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Analysis of Dynamics of Domestic Fuelwood Energy Consumption in Nigeria: Is Fuel Stacking Theory Apt?

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ABSTRACT

Most theoretical and empirical works in the literature on household energy consumption behavior in the developing countries are showing the failure of energy ladder theory inadequately explaining the dynamics of domestic energy consumption. As a result, fuel stacking (multi-fuel) theory was developed to provide alternative explanations. We take this to test by conducting an empirical study on fuel-wood energy consumption dynamics among Nigerian households to confirm the validity of fuel stacking theory using micro-level data. In the study, 120 Enumeration Areas (EAs) demarcated for Katsina State by the Nigerian National Bureau of Statistics (NBS) for socio-economic development data were used to capture 992 household fuel-wood consumers. We used descriptive statistics to analyze the results. The findings showed 72.2% of the household respondents used fuel-wood for domestic activities trice in a day, and 48.6% confirmed fuel stacking behavior among households due to family size, 43.6% price and 6.6% culture. The findings of the study can benefit the Nigerian government on energy planning.

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INTRODUCTION

Unlike developed countries with near-universal access to modern energy, households in developing countries often choose their energy type. They weigh solid fuels like fuel-wood, crop residue, animal dung and charcoal against modern fuels such as kerosene, liquid petroleum gas or electricity. The questions of modern vs. traditional energy vs. purchase carry relevance (Toole, 2015). Energy ladder and fuel stacking hypotheses were approaches that have progressively addressed how energy decisions occur as part of the multiple activities in which households of developing countries engaged. Both hypotheses rely on the microeconomic theory of the consumer and serve as the prominent explanations of the household energy transition (Muller and Yan, 2016). Presently, researchers are pointing to the reluctance of households in the developing countries to completely abandon traditional energy even when consuming modern energy on the adjacent, or on higher energy rung, this evidence contradicts the energy ladder hypothesis that depicts a process by which household move up the energy ladder as their income rises, moving away from traditional energy (e.g., biomass) to modern energy (e.g., kerosene, gas, and electricity). Because of these concerns, the issue of the household energy transition in developing countries has received growing research attention. Over the past three decades, many studies have investigated the factors

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driving this transition (Muller and Yan, 2016).

Problem Statement and Research Questions

This study aims to analyze the dynamics of domestic fuel-wood energy consumption to validate the fuel stacking hypothesis using Katsina State in North West Nigeria as our case study, where Unemployment and poverty are the highest when compared to the other five geopolitical zones in the country. Concerning this, three parameters were taken into consideration (i) frequency for using fuel-wood as a major source of energy (ii) reason for using fuel-wood as energy source (iii) reason for the combination of fuel-wood with other energy types. The study tests this ***hypothesis***

H_1: There is a relationship between household gender, marital status, education level, age, and domestic fuel-wood energy consumption.

DOMESTIC FUEL-WOOD ENERGY CONSUMPTION: AN OVERVIEW

Results from studies of the Nigerian fuel-wood situation suggest that the majority of the households are moving back to the use of fuel-wood energy in recent times despite the availability of modern energy in some parts of the country. For example, a study that investigates consumption patterns of fuelwood among households in Kano, northwest Nigeria over at least two decades by Maconachie et al. (2009), revealed that most families, despite using other cooking fuels in the past, are now reverting to the use of fuelwood. Naibbi and Hearley (2013) linked this phenomenon to inequality in the spatial patterns of fossil fuel supply in the country and the high price of modern energy. Energy Commission of Nigeria (ECN) in 2003, estimated that over 60% of the Nigerian population depends on fuel-wood for cooking and other domestic activities, this figure escalated to about 72% in 2013 (NPC and ICT international, 2014). Some think that the high poverty level made fuel-wood a substitute candidate in the Nigerian household energy mix. For example, the National Bureau of Statistics in their attempt to understand Nigeria's fuel-wood consumption patterns undertook an analysis of the relationship between poverty levels and the quantity of fuel-wood consumed by region. North-east and North-west regions that have the highest poverty rate consume more fuel-wood than the rest of the regions (95.9% and 95.3%) respectively. The Southwest and South-east regions that are economically better up consumes less fuel-wood (54.9% and 78.0%). Hence, there is a strong relationship between poverty and the use of fuel-wood in Nigeria (Zaku et. al, 2013:87, Cine-Cole and Maconachie, 2015).

