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CONSUMPTION OF LIQUEFIED PETROLEUM GAS AND ITS DETERMINANTS: A PROSPECT FOR INDISCRIMINATE TREE HARVESTING IN IMO STATE, NIGERIA

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ABSTRACT

The study analysed the consumption of liquefied petroleum gas and its determinants as a prospect for indiscriminate tree harvesting in Imo State, Nigeria. A total number of 96 questionnaires were distributed but only 90 of them were returned. Data collected were analysed using both descriptive and inferential statistics. Result shows that the weekly fuel wood and liquefied petroleum gas consumed by the households in the study area were 514.326MJ (37.27KG) and 65.92MJ (1.43KG) respectively. The result also identified indoor pollution, eye defect and loss of biodiversity with weighted means of 2.64, 3.00 and 2.67 respectively as very serious problems of fuel wood use. Result showed that clean fuels (as well as afforestation), ethanol cook stove, crop residue/animal dung and solar/water energy sources which ranked 1st, 2nd, 3rd and 4th respectively were the major prospects for indiscriminate tree harvesting in the study area. Results also indicated that at 1% levels of significance, price of liquefied petroleum gas, price of kerosene, household expenditure, household size and number of times electricity was available per month were the major determinants of liquefied petroleum gas consumption in the study areas. Given the urgency of the clean energy access, the paper recommends that relevant stakeholders should prioritize efforts and financial supports geared toward the alleviation of the problems of indiscriminate tree harvesting. It also advocates for LPG subsidization to encourage more users of the fuel.

Keywords: Indiscriminate wood harvesting, loss of bio-diversity, clean energy

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1.0 INTRODUCTION

Energy consumption is a very important aspect of human existence. The pattern of energy consumption in a family can serve as an expression of their welfare and level of achievement in life. It has the capacity to unlock sustainable economic growth, improve human health and well-being and enable women and children to lead more productive lives (United Nation, 2018; Corfee-Morlot, Paul, James and Famous (2019). It is not out of place to say that clean energy for all is critical to achieving the most desired United Nations Sustainable Development Goal number seven (7) adopted for 2030 which is to ensure access to affordable, reliable, sustainable, and modern energy for everyone. Despite the efforts by many counties towards achieving this goal, available statistics showed that in 2014, 3.04

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billion people in the world had no access to clean cooking fuel and of these, about 800 million people were from sub-Saharan Africa (United Nations Environment Programme (UNEP), 2019). To further buttress this point, International Energy Agency (2018) estimated that 600 million people in sub- Saharan region lack electricity and 890 million cook with traditional fuels such as fuel wood, animal dung, charcoal, crop residue etc.

Climate change has always been attributed to natural occurrences; however, there is now strong evidence that human activities are the main drivers of the recent increase in global temperatures, precipitation patterns and extreme weather. Greenhouse gases are released as a result of these two events (natural disaster and human activities) which are seemingly unrelated. It is worthy to note that the most significant and impactful greenhouse gas is the Carbon (IV) Oxide (Chikezie *et al.,* 2019). Other greenhouse gases include methane, nitrous oxide, fluorinated gases. The rising concentration of these gases in the earth's atmosphere is the cause of global warming. Available literatures have shown that the three primary sources of human-induced greenhouse gas emission are agriculture, burning of fossil fuels and change in land use patterns (Organization for Economic Co-operation and Development (OECD), 2019). Change in land use pattern involves the clearing of forests for cultivation, industry, and more so for domestic and industrial energy use. When ecosystems are altered and vegetation is removed for any of reason, the carbon is released into the atmosphere in the form of Carbon (IV) Oxide. According to UNEP (2019), an estimated 1–2.4 Gt of Carbon (IV) Oxide equivalent in greenhouse gases are emitted annually in producing fuel wood and charcoal in sub-Saharan Africa; this amount is approximately 2-7 per cent of global anthropogenic emissions.

Forests are natural resources that are essential for a healthy environment. According to Panagiotis (2018), they house many species, stabilize the soil, improve soil fertility, reduce the velocity of wind, protect watershed, provides products like timber, firewood, fruits etc. Literature has it that Africa relies predominantly on fuel wood and charcoal for its energy requirements more than other continents of the world. In countries like Nigeria, fuel-wood is specially known as the major source of cooking and heating energy for many rural dwellers. As at 2008, about 72.3 percent of Nigerian people rely on traditional biomass (fuel wood, charcoal, dung and agricultural residues) for cooking (UNEP; World Health Organization (WHO), 2009). Also, report by Maduka (2011) indicated that more than 54 percent of the total population in Nigeria rely on fuel wood or charcoal for their energy need. To this end, Food Agricultural Organization (2020) explains that an excessive deforestation without appropriate forest management has a devastating effect on the environment. According to their report, the adverse effects of deforestation include loss of biodiversity, migration of wildlife, ecological imbalance, flooding and desert encroachment. Deforestation also interrupts the normal nutrient cycle of the forest, increases nutrient leaching and makes the topsoil susceptible to erosion (Joseph, 2003; Arcenas *et al.,* 2010). Maduka (2011) further explained that the use of firewood predisposes the locals to the side effects of incomplete combustion such as indoor air pollution and lung diseases.

