cooked on kerosene. In some cases, it is a traditional *Hausa-Fulani* custom for women to cook very large quantities of food every day, so that it can be shared with extended families, neighbours or those in need, at a moment's notice; particularly during festivities such as naming or wedding ceremonies where people normally gather in hundreds in one house to eat *nyiri surga*. Therefore, such substantial portions of *tuwo or nyiri* food, can only be cooked in large pots on wood fires. Even in other regions like Western or Eastern regions, it has always been a common practice for people to gather in one household to eat together; particularly evening meals, sometimes it is done rotational from one house to another to foster communal relationships and some important issues affecting the community could be addressed.

Table 1: Correlation between Fuels, Poverty and Incomes Levels in Regions

Regions	corr. Btw biomass and poverty	sig	corr. Btw income and biomass	sig	corr. Btw kerosene and income	Sig	corr. Btw kerosene and poverty	Sig
NE	0.834	0.00	-0.945	0.00	0.913	0.00	-0.795	0.00
NW	0.733	0.00	-0.811	0.00	0.762	0.00	-0.912	0.00
NC	0.944	0.00	-0.735	0.00	0.817	0.00	-0.791	0.00
SE	0.673	0.00	-0.717	0.00	0.809	0.00	-0.568	0.00
SW	0.768	0.00	-0.691	0.00	0.711	0.00	-0.893	0.00
SS	0.901	0.00	-0.806	0.00	0.732	0.00	-0.661	0.00

Source: Annual Abstract of Statistics, 2011, National Bureau of Statistics Computed by the authors using IBM SPSS 22

From Table 1, the correlation result shows that there is strong positive correlation between poverty and biomass consumption in all regions, since the p-value (0.00) < alpha (0.05) which implies that the correlation coefficients are significant at 0.05 level of significance. The result suggests a strong degree of relationship between biomass and poverty in all regions, as poverty increases the use of biomass also increases. Also the correlation between income and biomass shows that there is an inverse correlation between incomes. Since the p-value (0.00) < alpha (0.05) which implies that the correlation coefficients are significant at 0.05 level of significance and explains that as income increases the use of biomass decreases and vice versa in all the zones. Then the correlation between income and kerosene reveals that there is strong correlation between income and kerosene, since the p-value (0.00) < alpha (0.05) which implies that the correlation coefficients are significant at 0.05 level of significance. Which further

explains that as income increases the use of kerosene also increases in all the zones. The correlation between poverty and kerosene shows that there is an inverse correlation between poverty and kerosene, Since the p-value (0.00) < alpha (0.05) which implies that the correlation coefficients are significant at 0.05 level of significance, which explains that as poverty increases the use of kerosene decreases and vice versa in all the six geo-political zones of Nigeria.

Table 2: Independent Sample Test

Zone	Types of fuel	N	Mean	Std Deviation	t	Sig
NE	biomass	6	93.7000	3.36333	48.286	0.000
	kerosene	6	3.9833	2.99093		
NC	biomass	6	91.7714	3.91012	38.479	0.000
	kerosene	6	5.8000	4.43321		
NW	biomass	6	77.2167	11.25458	9.961	0.000
	kerosene	6	18.2833	9.13004		
SE	biomass	6	37.2167	18.91575	1.623	0.136
	kerosene	6	54.4833	17.93560		
SS	biomass	6	74.7200	12.94399	6.434	0.000
	kerosene	6	23.0600	12.44239		
SW	biomass	6	58.7333	14.32601	2.557	0.029
	kerosene	6	37.8333	13.98695		

Source: Annual Abstract of Statistics, 2011, National Bureau of Statistics Computed by the authors using IBM SPSS 22

The results in Table 2 reveals that there exists a significant difference in the use of biomass and kerosene in North East, North West, North Central, South East and South

South of Nigeria. Since the p-value (0.00) < alpha value (0.05) for the NE, NW, NC and SS while SW has a p-value (0.029) < (0.05). which implies that there is more consumption of biomass than kerosene as it is seen in the table above for the mean of biomass (93.70)and kerosene (3.9833) for NE, mean of biomass(91.77) and kerosene(5.80) for NW, mean of biomass(77.22) and kerosene(18.23) for NC, mean of biomass(58.73) and kerosene(37.83) for SW and mean of biomass(74.72) and kerosene for SS. While in the SE there exist no statistical significant difference in the use of biomass and kerosene, since the p-value (0.136) > alpha (0.05) as it is also observed in the mean values of biomass (37.22) and kerosene (54.48). this implies that that the NE, NW, NC, SW and SS biomass is more consumed than kerosene statistically while in the SS biomass and kerosene are consumed equally statistically at 0.05 level of significance.