Other reasons that made fuel-wood a major energy source in Nigeria include electricity infrastructural gap and high cost of fossil fuels. For instance, Abd, Razack et, al. (2012:18) in their study on North Central Nigeria reported an increase in the price of kerosene and Liquefied Natural Gas (LPG) has made fuel-wood a substitute candidate. The cost of kerosene which is one of the major sources of energy for household activities rose from N0.40 per liter in 1991 to N6.00 in 1994 to N17.00 and in 1998 rose to N50.00. Also, the distribution challenges have given undue advantage to the kerosene hoarders, making it between N115-N125 per liter or even above these prices. Similarly, 12.5kg cylinder of LPG rose from N200 in 1991 to about N3, 900.00 in 2012. Electricity tariff has equally increased, it is estimated that over 73.0% of the households in Nigeria are badly affected by the increase in energy prices. This situation has led to households shifting from conventional energy to non-conventional ones. The proportion of consumers using fuel-wood for domestic activities have increased tremendously.

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Many have argued that, despite Nigeria being Africa's energy giant and the continent's most prolific oil-producing country, the poorest households earn about 1-2 US dollars per day and spend about 0.4 dollars per day on energy. This represents about 20-40 percent of the household's income spending on energy alone (Olisa and Nria-Dappa, 2009).

Modern Energy Access

Generally, lack of access to modern energy has been reported to have increased the level of fuel-wood consumption in African countries. International Energy Agency (2009) projected that the consumption of wood-based biomass by Sub-Saharan African households will increase in relative terms over the next thirty years as demographic growth continues to outstrip access to other modern energy. Sambo (2005:150) and Oluwagbenga et al. (2015:57) confirmed this report and attributed the increase in Nigeria to lack of access and erratic nature of electricity and petroleum products supply. Studies have shown that the electricity generating figures of Nigeria are very poor that it cannot meet half of the demand of Nigeria (Sambo, 2008:33, Naibbi and Healey, 2013:161, Nwachukwu et al., 2014:7). The GenCos, TCN and DisCos companies that are responsible for generation, transmission and distribution of electricity to urban and rural areas of Nigeria could only generate 4000MW or 6000MW daily from the estimated 8039MW of installed capacity. Even the one that is generated, the supply is erratic and of poor quality (Odularu & Okonkwo, 2009:46 & Olise & Nria-Dappa, 2009:3).

In the case of kerosene, the former Minister of Petroleum Resources Mrs. Diezani Allison-Madueke during her confirmation in the senate disclosed that there was an insufficient supply of kerosene in the country, but hoarding of kerosene by the marketers was identified by the former Minister as one of the problems of kerosene supply in the country, which seriously affect the availability and supply of the product. Despite the removal of subsidy on kerosene, she explained kerosene pricing will remain an issue even when kerosene is made available in the country in large quantity because the type of kerosene (DPK) used in the country has the same quality as aviation fuel, which some corrupt marketers buy at a cheaper rate and sell at higher prices as aviation fuel. In terms of LPG consumption, Nigeria is the 6th largest producer of liquefied petroleum gas (LPG) in the world and the second-largest in the African continent. There is an estimated natural gas reserve of 170 trillion cubic feet in Nigeria making it the 10th largest reserves in the world (NNPC, 2015). Unfortunately, Nigeria has the lowest LPG utilization per capita in Africa. Low consumption of LPG in Nigeria may also not be unconnected with the price of the product which is beyond the reach of average Nigerian. Another issue includes, most of the appliances used in LPG, for example, gas cookers, adaptors/regulators, cylinders and horses are all imported products and have high prices above the reach of many households. Additionally, most Nigerian families are not fully aware of LPG, even if they are aware, they associate the usage of LPG to status thereby giving it elitist connotation.