Heavy dependence on wood fuel for cooking and heating needs is primarily due to the lack of access to modern energy sources, such as electricity, kerosene and liquefied petroleum gas as

well as the cost of using them. Nigeria is a country richly blessed with natural resources such as oil and gas. Liquefied Petroleum Gas (LPG) as one of the products of natural gas and with its unique properties can serve as a better alternative to fuel wood for heating and cooking purposes. LPG burns efficiently without producing smoke, a quality which is capable of reducing indoor pollution. It is easily liquefied, stored in pressured containers and easily transported in cylinders to end users. LPG is safer to use because of the packaging and is less susceptible to adulteration than kerosene. It emits much less Carbon (IV) Oxide when burned than fuel wood and other traditional fuels (Maduka, 2011). Given the epileptic nature of electricity supply in Nigeria, liquefied gas is a better source of clean energy that can help achieve the Sustainable Development Goal number seven (7) of ensuring access to affordable, reliable, sustainable, and modern energy for all. Based on the foregoing, this paper estimated the quantity of fuel wood and liquefied petroleum gas consumed, examined the problems associated with the use of fuel wood (deforestation) as a domestic energy source, identified some prospects for indiscriminate tree felling and analysed the determinants of liquefied petroleum gas consumption in Imo State, Nigeria.

2.0 THEORITICAL AND CONCEPTUAL FRAMEWORK

2.1 Energy Transition

Since majority of the world's economic growth is powered by fossil fuels it means that anthropogenic climate change is one of the greatest threats to the earth's ecosystem. This is an indication that something urgent needs to be done and this involves creating the demand for energy system decarbonisation (International Energy Agency (IEA), 2019). The world must switch from high-carbon fuels like coal and oil to low carbon non- renewable energy options like natural gas. Indeed, natural gas has the lowest carbon content of the primary fossil fuels used in power generation. Energy transition is therefore defined as a pathway toward transformation of the global energy sector from fossil-based to zero-carbon (Notter, 2015). It promotes the move to reduce energy-related Carbon emissions which also has the capacity to reduce global warming. Energy transition refers to significant structural change which is determined by the availability of cleaner fuel sources (International Renewable Energy Agency (IRENI), 2018). It is driven by the global call to shift from fossil fuel energy to renewable energy sources. Energy transition could also entail a strong move towards increased sustainability of the ecosystem.

3.0 MATERIALS AND METHOD

The study was carried out in Imo State which is situated in tropical rainforest zone of Nigeria. Imo state shares common boundaries with Abia State on the East and North-East, Rivers State on the South, and Anambra state on the West and North-West. The state lies between latitudes 4°45'N and 7°15'N, and longitude 6°50'E and 7°25'E with an area of 5,100 Square kilometers (National Population Commission (NPC), 2006). Imo state is divided into Owerri, Okigwe and Orlu Agricultural Zones. The state has several natural resources including Limestone, Lead, Calcium Carbonate and zinc. The major occupation of the local people is farming and they produce food crops like cassava, cocoyam, yam, maize,

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melon, vegetables, etc. and livestock such as poultry, sheep, goat, and rabbits at subsistence levels

Four-stage purposive sampling technique was adopted for this study. From each agricultural zone, two (2) Local Government Areas (LGAs) where a good number of Liquefied Petroleum Gas users reside were purposively selected. The LGAs selected were Owerri, Ohaji Egbema, Oru-East, Orlu, Okigwe and Obowu LGAs. The second stage involved the purposive selection of four (4) autonomous communities giving to a total of twenty-four (24) communities. Out of the selected communities, 2 villages each were selected, giving a total of forty-eight (48) villages. From each village, 2 households were selected giving a total sample size of 96 farming households. A total of 96 of questionnaire were administered out of which 90 were returned.