4.0 Environmental, Health and Socioeconomic Effects of Biomass Consuption

The most difficult challenge facing Nigeria today on the dominance and accelerated use of biomass energy can be seen from two major angles, first the widespread inefficient and unsustainable production and use of traditional energy sources, such as fuelwood pose economic, environmental, and health threats to both rural and urban population. The second is the inadequate and highly expensive and uneven distribution and use of modern energy sources, such as kerosene, liquefied or compressed natural gas and electricity pose important issues of economics, equity, and quality of life and makes the smooth transition from biomass to commercial energy almost next to impossible in Nigeria. This situation can have serious environmental and socioeconomic consequences that may require deliberate market based and other policies to ameliorate the problems.

4.1. Environmental Consequences of Biomass

From the quality of the environment, the link between biomass use and quality of environment can be discussed from two perspectives; first, inefficient and unsustainable biomass consumption can indirectly be an underlying cause of deforestation and soil erosion. In areas which have been deforested, fuelwood is thought to have become increasingly scarce. Therefore, unsustainable and indiscriminate harvesting of woods as well as inefficient cooking practices can have serious implications for the environment, such as land degradation, local and regional air pollution. Unsustainable production of charcoal in response to urban demand, particularly in sub-Saharan Africa places a strain on biomass resources. Charcoal production is often inefficient and can lead to localised deforestation and land degradation around urban centres.

In semi-arid areas of Northern Nigeria such as Yobe , Borno, Katsina and Kebbi states, the scarcity of fuelwood leads to deterioration in the quality, and in the type of domestic energy used and an increase in deforestation because more trees have to be felled more than they are replaced to meet greater fuels needs. However, the rate of regeneration of the forest is very slow; this often creates wood fuel gap because wood is being harvested faster than it is being grown in these areas. Reliance on biomass (especially in the form of charcoal) also encourages land degradation. Another environment related problem of biomass energy is the emission of greenhouse gases and its consequence to global warming. Here this issue is bordered on efficiency and how the biomass is used. For example, many studies argue that biofuels are more environmentally friendly than fossil fuels like kerosene.

However, biomass use can only be harmful to the environment through inefficient burning of wood in three stone open fire, which may lead to emissions of some greenhouse gases including CO, CO_2, NO_x, hydrocarbons (HCs), and particulate matter. Furthermore, the burning of biomass fuels in poor homes does not convert all fuel carbon into CO_2 and water. Open fires and traditional stoves tend to be highly inefficient and lose a large percentage of the fuel energy as so-called products of incomplete combustion. These include the potent greenhouse gas methane (CH_4), which stays in the atmosphere for decades and combining the emissions of CO_2 and other greenhouse gases.

4.2. Impact on Health

In addition to its localized environmental effects, inefficient use of biomass energy, especially, through open-fire three stone stoves also has implications for individuals' health, particularly, for women who cook the meal and young children sitting beside them when cooking. They are susceptible to some respiratory related disease caused by indoor smoke.

The indoor air pollution from unventilated biomass cooking stoves is probably a major cause of respiratory illness in many areas of sub-Saharan Africa. Although the effects of exposure to indoor air pollution depend on the source of pollution (fuel and stove type), how pollution is dispersed (housing and ventilation) and how much of their time household members spend indoors. The type of fuel used and individuals' participation in food preparation have consistently been the most important indicators. The prevalence of indoor air pollution is significantly higher where income is below $2 per day per capita. As well as being much more dependent on biomass, poor households

rely on low-quality cooking equipment and live in poorly ventilated housing, exacerbating the negative health impact, as there is incomplete combustion and non-dissipation of smoke. It is estimated that indoor air pollution causes about 36% of lower respiratory infections and 22% of chronic respiratory disease.

Studies shows that a child exposed to indoor air pollution is two to three times more likely to catch pneumonia, which is one of the world's leading killers of young children. In addition, there is evidence to link indoor smoke to low birth weight, infant mortality, tuberculosis, cataracts and asthma. Besides its direct effects on health, indoor air pollution worsens the suffering and shortens the lives of those with both communicable diseases such as malaria, tuberculosis and HIV/AIDS, and chronic diseases, notably cardiovascular diseases and chronic respiratory diseases, which are by far the world's worst killers. Four out of five deaths due to chronic diseases are in low- and middle-income countries (WHO, 2005). Nearly 2 million people a year die prematurely from illness attributable to indoor air pollution due to solid fuel use. Among these deaths, 44% are due to pneumonia, 54% from chronic obstructive pulmonary disease (COPD), and 2% from lung cancer. Biomass infectious related diseases of the respiratory tract in children are the main reasons of high infant mortality.