Domestic Energy Consumption Patterns

In Nigeria, the household sector accounts for the largest share of energy use about 65% and cooking accounts for staggering 91% of the household consumption, then followed by lighting 6% (Oyedepo, 2012:11). Nigerian urban households use multiple energy sources (fuel stacking), fuel-wood, kerosene, and gas are the dominant energy sources with little electricity use due to unreliability in supply. While in the rural areas due to lack of electricity and poor distribution network of

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fossil fuel, fuel-wood has become the widely used energy. For example, an analysis of domestic consumption of different fuel types among households in Nigeria, reveals that more fuel-wood is being used for cooking than any other fuel type. Out of the 28,197,085 households in Nigeria (NPC, 2010), only Lagos state uses less fuel-wood. Fuel-wood use varies across the different states; the northern states are the largest users. While kerosene (modern fuel) is the second most important fuel after fuel-wood (in terms of usage among households), the use of kerosene dominates the southern part of the country, particularly in the states of Lagos, Oyo, Rivers, and Ogun. For example, out of the 2,195,842 households in Lagos State, about 1,771,100 households (more than 80%) solely use Kerosene for their domestic cooking and boiling (NPC, 2010). In contrast, more than 70% of households in most northern states use fuel-wood for their domestic cooking and boiling.

THEORIES AND EVIDENCE

Energy Ladder Theory

The idea of the energy ladder model hypotheses came about as a result of the perception of a fuel-wood crisis in the 1970s and 1980s (Toole, 2015:3). Since then energy ladder model has become one of the models used in explaining domestic fuel choices in developing countries (Hosier and Dowd 1987, Leach 1992 Alamo, Sathaye and Barnes 1998; Davis 1998, Campbell et al. 2003, Shackleton, 2007 and Maconachie et al. 2009). The conventional view is that economic growth will trigger a reduced demand of fuel-wood and other biomass energy by the households and shifted towards the use of commercial fuels such as kerosene, LPG and electricity (World Bank, 2011:29). So, the concept of the energy ladder is used to describe movement from traditional to modern energy services in the event of an increase in income or economic status of the household or vice versa (Nazer, 2015:51). The model is predicated on the economic theory of consumer behavior (Hosier and Kipondya, 1993), meaning that when income increases, households not only consume more of the same good they also shift to more sophisticated goods with higher quality. This means as the income increases, households will firstly move away from traditional fuels to transitional fuels such as charcoal and kerosene before finally moving to modern fuels such as grid-based electricity and LPG which are superior to traditional or transitional fuels. The main reason for the movement is because households preferred clean fuels, ease of use and efficient, modern fuels have these qualities unlike traditional fuels such as fuel-wood, crop residues and dung (Darazo and Babayo, 2016:84). The energy ladder also assumes that more expensive technologies are locally and internationally perceived to signify higher status. Families desire to move up the energy ladder not just to achieve greater fuel efficiency or less direct pollution exposure, but to demonstrate an increase in socioeconomic status (Masera et al. 2000: 2084).

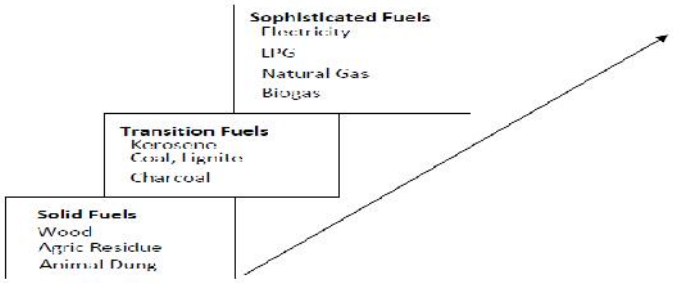

Figure 1: Energy ladder model; Source: Abdullahi et al. (2017:353)