Primary data were obtained with the use of structured questionnaires as well as through personal interviews. The variables on which primary data were collected include: socio economic characteristics of the farming households, awareness of harmful effects of using traditional fuels and technologies and the adoption of clean energy and modern technologies for cooking. The questionnaires were administered to individuals who are responsible for cooking/heating energy decisions in the household. In order to have a common basis for comparison the cooking energy (LPG originally measured in kilo grams) and its close substitute (kerosene measured in kilogram) were both converted to mega joules. LPG has a typical specific calorific value of 46.1 MJ/kg (Organization for Economic Cooperation and Development (OECD), 2017) while kerosene has caloric value of 35.2 MJ/kg (U.S. Department of Energy 2008). Firewood, on the other hand, contains caloric value of 13.8MJ/kg (FAO, 2004)

Descriptive statistics (3-point likert type scale) was used to examine the problems associated with the use of fuel wood as a domestic energy source and to identify some prospects for indiscriminate tree felling. The ranking was done by first calculating the mid-value and then used to compare individual weighted mean of each problem (and prospects). Ordinary Least Square Regression analysis was used to analyze the determinants of Liquefied petroleum Gas. The explicit form of the regression model is as follows:

$$Y = \alpha_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_8 X_8 + ei \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{ eqn (1)}$$

Where:
Y = Households liquefied petroleum gas consumption (KG) / month
X_1 = Price of liquefied petroleum gas (Naira)
X_2 = Price of close substitute (kerosene) (Naira)
X_3 = Household expenditure (Naira/month)
X_4 = Household size (Number)
X_5 = Age (Years)
X_6 = Primary Occupation (1 if farmer; 0 if otherwise)
X_7 = Electricity supply (Number of times electricity was available per month)
X_8 = House Ownership (1 if Landlord; 0 if Tenant
e = error term

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It is expected *a priori* that X_2, X_3, X_4, $X_8 > 0$; X_1, X_5, X_6, $X_7 < 0$.

The Consumption function were fitted into four different functional forms (linear, exponential, double log and semi-log) and the one with the best fit in terms of its conformity to *a priori* expectation and statistical robustness was chosen as the lead equation

4.0 RESULTS AND DISCUSSION

4.1 Fuel Wood Energy Consumption

Table 1 presents the distribution of respondents according to weekly consumption of fuel wood.

Results in Table 1 show that while 18.88% of the respondents consumed between 289.8 – 414 Mega Joules (MJ) of fuel wood per week, 44.44% of them consumed between 427.8 – 552MJ of the fuel in one week. The result also shows that the remaining (36.68%) of the households consumed between 565.8 – 690MJ which are equivalent to 41 – 50KG of fuel wood per week. Average fuel wood consumed by the households in the study area was 514.326MJ (37.27KG). The finding on fuel wood energy compares to the findings by Onyeneke (2015) who worked on the determinants of fuel wood consumption in Imo State and found that on the average, a farming household consumes 21.5kg/week of fuel wood which is equivalent to 296.7MJ/ week. This implies that the forest in the area is under pressure and if no urgent step is taken to ensure forest regrowth, it may lead to excessive loss of biodiversity and desertification. The finding on fuel wood energy consumption is not surprising considering the reports by Food and agricultural development (2016) which states that Africa consumed a total of 665.6 million m3 of fuel wood in 2015 of which Nigeria ranked 3rd with a total consumption of 65 million m3 of fuel wood.

4.2 Problems Associated with Fuel Wood Use in the Study Area

Table 2 presents health and environmental challenges associated with tree harvesting for cooking or heating

A 3-point likert type scale was used to examine the problems associated with the use of fuel wood as a source of domestic energy for cooking /heating in the study area. The mid-value of 2 was estimated. The result shows that 36.25% of the respondents adjudged indoor air pollution as a serious problem while the remaining (57.85%) respondents considered the problem as a very serious one. The weighted mean value of 2.64 was estimated for indoor pollution. This finding is in line with Obayelu, Lawal, and Omotuyole, (2017) who confirms that incomplete combustion of fuel wood is a major cause of indoor pollution and also a very serious health related problem. Also, 15.00% of the energy end users adjudged high incidence of lung disease as very serious while 36.25% of them perceived it as a serious problem. According to Nwofe (2013), regular use of fuel wood is associated with many health risks such as respiratory and pulmonary diseases. The remaining 48.75% considered lung disease as a problem that is not serious. The weighted mean value for high incidence of lung disease is 1.66.

