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# Mitigating Climate Change and Determinants of Access to Liquified Petroluem Gas (LPG) Among Urban Households in Abia State, Nigeria

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## Abstract

The danger of climate change is imminent. This study is an attempt to encourage access to LPG as a preventive measure to prevent the worst effect of climate change in Nigeria. The study exposes the determinants of access to LPG use among urban households in Abia State, Nigeria. It specifically seeks to determine the factors influencing access to LPG; identify problems associated with LPG use and preference pattern of selected cooking energy sources outside LPG. To achieve this, the study employed mixed research method in the selection of location (Aba and Umuahia) and 120 housewives as respondents. Data were obtained with structured copies of questionnaire and analyzed using descriptive statistics and Probit regression model. Results showed that the respondents were mostly married adults, mature with bloated household size and capable of taking decisions in their respective families. It further showed that education, income, price of LPG, availability and distance from house to place of purchase have relationship with access to LPG. More so, product unavailability, psychological fear of explosion and high cost of starting up are some of the major constraints to LPG use in the study area. Finally, it was observed kerosene is the most preferred cooking energy in urban areas. The study recommends that prices of LPG should be made affordable and product highly available. Also safety and public sensitization campaigns should be organized to educate households on the use of LPG and negative impact of climate change. This will help ease the psychological barrier to demand for LPG.

**Keywords:** Access; Climate change; Energy; Liquefied petroleum gas; Sustainable development

## Introduction

Besides issues of food security, terrorism, instability and inequality and economic crisis, climate change is another major challenge facing the world today. In recent times, the world has continued to witness dramatic environmental changes and threat arising from activities of climate change. For instance, in what many saw as irregular pattern in 2014, United States and other parts of the world experienced extreme hot temperature in history. In 2012, Nigeria recorded extreme flooding. The unprecedented flood ravaged 21 states out of 36 states in Nigeria, affecting over 7 million people, displaced and killed thousands of residents; destroyed homes, farm lands and infrastructures resulting in some loss in food production [1]. Other experiences around the world includes hurricane, drought etc. All these are clear evidences of vulnerability of nations to the threats of climate change.

Issues bordering on climate change and variability, mitigation and adaptation measures have become topical and occupy the center stage of many scientific studies and discussions [2,3]. Although impact of climate change is global, but its severity is huge and appeared to have made its nest in Africa's social and economic development because of poor adaptation capacities and measures by government and individual [4,5]; especially those that concerns attitude aimed at creating a sustainable environment by reducing greenhouse gas emission such an carbon emissions from the consumption of energy.

Over the years, many efforts of government and agencies have been directed at preventive measures rather than reactionary measures. This was seen as the basis for #21.6 billion flood relief fund by Nigerian government to reduce the impact of 2012 flood. Although this measure may have reduced the severity of the flood on agricultural GDP, however, according to Okonjo-Iweala [1], these are scare financial resources that could have been deployed to much needed public services like health, education and other key sectors, if there were measures taken to mitigate the occurrence of such huge environmental threat. In mitigating threats of climate change, what is important as a response mechanism is solid knowledge, in terms of causes. Beyond that is to obtain commitment from the people to ensure compliance. Theoretical and empirical evidences suggest that carbon pollution is the biggest causes of climate change. Carbon dioxide ($CO_2$) emissions are caused by human activities. One of the main human activities that emit huge volume of $CO_2$ in Nigeria beside gas flaring is emission from household cooking energy.

Nigeria as a large developing country has a considerably high energy requirement for cooking. Cooking energy choices include Liquefied Petroleum Gas (LPG), kerosene, electricity, charcoal, firewood or fuel-wood and other solid fuels. According to International Energy Agency (IEA) [6], approximately 2.4 billion people in developing countries rely primarily on traditional biomass fuel for cooking and heating needs. Although Nigeria is the largest oil producing country in Africa with large natural gas reserve and renewable energy resources, more than 117.8 million Nigerians rely on wood and biomass for cooking. These biomass fuels include fuel wood, charcoal, low dung and crop residues. In Nigeria, fuel-wood and charcoal has specially been known to be the major sources of energy for cooking and heating needs purposes for people in the rural area, while kerosene are mostly used in the urban areas. According to Ebe [7] and Chukwu [8], more than 70 percent of the total population in Nigeria relies on fuel wood or charcoal. The

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preference for biomass fuel and kerosene among mostly poor people and developing countries is seen as a viable alternative to high cost options in other modern energy used by household. However, new studies have found that black carbon, which is mostly "soot", formed in the combustion of wood and fuel such as diesel and kerosene is the second most important contributor to global climate change [9].