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In the energy ladder model, fuel switching becomes the central concept, referring to the displacement of one fuel by another. A household's move up to a new fuel is automatically a move away from the fuel used before (Van Der Kroon et al, 2013:6). Hosier and Dowd (1987) present a five-rung ladder to describe the linear movement of energy ladder; gathered fuelwood, purchased fuelwood, transition fuels, kerosene, and electricity. In the case of Reddy (1995), six rung ladder was proposed; dung/waste, fuelwood, charcoal, kerosene, LPG, and electricity. While Van Der Kroon et al. (2013) separated fuels into three classifications, primitive, transition and advanced, with multiple fuels under each. Furthermore, Nazer (2016) sheds more light on the energy ladder as it relates to the level of economic development. Household energy use was classified into (cooking, lighting, boiling, and equipment) based on income levels and level of economic development. In the developing countries, low-income households consume only traditional energy such as fuel-wood, charcoal, animal dung, and agricultural residue, the middle-income households combine both traditional and modern fuels like fuel-wood and kerosene while high-income households in the developing countries consume less of traditional fuels and more of modern fuels like kerosene, LPG and electricity. In developed countries, traditional energy consumption is almost none existence.

In summary, the energy ladder model expounds a strong correlation between income and household fuel choice, the model portrays fuel-wood as an inferior good and modern energy as superior good. Many Cross-country comparisons revealed a positive correlation between economic growth and modern fuel uptake, suggesting that as a country progresses through the industrialization process, its reliance on petroleum products and electricity increases and the importance of traditional energy decreases (Hosier and Dowd, 1987: 347, Van Der Kroon et al. 2013:7). On the contrary, studies conducted by (Alam et al. 1998; Campbell et al. 2003; Davis 1998; Heltberg et al. 2000; Mesara, 2005; Ouedraogo 2006; Madubansi and Shackleton 2007) provided other evidence that does not support the energy ladder model, instead showed that relationship between household fuel choice and income level are rarely as strong as assumed by the energy ladder, factors such as income, access to electricity and forest scarcity on the determination of fuel transitions play a significant role in determining fuels choice. In the same way, Leach, 1992; Barnes, Krutilla, and Hyde, 2002; Barnes and Floor, 1999, Maconachie et al. 2009, alluded that the main driver affecting the movement up the energy ladder is hypothesized to be income and relative fuel prices.

Limitations of Energy Ladder Theory

The complexity of the household's fuel use and fuel switching process in the developing countries have rendered the energy ladder model insufficient to explain energy consumption dynamics. The early critics of the model are Masera and Navia (1996) who pinpointed out the deficiency of the energy ladder model based on a study conducted in three Mexican states between 1992 and 1996. Masera et al. (2000) went further to argue that there was no transfer of complete fuel consumption, a process should be considered resulting from simultaneous interactions of factors pushing households away from biofuels and pulling them back towards biofuels i.e a bi-directional process. Factors such as convenience from the use of modern fuels, the pride associated with the use of these fuels, the social status may push consumers up the ladder while economic factors such as incomes and prices push consumers down the ladder. According to them, the energy

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ladder failed short of linking economic and socio-cultural issues. Other studies that faulted the energy ladder model include Peng, Hisham and Pan (2010:241) in rural Hubei in China which shows only less than 10 percent of the sampled households fully abandoned the use of biomass as a result of the increase in income. Also in Uganda, 83% of the households on the top quintile in the urban areas use biomass as their primary cooking fuel (World Bank, 2011:29). Similarly, Campbell et al (2003:560-561) confirmed that the energy ladder model has failed in Zimbabwe because of the resistance of the households in abandoning fuel occupying the middle rungs of the ladder. Kerosene was not abandoned even after they adopt electricity. Taylor et al (2011:924) in Guatemala, concluded that 77% of the migrant households maintained fuel-wood as primary energy despite the ownership of LPG. In Nigeria, Maconachie et al. (2009) revealed that most families in Kano, Northern Nigeria are reverting to the use of fuel-wood from modern fuels due to poverty and inconsistency in the supply of modern energy. Madubansi and Shackleton (2003) in the Bushbuckridge region of Limpopo, South Africa showed that fuelwood has remained the most important energy source even after electrification as a result of prices. Even though the consumption of modern fuel can increase with the increase in incomes, changes in the relative prices of fuels can also influence the types and quantities of fuel consumed. Cultural and social factors may make the consumers behave contrary to these expected patterns. Factors such as education level of the household, dwelling characteristics, preparation of traditional meals and gender of the head of the households could also contribute to the complexity of the energy ladders model (Masera, 2000). Generally, energy ladder model has been used to explain domestic energy consumption dynamics in the developing countries, in its general principle and specification, the model provides a limited view on the reality of household energy consumption. It is specifically limited in its ability to provide the actual determinants of domestic energy consumption. This limitation necessitates the need to study another model.