All the respondents perceived eye defect as a very serious problem encountered in the use of firewood as an energy source for cooking and heating with weighted mean value of 3. Also,

majority (67.50%) of the energy end users adjudged loss of biodiversity as a very serious problem of deforestation while the remaining 32.50% perceived it as a serious problem. The result also shows that 30.00% of the respondents agreed that there is increasing atmospheric carbon to a very reasonable extent, 29% of them agreed that it was not a serious problem at all while the remaining 41.25% considered it was serious. About 35.00% (WM =2.67) indicated that loss of top soil was not a serious, 42.50% saw it as a serious problem while the remaining 22.50 % adjudged it as a very serious problem. The estimated weighted mean values for loss of biodiversity, increased atmospheric carbon and loss of top soil were 2.67, 2.02 and 1.88 respectively. From the Table, the problem eye defect ranked 1st. This was followed by loss of biodiversity, indoor pollution, and increased atmospheric carbon, loss of top soil and high incidence of lung disease which ranked 2nd, 3rd, 4th, 5th and 6th respectively. These health conditions identified by energy end users in the study area are in conformity with available literature. According to UNEP (2019), the health impacts of using fire wood for cooking and heating include respiratory problems, eye irritations, headaches and backaches.

4.3 Prospects for Indiscriminate Tree Harvesting for Energy Use

Table 3 shows the responses of farmers on the various ways to solve the problem of deforestation in the study area.

All the respondents indicated the transition to a cleaner fossil energy (LPG) and afforestation as the solution to the problem of incessant and uncontrolled deforestation for energy use. Also, the use of ethanol cook stove was adjudged a sustainable practice and a better energy source than fuel wood by 93.75% of the respondents. These finding are supported by UNEP (2019) which affirms that avoiding health risks associated with fuel wood will involve switching to clean fuels such as LPG or adopting advanced cook stoves that burn biomass more cleanly and efficiently. Approximately 88% of the respondents indicated the use of crop residue or animal dung as a good substitute for fuel wood. While 43.75% of the energy users adjudged the use of solar energy or water energy as a good substitute for firewood, 31.25% of them believed that agroforestry is a sustainable practice for solving the problem of indiscriminate felling of trees.

4.4 Liquefied Petroleum Gas Consumption

The distribution of respondents according to weekly consumption of liquefied petroleum gas is presented in Table 4.

Table 4 reveals that the weekly consumption of LPG in the study area ranges from 46.1MJ (1.0KG) to 69.15MJ (2.7KG) with an average consumption of 65.92MJ (1.43KG). Majority (75.55%) of the respondents consumed between 46.1MJ and 69.15MJ of LPG within a period of one week. While 18.88% of the respondents consumed between 73.76MJ and 96.81MJ, approximately 6.0% of them consumed between 101.42MJ and 124.47MJ. The result is consistent with findings of Chidiebere-Mark, Agunanne and Anyanwu (2018) who worked on determinants of cooking energy consumption among farming households in Owerri agricultural zone, Imo State, Nigeria. According to the study, the average consumption is the

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farming households consumed 1.56 KG of liquefied petroleum gas which equivalent to 71.92MJ weekly

4.5 Determinants of Farming Household Liquefied Petroleum Gas Energy Consumption

Table 5 shows the results of factors that influence farming household liquefied petroleum gas energy consumption.

The four functional forms were tried and the lead equation (Double Log) was chosen based on the R^2 values, F value and the number of significant explanatory variables. From the results, therefore the lead equation is double log functional form with the R^2 value of 0.648071. This means that 65% of the variations in the dependent variables (gas consumption) were explained by the included variables. The F value of 10.82 which is significant at 5% level was estimated. The result also shows that out of the included variables, price of gas, price of close substitute (kerosene), household expenditure, household size and number of times electricity was available per month (Electricity supply) were significant at 1% level of significant while house ownership was significant at 10% level of significant.

As expected, price of LPG is negatively signed and significantly related to its consumption at 1% level. This means that as price of gas decreases by 1 naira, the gas consumption increases by 0.10974. Price of close substitute is positively and significantly related to gas consumption at 1% level meaning that as the price of close substitute increases by 1 naira, the gas consumption increases by 0.194582. This result on kerosene is in line with *a priori* expectation of direct relationship. Household income (which is represented by household expenditure) is positively signed and significantly related to gas consumption at 1% level and this indicates that as household income increases by 1 naira, the gas consumption increases by 0.110513. This conforms to the *a priori* expectation a direct relationship between income of household and quantity of gas consumed. The result also shows that against *a priori* expectation, household size is negatively signed and significantly related to gas consumption at 1% level indicating that as price of gas decreases by 1 naira, the gas consumption increases by 0.13328. Finally, a direct relationship is estimated for electricity supply and it is significantly related to gas consumption at 1% Level. Though this was contrary to *a priori* expectation, it shows that as number of times electricity is supplied increases by 1 unit, the gas consumption increases by 0.517525.