Globally, there is an influence on the greenhouse effect and locally the population may be affected by chronic lung diseases, heart conditions, lung cancer, diseases of the respiratory tract, other childhood diseases, and increased infant mortality. It is instructive to note that in most rural areas in Nigeria, cooking is normally done in unventilated kitchens using open three stone fire stones; this therefore make more women and their children exposed to biomass related dieses.

4.3. Socioeconomic Effects

To some extent, in many areas of Nigeria, felling of threes for use as a source of energy or making charcoal provides employment, not only for men but also for women and children. However, since the practice is not done in organized and formal ways. There are so many hidden costs that are not accounted for when selling the wood; suggesting that they are normally undervalued.

In rural areas, wood collection is carried out not only for meeting household daily energy needs, but also for marketing to earn a daily livelihood; thus it becomes an important source of income, especially for low income households in both rural and peri-urban areas. However, from socioeconomic perspectives, there is an economic cost of gathering fuel-wood. In states like Yobe, Borno, Katsina and Kebbi where desert is fast encroaching the average distance for fuelwood collection is over five kilometres per day. Collection time has a significant opportunity cost, limiting the opportunity for women and children to improve their education and engage in a more productive income-generating activities. Many children, especially girls, are withdrawn from school to attend to domestic chores related to biomass use, reducing their literacy and restricting their economic opportunities. Similarly, Women can suffer serious long-term physical damage from strenuous work without sufficient recuperation. In the 2006 symposium organized by the United Nations Foundation, it was argued that biofuels could also provide opportunities for poverty reduction and for satisfying energy needs in rural and remote region, help generate employment and local economic development opportunities and enhancement of energy security.

5.0 Policy Options

From the three preceding sections, it is clear that in Nigeria the consumption of biomass was rising unprecedentedly and thriving over the last four decades. However, at varying levels and there is also divergence among various regions.

Furthermore, traditional energy is still widely used for cooking and home heating in rural households and rural based industries. However, there has been little effort policy wise, to ensure sustainability and efficiency in traditional energy use. As a result of that, inefficient and unsustainable use of traditional fuels not only increases fuel consumption but also have socioeconomic problems and increases health hazards for women and children as well as causes environmental deterioration-e.g. air pollution and deforestation

The importance of sound and effective supply side and demand management energy policies and programs to promote efficiency and energy conservation as well as access to clean energy and final inter-fuel substitution in end-user sectors needs not to be over emphasized. These policies may take a form of market-based policies such as taxing of biomass, proper pricing of petroleum products, electricity tariffs and tax holidays and other financial incentives to investors in energy sector as well as non-market based policies such as diffusion of efficient appliances, energy efficiency standards regulations and public enlightenment programmes on the importance of energy efficiency and conservations. From the supply side, investments in natural gas infrastructure and trees planting in both rural and urban areas will enhance sustainability and accessibility to energy for both rich and poor in the society.

In Nigeria since independence most of the energy policies are biased towards the supply side of the market. Although there were some policies that affect the demand for energy such as subsidies on petroleum products and electricity. In 1986, as part of Structural Adjustment Program, the Nigerian government started periodic reviews and gradual phasing out of those subsidies; but most of those reviews were driven by the need for government to generate more revenue and reduce spending rather than to manage the increasing demand for energy. Nevertheless, those policies are not strong enough to promote efficiency and conservation of energy in the country.

Given the foregoing, biomass dominates the energy consumption in Nigeria. Therefore, for any meaningful demand management policy to achieve desired objective of efficiency and conservation; the government need to encourage a smooth transition from traditional to modern energies (because the thermal efficiency of modern energy is far higher than traditional biomass and efficiency and conservation policies from experience are likely to be easier to implement and are more effective on modern commercial than biomass energy). The first step is to diversify its energy supply mix by improving its energy supply infrastructure. Nigeria is blessed with abundant energy resources; both renewable and non-renewable, diversification of energy resources is critical to ensure that the country become less dependent on a biomass in both industrial and residential sectors. For example, natural gas can be made readily available for industrial and residential sector may get kerosene and LPG available and affordable.