Fuel Stacking (Multi-Fuel) Theory

More recently, there have been arguments that households in developing countries do not switch to modern energy sources but instead tend to consume a combination of fuels which may include combining solid fuels with non-solid fuels as sources of energy. Thus, instead of moving up the ladder step by step as income rises, households choose different fuels as from a menu. This method of fuel usage is known as fuel stacking (Mekonnen et al 2009:1). Fuel stacking model envisaged that energy transition does not occur as a series of simple, discrete steps, instead, households simultaneously use multiple different fuels. According to Masera et al. (2000), households choose to consume a portfolio of energy options at a different point along the energy ladder instead of switching fuels, this process is termed fuel stacking. Incomes increase makes households to adopt the use of modern fuels, but at the same time continue using traditional fuels for some activities, thus 'mixing' various energy sources. The transition towards the use of modern fuels takes place in the context of the simultaneous use of various types of fuels. In this view, poorer households usually use a small variety of traditional fuels, such as fuel-wood, animal residue and charcoal (Elias and Victor, 2005:3, Van Der Kroon et al., 2013:7). Multiple fuel use arises for several reasons. First, households may not have enough funds to immediately purchase new energy-consuming appliances at the time they gain access to new energy more especially in the situation where they have invested significantly in "traditional"

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technologies (e.g., wood-burning stoves). Second, the expensive nature of modern energy services. Finally, multiple fuels can provide a sense of energy security because complete dependence on commercially-traded fuels leaves households vulnerable to variable prices and often unreliable service. Therefore, households must have one or two fuels that can be used as backups if their primary fuels are temporarily unavailable (Elias and Victor, 2005:3). Empirical studies in many developing countries have validated the fuel stacking hypothesis, showing households adopting new fuels and technologies that serve as partial, rather than perfect substitutes for more traditional ones with an increase in income. The study of Ogwumike et al. (2014:255) in Nigeria revealed, instead of households abandoning traditional fuels as income increases, households tend to stack different forms of fuels which is consistent with consumer preferences in the face of supply constraints. This situation was also found in South Africa in small electrified towns in Makana District of Eastern Cape Province where it was discovered most of the households continued to use fuelwood for cooking and heating despite the widespread of electrification (Shackleton et al, 2007:6). In Ethiopia, Mekonen, GebreEgziabher, Kessie and Kolin, (2009:4) found households in Tigrai, Northern Ethiopia switched to multiple fuels strategy (fuel stacking.

Generally, energy stacking behavior can be seen as a livelihood strategy through which households cope with unstable income flows, protect themselves from fragile markets and hold on to their cultural practices, while benefitting to some extent from modern fuels. The model has stressed the need to look beyond income as the prime driving force behind fuel switching (Van der Kroon, 2013:19).

STUDY AREA

Katsina state is among the top list of poorest states in Nigeria. According to the information on the states of the federation by the Nigerian National Bureau of Statistics (2013), other states with over 70% poverty rate include Katsina state with 74.5%. A study conducted by Forest Management Evaluation and Coordinating Unit (FORMECU) in 1991 through "Silviconsult" to determine the domestic energy use in Katsina state. Taking into cognizance of (4) energy sources i.e. fuel-wood; Sorghum stalks (*Kara*), Kerosene and gas concluded that poverty has forced the majority of the people to use fuelwood and sorghum stalk in the state.