Several other studies have shown that inefficient and traditional utilization of biomass fuel and kerosene has severe health implications such as risk of low birth weight and pulmonary tuberculosis in developing countries, productivity and the environment [10-12]. According to World Health Organization (WHO) [13], the risk associated with air pollution from solid fuels accounts for 2.7 percent of global losses of healthy risk. Statistically, about 1.3 million people, mostly women and children die prematurely every year from exposure to indoor air pollution from biomass. This is a serious global challenge which has continued to receive global attention in response to demand for sustainable development. As a measure to reduce the negative health and environmental impact of climate change occasioned by activities of man, scientists, policy makers and researchers have in unionism advocates for a clean and efficient energy alternative that is cost effective and available as a one of the resilient strategies. Many of these strategies are cross cutting and apply to home, businesses, industry and transportation.

As a home strategy, liquefied petroleum gas (LPG) is mentioned in the context of sustainable development [14], because it is a cleaner, low carbon, gaseous fuel. LPG is one of the products of natural gas and usually consists of mixture of propane ($C_2H_8$) and butane ($C_4H_{10}$) for standard heating and cooking purposes. Its unique properties make it a versatile energy source. In comparison with other fuels employed for household cooking around the world, LPG has clear cut benefits in terms of health, efficiency, availability and climate impact. Perhaps the most compelling argument against other energy source is their inability to even consider the fact that threat to climate change is imminent. According to Williams [14], if average African household switched to LPG, each family would have saved 120 kg of firewood annually. In addition, it is estimated that if half of the number of households currently cooking with solid fuels switched to LPG, it can provide health and productivity gain of more than USD 900 billion over the next ten years [13].

Fortunately for Nigeria, she is blessed with a proven gas reserve of more than 187 trillion cubic feet [15]. This suggests that Nigeria can stabilize carbon emission through massive development, investment and utilization of LPG thereby entrenching Low Carbon Economy (LCE). According to Okonjo-Iweala [1], the multiplier effect of investment and savings from the sale of gas and associated LPG is estimated to yield a net present value of $7.5 billion over the next 25 years, besides the environmental impacts. Despite resources availability and other empirical benefits, only about 5 percent of Nigeria's households use LPG, with total annual consumption of paltry 150,000 metric tonnes. This translates into 0.9 kg per capita, compared to Senegal annual per capita consumption of 13 kg with its 12.77 million and the West Africa regional average of 3.5 kg. Without doubt, Nigeria is ranked among the lowest consumers of LPG in Africa. Given her population, Nigeria could consume more than 3.5 million MT if LPG was its major fuel for cooking but reliable data shows that Nigeria recorded about 39 percent growth in domestic consumption of LPG between 2005–2012, indicating a very slow growth over the years notwithstanding government interventions [15].

Low consumption and growth of LPG market in Nigeria has been attributed to many factors. The question of availability, affordability, income, government and international oil policies, other household characteristics such as price has been noted as some of the factors influencing demand for energy choices among households such as price [12,14,16]. It is evident that LPG market responds to market changes in international oil prices; from primary law of demand that increase in international price of LPG affect domestic consumptions as consumers move down the energy chain towards other energy alternatives. Houthakkar and Talor [17] argued that consumers may continue to make purchases on the basis of habit even if prices have changed. Other hindrances to the growth of LPG market include subsidization of kerosene by successive governments in Nigeria, low public awareness, poor infrastructures, and lack of investment in the gas value chain [18]. Like in other markets in Nigeria, LPG market is constrained by poor market infrastructure and logistics challenges [19]. The implication of poor market access is low energy utilization with adverse effect on economic growth. Therefore, the need to reverse this trend in order to fully maximize the benefits therein makes the consideration of this study imperative.

The strength of this study lies in its contribution to mitigating the challenges of climate change impact in Nigeria; the need to expose the extent to which households have access to LPG and the problems encountered by households in their bid to access LPG. Several studies in time past left these issues outside its purview and concentrates on energy preference [16]; household fuel use and fuel switching [12]; LPG pricing situation and analysis of household energy use and indoor air pollution [13]. This present study is anchored on the following specific objectives: determine the factors influencing access to LPG; identify the preference pattern of selected cooking energy outside LPG and problems associated with its use in the study area. The following hypotheses were tested:

$Ho_1$: Availability does not influence access to LPG among households

$Ho_2$: income has no effect in the demand for LPG among households in the study area.