5.0 CONCLUSION

Having identified and analysed the quantities of domestic energy consumed, problems and prospects associated with indiscriminate deforestation for energy use, the paper concluded that the consumption of fuel wood energy in Imo is high. The paper also concluded that the quantity of liquefied petroleum gas consumed is appreciable and farming households in Imo State are beginning to understand the importance of using clean energy such as LPG for cooking and heating. This is evidenced in the increasing number of liquefied petroleum gas users in the State. The major driving factor for LPG consumption are price of LPG, price of firewood, household size, household expenditure and electricity supply. The prospects

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examined will help to solve the energy need of the present generation without compromising the integrity of the ecosystem for future generation.

6.0 RECOMMENDATIONS

Based on the findings, this paper recommends the following:

i. In order to adequately ensure the achievement of Sustainable Development Goal on energy use, government and relevant agencies should create significant consumer awareness on the opportunities and benefits of clean energy cooking.

ii. It advocates for supports from governments and non-governmental organizations to ensure a rapid transition to cleaner fuels which include ethanol, liquefied petroleum gas and natural gas.

iv. The price of LPG should be subsidized to encourage more users of the fuel.

v. The paper advocates the planting of more trees in order to sustain the integrity of the ecosystem.

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APPENDIX

Table 1 Distribution of Respondents by Fuel wood Energy Consumption/ week

Energy Consumed in Kilogram (kg)	Energy Consumed in Mega Joule (MJ)	Frequency	Percentage
21 – 30	289.8 - 414	17	18.88%
31 – 40	427.8 - 552	40	44.44%
41 – 50	565.8 - 690	33	36.68%
Total		90	100

Source: Field Survey Data, 2018 Mean = 37.27KG (514.326MJ)

1kg firewood = 13.8MJ (FAO, 2004)

Table 2: Distribution of farmers' perception on challenges of using fuel wood

Problems	Not serious	Serious	Very Serious	Weighted Mean (WM)	Rank
Indoor pollution	0 (0)	29 (36.25)	51 (57.86)	2.64	3rd
High incidence of lung disease	39 (48.75)	29 (36.25)	12 (15.00)	1.66	6th
Eye defect/Blindness	0 (0)	0 (0)	80 (100.00)	3.00	1st
Loss of biodiversity	0 (0)	26 (32.50)	54 (67.50)	2.67	2nd
Increased atmospheric carbon	23 (28.75)	33 (41.25)	24 (30.00)	2.02	4th
Loss of top soil	28 (35.00)	34 (42.50)	18 (22.50)	1.88	5th

Source: field survey, 2018

Figures in parenthesis are percentages

Table 3: Distribution of farmers' responses on prospects for indiscriminate deforestation

Sustainable Practices	Frequency	Percentage	Rank
Use of solar/water energy	35*	43.75	4th
Use of cleaner fossil fuel (LPG)	80*	100.00	1st
Agroforestry	25*	31.25	5th
Afforestation/tree planting	80*	100.00	1st
Use of crop residue/animal dung for fuel	70*	87.50	3rd
Use of ethanol cook stove	75*	93.75	2nd

***Source: field survey, 2018; ****Multiple responses

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Table 4 Distribution of Respondents by Liquefied Petroleum Gas Consumption/ Week

Energy Demanded in Kilogram (kg)	Energy Demanded in Mega Joule (MJ)	Frequency	Percentage
1.0 - 1.5	46.1 – 69.15	68	75.55%
1.6 – 2.1	73.76 – 96.81	17	18.88%
2.2 – 2.7	101.42 – 124.47	5	5.57%
Total		90	100

Source: Field Survey Data, 2018 Mean = 1.437KG (65.92MJ)

1kg LPG = 46.1MJ (*OECD 2017****)***

Table 4.5 Results of factors that influence liquefied petroleum gas consumption

Explanatory variables	Double log	Standard Error	T -values
Price of LPG	-0.10974	0.306027	[-2.78866]***
Price of substitute (Firewood)	0.194582	0.526133	[2.703914]***
Household Expenditure	0.110513	0.316984	[2.868296]***
Household size	-0.13328	0.302112	[-2.82668]***
Age	0.001641	$6.460617e\text{-}^{5}$	[0.03937]
Occupation	0.035237	0.040637	[1.15335]
Electricity supply	0.517525	2.08236	[4.023695]***
House ownership	-0.08635	0.15825	[-1.83276]*
Constant	-4.61337	19.8365	[-4.29978]
R^2	0.648071		
F-values	10.82		

*Source: field survey, 2018; *, ****= significant at 10% and at 1% respectively

Electricity supply = *Number of times electricity was available per month*