METHODOLOGY

The above theories and empirical evidence showed that both the energy ladder and fuel stacking models were trying to link domestic energy consumption with a household choice of energy. Therefore, this study used a structured questionnaire to collect data from 1199 household fuel-wood consumers using a two-stage sampling technique. Ten (10) households (HH) or sampling unit were randomly selected in each Enumeration Area (EA) and a questionnaire was administered to them making a total of 1199 households (HH) in the one hundred and twenty (120) Enumeration Areas (EAs) demarcated for Katsina State. The 120 EAs were demarcated by Nigeria's National Bureau of Statistics in 2015 for socioeconomic development data in the country. The National Bureau of Statistics is the main National Agency responsible for the development and management of official statistics, the authoritative source and custodian of official statistics in Nigeria established by Act (2007).

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FINDINGS

Frequency of using fuel-wood as a major energy source

Table 1 below, revealed no significant difference between the frequency of using fuel-wood as a major energy source and gender. Females frequently use fuelwood as a major energy source than men. Out of 991 respondents, 866 use fuelwood trice a day as their major source. This could be because women cook more than men, and also because most of the respondents are female.

Table 1: Frequency of using fuel-woos as major energy source * Gender

		Gender		Total
		Male	Female	
FreqMajEnergySourceNIG	Once a day	4	9	13
	Twice a day	11	77	88
	Trice a day	128	738	866
	Other	5	19	24
	Total	148	843	991

Source: Field Survey, 2019

Similarly, there is no significant difference between frequently using fuel-wood as a major energy source and marital status in Nigeria. Table 2 showed more singles frequently use fuelwood as a major energy source trice a day. Out of 991 respondents, 688 frequently use firewood as a major energy source trice a day.

Table 2: Frequency of using fuel-wood as major energy source * Marital Status

				Marital Status				Total
		Single	Married	Divorced	Separated	5		
FreqMajEnergySourceNIG	Once a day	6	6	1	0		0	13
	Twice a day	42	27	10	9		0	88
	Trice a day	387	296	91	88		4	688
	Other	12	7	1	3		1	24
	Total	447	336	103	100		5	991

Source: Field Survey, 2019

The result in table 3 below showed more respondent with secondary education in Nigeria frequently uses fuel-wood as major energy source trice a day. Out of 991 respondents, 866 frequently use fuel-wood as a major energy source trice a day. There is a significant difference between frequently using fuelwood as a major energy source and education. This finding corroborated a study conducted by Maconachie et al (2009) in Kano Northern Nigeria where education level did not reduce the level of fuel-wood consumption and disagree with the study of Baiyegunhi and Hassan (2014) conducted in Giwa LGA Kaduna Northern Nigeria, where they observed that a higher education level induces households to reduce the frequency of using fuel-wood towards the use of kerosene and LPG.

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Table 3: Frequency of using fuel-wood as major energy source * EducLevel

				EducLevel			Total
		Primary	Secondary	Certificate	Diploma	5	
FreqMajEnergySourceNIG	Once a day	4	5	2	2	0	13
	Twice a day	15	60	7	2	4	88
	Trice a day	215	523	82	35	11	866
	Other	8	15	0	1	0	24
	Total	242	603	91	40	15	991

Source: Field Survey, 2019

Also, table 4 below showed respondents in the age bracket of 30 to 44 use fuelwood frequently as their major energy source trice a day. Across the ages from 17 to 60 above, more people frequently use fuelwood as their major energy source trice a day. There is a significant difference between frequent major energy source and age.

Table 4: Frequency of using fuel-wood as major energy source * Age

			Age			Total
		17 to 29	30 to 44	45 to 60	60 above	
FreqMajEnergySourceNIG	Once a day	2	9	0	2	13
	Twice a day	10	62	11	5	88
	Trice a day	98	601	95	72	866
	Other	4	17	1	2	24
Total		114	689	107	81	991

Source: Field Survey, 2019

Table 5 below showed no significant difference between reasons fuel-wood is being used as a major source of energy and gender. Females (636) said their reason for using fuel-wood as a major source of energy is because it is affordable. This disagrees with the findings of Farsi et al. (2007), Rao and Reddy (2007) and Rahut et al. (2014) that showed female-headed households prefer modern fuels to traditional fuels (fuel-wood and other biomass). The main reason could be attributed to the fact that women are often responsible for household cooking and thus are directly affected by the air pollution emitted from the burning of the dirty fuels (Muller and Yan, 2016). This evidence is challenged by An et al. (2002), Ouedraogo (2006) and Abebaw (2007) who observed the coefficient of the gender of the household's head is insignificant in some contexts.