## Theoretical Framework

It is undoubtable that Nigeria with its population strength has a large energy requirement for cooking. These energies include but not limited to biomass fuel and Gas (propane, butane and LPG). However, there appear to be a class structure in terms of choice, adoption and demand for cooking energy in Nigeria, nay developing countries. For instance, fuel-wood and charcoal account for 70 percent of total energy used in cooking and heating among households especially in the rural areas [8]. This choice is assumed to be as a result of energy poverty. According to Reddy [11], energy poverty is the absence of sufficient choice in accessing adequate, affordable, reliable, high-quality, safe and environmentally benign energy services. The absence of sufficient choice can manifest in either of two main ways: quality and quantity, which lend credence to the fact that poverty is a major limiting force in energy choice among households in Nigeria [20]. It is well established that poverty and income inequality in Nigeria is mostly a rural phenomenon, as such it reflects in household choice of energy consumption which in most cases are limited to quantity and affordability. This denies households the unique experience of broadening their choice of fuel choice or energy substitution; unless their economic situation improves.

The situation is somewhat different in urban areas where choice

of energy consumption is broader and mainly built on the concept of fuel substitution and energy mix, occasioned by improved economic situation and other variables. This idea is encapsulated in energy ladder hypothesis model [21,22]. From a point of economics, the hypothesis reflects the understanding of income elasticity of demand. The model emphasizes that energy choice and acquisition is a function of socio-economic characteristics of consumers. According to Masera et al. [22], as households gain socio-economic status, they abandon technologies that are cheaper, and start using more modern technologies. Theoretically, this is true. In reality, household cooking energy choice is dynamic with complex set of decisions and factors considered. In Nigeria for instance, despite evidences of improved economic conditions and reduction in prices of modern fuel, evidences have shown that infinitesimal number of households showed interest in the adoption of modern energy sources. The reluctance to climb the energy ladder is due in part to certain identified challenges [20,23].

The above scenario described the operation of energy ladder at the micro level. At the macros level, energy consumption increases with development and is also accompanied by higher reliance on modern fuel [21]. Energy required for cooking is a two edge sword. One, it is a major contributors of climate change impact and secondly, an important element of sustainable development. In response to these, many nations are investing massively in clean energy coupled with good policies aimed at reducing emission from energy related substances. One of such clean energy in abundant supply in Nigeria is LPG, which is mentioned in the context of sustainable development [14]. In this study, LPG is seen as a preventive measure and resilient strategy to reduce impact of climate change. Therefore, Nigeria government must show commitment through good policies to increase its adoption as an investment and its contribution in the fight against climate change.

## Methodology

Abia State is the study area. Abia State is in southeastern Nigeria and one of the oil producing States of the Niger Delta. The state lies between longitude 04° 45' and 06° 07' North and Latitude 07° 00' and 08° 10' East. Abia state is bounded by Imo state at the western border; Ebonyi and Enugu states at the North; Cross River and Akwa-Ibom states at the East and Rivers state at the south. Its population stood at about 2.883.999 persons with a relatively high density at 580 persons per square kilometer [24]. Abia state is divided into administrative blocks called Local Government Areas, which is further grouped into three (3) agricultural zones namely, Ohafia, Umuahia and Aba zones.

The primary occupation of the rural populace is farming while those at the urban centers are reputedly known for their enterprising, entrepreneurial, and industrious and highly market orientation. Civil servants also make up a large population of the people in the state.

In terms of data collection, mixed research methods were employed in the selection of respondents and locations. The study purposively selected two urban areas of the state – Aba and Umuahia, while 120 households, 60 each from the two (2) urban areas were randomly selected for the study. Data for the study consist mainly of primary and collected with the aid of questionnaire administered on the households (housewives) who consented to participate in the study. The interest in housewives is sequel to their roles as homemakers and major participant in the kitchen buying process.

Analytically, the study employed descriptive statistics such as frequencies and percentage, and probit regression in order to realize the objectives of the study. The choice of Probit regression model especially was due to the binomial response of the dependent variable. Probit model constraints the estimated probabilities to be between 0 and 1; this is not peculiar to probit model alone since it share similar characteristic with logit model. However, the differences in the results of both classes of models are often negligible [25]. The strength of both over other models is that its significance and the individual coefficients can be tested. Therefore, the stability of the model can be assessed more effectively than in other models. The independent variables constitute important factors that are consistent with *a prior* and from literatures that exert influence on whether or not to use LPG by $i^{th}$ household. These views are in line with those of authors such as Agwu et al. [26]; Quedraogo [16]; Ogwumike *et al.* [20] and Mensah and Adu [27]