Arguably, if better understanding of the regional dimension of energy poverty is achieved by the policy makers in Nigeria, regional biased pro-poor poverty alleviation policies that influence energy access and pricing of modern energy services can be implemented to reduce energy poverty in each region. However, more efficient use of

traditional energy is equally as important in the Northern region where they are highly energy deficient. In fact, some sound and pro-poor energy policies, such as access to electricity can help to alleviate poverty, they are mutually reinforcing if pursued.

Secondly, government needs to make biomass relatively more expensive than modern energy by making modern energy readily available, affordable and the energy using equipment accessible. This will discourage the use of biomass and encourage a shift towards modern energy.

The most viable policy option to discourage the over use of traditional biomass is for the Nigerian government to adopt the system used by its neighbour- Niger Republic. In Niger, the government imposed a tax fee on tree cutters to compensate for the fact that the harvester has not paid for the planting, protection, and caring for the tree over its lifetime. Communities were given control over local natural woods land and were allowed to manage them. Those communities drive income from the sale of woods, but most adhere to an agreed-upon land natural resource management plan (Gerry Foley, 1997). A resource tax on firewood coming into the cities was also imposed, to help pay some expenses of wood management programs.

In Nigeria, imposition of such stumpage fee either at the point of harvest, the point of production, or the point of importation into an urban area, will have two relevant effects. First, it raises funds to be able to replace the trees. Second, it serves to raise the price of the fuel creating an incentive for the household to either utilize less wood or charcoal or to find another alternative, one either lower or higher on the energy ladder. Thus, pricing policies can stimulate movements either up or down the energy ladder. Such movements may be intentional or unintentional, depending on the situation.

According to IEA, (WEO-2010), there are three main determinants in the transition from traditional to modern energy; they are fuel availability, affordability and cultural preferences. If a modern distribution system is not in place, households cannot obtain access to modern fuels, even if they can afford them. LPG penetration rates are slow in Nigeria, partly because distribution infrastructure is lacking. The affordability of energy-using equipment is just as important as the affordability of fuels and the initial cost of acquiring kerosene and LPG stoves may discourage some people from switching away from biomass. In some cases, traditions determine the fuel choice regardless of fuel availability and income.

Generally, in developing countries where biomass is the dominant energy use in this sector; some countries introduce and promote the use of efficient biomass cooking stoves and transition to modern energy, for example, countries such as Senegal, Cameroon and Niger Republic are classic examples. These countries encouraged and supported the production of efficient biomass stoves locally and support the poor communities in acquiring them through loans or grants. Similarly, some countries put some measures to make biomass more expensive in relation to modern fuels so that people will be discouraged from using biomass and switch to commercial fuels. In Nigeria, improved versions biomass stoves have been developed locally by the Energy Commission of Nigeria through its energy research centres at the University of Nigeria, Nsukka and Usumanu Dan Fodiyo University in Sokoto; these stoves which could reduce fuelwood consumption for a particular process by 50%. Similarly, some NGO's in Nigeria, an Alliance for Clean Cookstoves was established in April 2011 with the aim to introduce 10 million fuel efficient stoves to Nigeria by 2021. However, there is a need for more elaborate programme by the government to disseminate the technology nationwide to encourage the adoption of such technology by the households as the case of some developing countries like Niger and Senegal.

Government may also promote a solar-powered cooking stove program in both rural and urban areas; Nigeria's neighbours like Senegal, Cameroon and the Gambia already have a special program on solar-powered cooking stove in both rural and urban areas. For example, in Senegal, in May 2015, three hundred and fifty Hotpots were distributed in 20 villages in the Kaolack region along the border with Gambia. These Hotpots were part of a 2,000 Hotpot Initiative in Senegal. Previously, 1,000 Hotpots were distributed in the region of Thies in Western Senegal.

Similarly, in the urban areas, government may make modern fuels such as LPG and kerosene and their using appliance readily available at reasonable prices, this will smoothen the transition and more efficient use of energy. Evident from developing countries is that consumers will switch to kerosene and LPG if appliances are more affordable, fuels are not taxed heavily and they are marketed in sufficient quantities to meet energy use needs (Barnes and Floor, 1999).

There may also be a case for subsidising the up-front costs of buying gas stoves and cylinders in urban areas, in view of the potentially large impact and relatively small overall cost of such a programme. Governments could also facilitate commercialisation of LPG by designing financial incentives and training private entrepreneurs, setting technical standards, extending credit facilities to stove-makers and providing marketing support. Another approach is to promote the use of smaller LPG cylinders. These would lower the initial deposit fee and refilling costs, encouraging more regular LPG consumption, especially in rural areas, and more widespread use of the fuel. This approach has had some success in Morocco. On the other hand, small cylinders do involve higher transaction costs and hence higher unit prices.