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Reason for using fuel-wood as a major energy

Table 5: Reason for fuel-wood as major energy source* Gender

		Gender		Total
		Male	Female	
Reason as Major Source NIG	A bit affordable	5	25	30
	Relatively affordable	7	41	48
	Affordable	112	636	748
	Very affordable	24	140	164
	6	0	1	1
	Total	148	843	991

Source: Field Survey, 2019

The result from table 6 below indicated no significant difference between the reason for using fuelwood as a major source and marital status. More singles said the reason they use fuelwood as a major energy source is that it is relatively affordable. Out of 1199 respondents, 817 said the reason they use fuelwood as a major energy source is that it is relatively affordable.

Table 6: Reason for fuel-wood as major energy source * Marital Status

			Marital Status				Total
		Single	Married	Divorced	Separated	5	
Reason as Major Source NIG	A bit affordable	14	9	4	3	0	30
	Relatively affordable	19	19	3	7	0	48
	Affordable	342	251	76	75	4	748
	Very affordable	72	56	20	15	1	164
	6	0	1	0	0	0	1
Total		447	336	103	100	5	991

Source: Field Survey, 2019

Table 7 below showed more respondents with secondary education indicated the reason they use fuelwood as a major energy source is that it is affordable. Out of 991 respondents, 748 said the reason they use fuelwood as a major energy source is that it is affordable. There is a significant difference between the reason for using fuelwood as a major source and education level.

Table 7: Reason for using fuel-wood as major energy source * EducLevel

			EducLevel					Total
		Primary	Secondary	Certificate	Diploma	5		
Reason as Major Source NIG	A bit affordable	6	17	4	2		1	30
	Relatively affordable	14	29	5	0		0	48
	Affordable	180	453	71	31		13	748
		42	103	11	7		1	164
		0	1	0	0		0	1

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			EducLevel					Total
		Primary	Secondary	Certificate	Diploma	5		
	Very affordable 6							
	Total	242	603	91	40		16	991

Source: Field Survey, 2019

The result in table 8 revealed no significant difference between the reason for the combination of fuel-wood with other energy types and gender. The findings in the table indicated that the reason for combining fuel-wood with other energy types in the study area was family size and price. 411 female respondents said family size was the main reason for their fuel stacking behavior. While 371 female respondents indicated price as the main driver of combining fuel-wood and other energy types. It was earlier mentioned that the religion and culture of people in the study area allow one man to marry up to four wives and the social beliefs that larger families command some level of recognition and security. According to Rao and Reddy (2007), Pundo and Fraser (2006), larger households in the developing countries are often related to lower incomes this translating to their limited capacity to purchase commercial fuels to feed a large family that requires a large amount of fuel. Using fuelwood is cheaper due to its lower prices compared to kerosene, LPG and electricity. The greater the number of occupants in a household the greater the level of fuel-wood energy consumed. This could be the reason respondents indicated family size and price as the reason for fuel stacking behavior.

Reason for the combination of fuel-wood with other energy types

Table 8: Reason for the combination of fuel-wood with other energy types * Gender

		Gender		Total
		Male	Female	
Reason for Combination	Price	62	371	433
	Culture	10	45	55
	Family	71	411	482
	Other	5	17	22
Total		148	844	992

Source: Field Survey, 2019

Table 9 below showed more singles combine fuel-wood with other sources of energy. Out of 1199 respondents in Nigeria, 482 indicated family size and 433 said price were the reasons for the combination of fuel-wood with other energy types. The Pearson Chi-Square value in table 10 is 21.253 and the Asymp. Sig. (2-sided) 0.026 which showed there is a significant difference between the reason for combining fuel-wood with other energy types and marital status.