The Probit model for the estimation of access to LPG by households is specified thus:

$$P(Y=1/X)=F(XB)=1/\sqrt{2\Pi}\int_{-\infty}^{XB} e\frac{-(XB)2}{2}dx \quad (1)$$

Where: $X=(1, x_{1i}, x_{2i}, \ldots\ldots\ldots x_{ki})$

$\beta'=(\beta_0, \beta_1, \ldots\ldots\ldots\ldots..\beta_k)$

Y=vector of dependent variable (1 for $i^{th}$ household with access to LPG; 0 for $i^{th}$ household without access to LPG);

X=vector of explanatory variables (predictors);

α=Probit coefficients;

e random error term.

i=

The explanatory variables included in the model are: For this study, the following independent variables were used: household size, monthly income, availability, education of household head, price of LPG/12.5 kg cylinder, price of kerosene/25 litre can, price of firewood, household size, ownership of dwelling etc.

The output of the probit model parallels the output from traditional Ordinary Least Squares (OLS) estimates techniques [28-30]. The parameter estimate of each independent variable (Xj) is reported with an (asymptotic) standard error and t-test. However, interpretation of the parameter estimates is slightly different. Each one unit increase in the explanatory variable leads to increasing the probit index by 0.08233 standard deviation [30].

## Results and Discussion

Table 1 show that the respondents are mostly married adults, mature and could take decisions in their respective families. This result is consistent with a priori expectation. Also, majority of the respondents have a bloated household size. This has a strange implication in terms of pressure on household income and ability to demand for quality and modern energy source in place of quantity energy source. In terms of education, majority of the respondents are literate, which implies that they understand the dangers of environmental hazard. Finally, the table observed that only about 43 % of the households earn N101000 and above, that is approximately $507.53 at current exchange rate. This shows that the daily income of each household on an average is $16.92. This is small compared with the cumulative expenditure of the $i^{th}$ household.

From the results as shown in Table 2, education of household head, income level, price of LPG, availability and distance from the house to place of purchase were statistically significant at various level with different signs. Education was positive and significant at 10 percent level. This implies that the higher the level of education of the household,

| Characteristics | Frequency | Percentage |
|---|---|---|
| **Age** | | |
| 31–40 | 56 | 49 |
| 41–50 | 32 | 27 |
| 51–60 | 28 | 23 |
| 61–above | 4 | 3 |
| **Total** | 120 | 100 |
| **Marital status** | | |
| Married | 104 | 87 |
| Single | 16 | 13 |
| **Total** | 120 | 100 |
| **Education:** | | |
| Primary | 4 | 3 |
| Secondary | 20 | 17 |
| Post-secondary | 24 | 20 |
| University | 48 | 40 |
| Others | 24 | 20 |
| **Total** | 120 | 100 |
| **Household size**: | | |
| 0–4 | 24 | 20 |
| 5–9 | 76 | 63 |
| 10–14 | 20 | 17 |
| 15–above | - | - |
| **Total** | 120 | 100 |
| **Income**: | | |
| 20,000–40,000 | 26 | 22 |
| 41,000–60,000 | 24 | 24 |
| 61,000–80,000 | 6 | 5 |
| 81,000–100,000 | 12 | 10 |
| 101,000–above | 52 | 43 |
| **Total** | 120 | 100 |

Source: Computed by the authors

**Table 1:** Socio-economic profile of the households.

| Variables | Co-efficient | Standard errors | t-values |
|---|---|---|---|
| Education of household head | 0.03372 | 0.01716 | 1.96503* |
| Income | 0.03546 | 0.01101 | 3.22071*** |
| Price of alternative sources of energy | 0.00001 | 0.00004 | 0.21111 |
| Price of LPG | -0.00062 | 0.00012 | -5.16667*** |
| Availability | -0.00043 | 0.00017 | -2.52397*** |
| Distance | 0.07149 | 0.03130 | 2.28403** |
| No of times | -0.01638 | 0.08115 | -0.20189 |
| Age of household head | 0.051638 | 0.02964 | 1.79049 |
| Ownership of dwelling | -0.00572 | 0.04821 | -0.011867 |
| Household size | -0.00660 | 0.05216 | -0.12642 |
| Constant | -4.13284 | 0.081346 | -5.08059 |
| Chi-square | 106.291 | | |
| DF | 55 | | |
| P | 0.000 | | |

Source: Computed by the authors
***1%, **5%, and *10% level of significance respectively

**Table 2:** Determinants of access to liquefied petroleum gas (LPG) among households in Abia State.

the greater the chances of having access to LPG. A possible reason for these finding is that education enhances individual awareness of the detrimental effect of our decision on the environment and knowledge varying from nutrition to the use of things [20,31]. This result also agrees with UNDP/ESMAP [12] and Quedraogo [16]. It is believed that the tendency to increase the use of modern and quality energy source will be higher with the knowledge and awareness that LPG produces cleaner and safer fuels.