While there is a need for reforming the prices of petroleum products; the issue needs to be approached in a manner that minimizes the impact on the vulnerable poor in the society and does not adversely affect the initiatives on fuel efficiency or penetration of cleaner fuels. Particularly important in this context are the subsidies on kerosene. Arguably total removal of subsidy on kerosene like what the government did for diesel might likely to work in opposite direction and neutralize the intended objective of encouraging the transition from biomass to clean fuels; therefore in the process of promoting efficiency, welfare of the poor should not be sacrificed. It would be worthwhile to explore new technology-aided options not just to improve the mechanism of subsidy delivery, but, primarily, to ensure that the subsidies reach the intended beneficiaries. The best option of the Nigeria government may use the current INEC biometric identity to allocate unique identification numbers for all households in both rural and urban areas.

Initially, the government may consider choosing a representative sample of pilot sites accounting for rural/urban areas, poor/middle-income groups and connected/remote areas in some local governments in each state. District heads should be involved in administering the program at the district-level and with due involvement of the Social Welfare Department in each Local Government. In the process, a standard national cap should be imposed on the litres of subsidized kerosene that each household can purchase in a month or in one year.

Using Biometric Unique Identification Number, each household's information is stored in the national database. Probably either a smart card or using his mobile telephone number, every month certain litres would be allocated to a household, depending on the size of that household. Once, a household buys his entitled litres of subsidized kerosene this month; it is already recoded in the national database, any attempt to buy

over and above its monthly entitlement, the system will automatically detect that. Such measures would also minimize inefficient and illegal usage of subsidized kerosene.

Alternatively, the government could completely withdraw whatever subsidy on kerosene and consider biometric-identification-based cash transfers instead of price-based subsidies in this case; the whole subsidy on kerosene will be completely withdrawn. To cushion the negative consequences on the households, some cash transfers should be made to each poor household. Chaudhuri and Somanathan (2011), identified some advantages of biometric-identification-based cash transfers, and these include; Empowerment of women through an independent and assured source of income and enhancement of the dignity of the poor by giving them an entitlement without any harassment. Finally, government could use the identification program to exclude income tax payers and other wealthier persons from the subsidy scheme and providing a boost to electoral politics by incentivizing a movement towards universal social security, education and healthcare and away from price-based, regressive subsidies that only favour certain interest groups.

Government can either adopt a conditional or unconditional cash transfer, conditional cash transfer will be used by the government to encourage poor households to participate in government programmes such as enrolment of their children into primary schools or immunization, such that for any household to be eligible for registration to benefit in the programme must present an evidence of enrolling his children or immunizing them for example. Otherwise government may just transfer the money to the poor unconditionally. The advantage of conditional transfer is that, it will be used by the government to mobilize its population to participate actively in its developmental and welfare programmes. In fact, government may use conditional cash

transfer to mobilize people in planting trees to fight desertification in arid areas of the country.

6.0 : Concluding Remarks

Our analysis of the consumption of biomass energy in Nigeria reveals that the consumption of biomass has maintained an unprecedented increase over the last four decades; the consumption of biomass surpasses all the other major commercial energy sources such as kerosene, LPG and electricity, despite Nigeria being a major producer and exporter of commercial energy globally.

The study reveals that the reasons for the predominance of biomass in the Nigerian primary energy mix are due to interplay of some economic factors such as poverty, lack of easy access to commercial energy sources as well as cultural factors. These factors led to wide disparity between various regions in the consumption of biomass. Furthermore correlation analysis shows poverty levels are highly correlated with biomass consumption in all the six geopolitical regions. However, there is a negative correlation between biomass consumption and real incomes.

The study also unravelled the environment, health and socioeconomic consequences of the predominance of biomass consumption in Nigeria. The negative consequences of biomass consumption can be viewed from sustainability of biomass use resulting from high levels of desertification, soil erosion and decline in the quality of fuelwoods. On the other from the efficiency aspect, it has been shown that the inefficient use of fuelwood particularly cooking in three-stones open fire stoves have negative consequences for women and children.

Finally the paper suggests some policy options to alleviate the problems. These options include dissemination of efficient biomass stove, making commercial energy and energy using appliances easily accessible and affordable, reinventing the subsidy regime as well as deliberate policy for tree planting in desert and erosion prone areas.

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