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Table 9: Reason for the combination of fuel-wood with other energy sources * Marital Status

			Marital Status						Total
			Single	Married	Divorced	Separated	5		
Reason for Combination	Price		175	162	44	47		5	433
	Culture		20	26	3	6		0	55
	Family		241	141	55	45		0	482
	Other		12	7	1	2		0	22

Source: Field Survey, 2019

Table 10: Chi-Square Tests

	Value	df	Asymp. Sig. (2sided)
Pearson Chi-Square	23.168[a]	12	.026
Likelihood Ratio	25.263	12	.014
Linear-by-Linear Association	5.852	1	.016
N of Valid Cases	992		

The result from table 11 below showed more respondents with secondary said the reason they use fuelwood as a major energy source is because of family size and price. There is a significant difference between the reason for combining fuel-wood with other energy types and education.

Table 11: Reason for the combination of fuel-wood with other energy types* EducLevel

				EducLevel					Total
				Primary	Secondary	Certificate	Diploma	5	
Reason for Combination	Price			102	265	43	16	7	433
	Culture			10	37	5	2	1	55
	Family			122	289	42	22	7	482
	Other			8	13	1	0	0	22
Total				242	604	91	40	15	992

Source: Field Survey, 2019

Result in Table 12 below showed respondents between the ages of 30 to 44 have indicated family size and price are the reasons for combining fuel-wood with other energy types. There is a significant difference between the reason for combining fuel-wood with other energy types and age.

Table 12: Reason for the combination of fuel-wood with other energy types * Age

		Age				Total
		17 to 29	30 to 44	45 to 60	60 above	
Reason for Combination	Price	58	285	47	43	433
	Culture	6	37	9	3	55
	Family	50	351	49	32	482
	Other	1	16	2	3	22
Total		115	689	107	81	992

Source: Field Survey, 2019

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DISCUSSION

Based on the findings above, the fuel stacking theory has progressively addressed how fuel decisions occur as part of the multiple activities in which households of Nigeria engaged. According to Toole (2015), beyond wealth, the effects of other variables such as asset and demographics display high statistical significance, suggesting that other factors influence fuel use to a greater extent than the standardized wealth (income) index. Neither the availability of the fuel source nor wealth entirely determines fuel choice. Many studies on household energy consumption in the developing countries have indicated that the majority of the households in the highest wealth quintile still identify traditional and non-traditional energy as their primary source. This fact suggests that household stack different energy types for domestic purposes. For long, Nigerian households use different types of energy for their daily consumption due to the influence of family size, marital status, culture, educational level, gender, age, and other demographic variables. This trend has continued as the findings indicate, this confirmed fuel stacking hypothesis. It could be argued that it is true fuel stacking theory has adequately captured the dynamics of domestic energy consumption in Nigerian as evidently seen in many other developing countries (Peng, Hisham and Pan, 2010, Mekonnen et al., 2009, Campbell et al. 2003, Masera et al. 2000,). However, it should be mentioned that income is also a very important determinant in energy consumption but is not a sole significant variable as advocated by the energy ladder theory.

CONCLUSION

This study intends to confirm whether the dynamics of fuel-wood energy consumption in Nigeria validates the fuel-stacking theory. The study found that the frequency of using fuel-wood as a major source of energy is high and more than 70% of the respondents frequently use fuel-wood as major energy source trice a day, suggesting no significant difference between gender, marital status, age and frequency of fuel-wood energy consumption among household's bur there is a significant difference between education level and frequency of using fuel-wood. In terms of reason fuel-wood is used as a major energy source, the results showed the affordability of fuel-wood is the main reason. Family size, culture, and price are significant determinants of the household's combination of fuel-wood with other energy types (fuel-stacking). The study came the conclusion that fuel stacking theory could be used in explaining the level of energy poverty of a country and government can use it to develop an energy policy that can take care of poor man's energy especially from the look of things, fuel-wood energy has become inescapable household energy in Nigeria.

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