The coefficient of income was also positive and significant at 1 percent level. This result is consistent with *a priori* expectation. This result implies that the higher the income levels of the household head, the higher the probability of having access to LPG. This result agrees with those of Quedraogo [16] in a study on household energy preference for cooking in urban Quagadougou and Ogwumike et al. [20].

Price was significant at one percent level but has a negative coefficient. This means that as the price of LPG increases, the probability of households having access to the product decreases. This result is typical of the basic concept of demand. This result is also in line with Quedraogo [16]. Availability (level or degree of availability) was also significant at one percent level but with a negative coefficient. This implies that non-availability of the product reduces access. It is known that in the past 10-15 years, most of Nigerian's domestic petroleum products, LPG inclusive are refined outside Nigeria. Furthermore, according to Williams [14], about 58,000 tonnes of LPG used in Nigeria as at 2006 was imported from Benin Republic. Given this scenario, the result of this study did not come as a surprise. More so, distance from the point of sale to resident was positive and significant at 5 percent level. This means there is a positive relationship between (distance) place of purchase and household's access to LPG. This result is in contrast with many previous studies on access such as Agwu et al. [32]; Kamara [33]. These studies suggest that the closer the point of purchase to households, the more access or greater the chances of using the items.

The diagnostic statistics showed that chi-square value is 106.291 with *df* value is 55. This value showed that P>0.05. We reject $Ho_1$ and $Ho_2$, because we have statistically significant evidence at α=0.05 to show that $H_0$ is false.

Table 3 showed that the predominant challenges to LPG use are product unavailability, psychological fear of explosion and high cost of starting up among others. In terms of starting up, these costs are linked to the cost in purchasing the burner, cylinder and filling and refilling the gas itself. When compared with other energy sources like kerosene, fuel wood and coal, intending households may be discouraged.

The above Table 4 shows that kerosene ranked first as the most preferred cooking energy used in place of LPG by households. This result is expected given that price of kerosene is relatively cheap as a result of government subsidy and little prestige it offers to households in urban areas than other energy sources such as fire-woods. In most urban areas, fire-woods, charcoal and saw dust are mostly used by food vendors and restaurants.

## Conclusion

In response to increasing environmental threat, the major focus

| Problems | Frequencies | Percentages |
|---|---|---|
| High cost of starting up | 105* | 87.50 |
| High cost of refilling the cylinder | 92* | 76.67 |
| Weight of carrying the cylinder about | 100* | 83.33 |
| Danger of explosion | 110* | 91.67 |
| Unavailability/unstable supply | 120* | 100 |

*Multiple responses
Source: Computed by the authors

**Table 3:** Problems associated with LPG use in the study area.

| Energy source | No. of respondents | Percentage | Rank |
|---|---|---|---|
| Kerosene | 92 | 76.66 | 1 |
| Firewood | 15 | 12.50 | 2 |
| Coal | - | - | - |
| Saw dust | 4 | 3.34 | 4 |
| Charcoal | 4 | 3.34 | 4 |
| Electricity | 5 | 4.16 | 3 |

Source: computed by the authors

**Table 4:** Preference pattern in the use of selected cooking energy sources outside LPG.

on global development agenda is towards sustainable development. To achieve this, many countries are making massive investment in energy that is cleaner with low carbon. The focus on energy is because it is a two edge sword – it is a major contributor to climate change impact and an important element of sustainable development. This study focused on factors that determine access to LPG as an important energy source required for cooking by urban household. The consideration of LPG is because it is mentioned in the context of sustainable development. Unfortunately, its consumption in Nigeria can at best be described as abysmally low. As a measure to improve demand for LPG, this study observed that education, income, price of LPG, availability and distance hinders efforts to access this modern and quality energy. The preference for other less costly energy source for household cooking is seen as a result of energy poverty, given that one of the major hindrances to LPG demand is high cost of startup. On the strength of the findings, this study recommends that prices of LPG, should be made affordable and product should be highly available. Finally, safety and public sensitization campaigns should be organized to educate households on the use of LPG and negative impact of climate change. This will help ease the psychological barrier that discourages household demand for LPG. The idea is to use LPG as a preventive measure to prevent the worst effect of climate change.

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