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COST ASSESSMENT OF LIQUEFIED PETROLEUM GAS (LPG) AND CHARCOAL, EFFECT ON CONSUMERS' HEALTH AND THEIR ENVIRONMENTAL IMPACTS IN DAMATURU LOCAL GOVERNMENT AREA, YOBE STATE, NIGERIA

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ABSTRACT

The importance of cooking fuels in the life of every household is not debatable because most food items must be cooked, smoked, dried or heated before consumption in Nigeria. This study was carried out to assess the Cost of Liquefied Petroleum Gas (LPG) and Charcoal, Effect on Consumers' Health and Their Environmental Impacts; in some selected communities in Damaturu, Yobe State Nigeria. A total of 100 questionnaires were administered to the participating households in some selected communities in Damaturu, purposive sampling techniques were used in generating primary data through questionnaire, and the data obtained were analyzed using descriptive statistics. The result of the study towards barriers, cost and rate of using Gas and Charcoals for cooking in Damaturu revealed that expensiveness of Gas as the factors that prevent consumers from using it as a cooking energy source (58.14%). Result on the bases of Perception on consequences of using gas and charcoal towards human health shows the risk associated with gas and gas cylinder in cooking as highest as that of the Charcoal with 88.37%.The Result also revealed perception of the environmental impact of using gas and charcoal for cooking in Damaturu that, Gas as the most suitable energy for cooking (34.88%). Therefore, both charcoal and cooking gas have been a source of energy in cooking and both the two have different usage process and contribute something to the well-being of domestic users. Countries therefore need to implement strategies to realize their energy policy goals in the area of cooking energy.

Keywords: Liquefied Petroleum Gas, Charcoal, Environment, Communities, Damaturu, Health, Yobe State

INTRODUCTION

Due to daily reliance on it for home purposes like cooking, lighting, and heating as well as for industrial, mechanical, communication, and transportation activities, energy is a crucial component of human existence. According to the International Energy Agency (IEA) (2006), cooking is the main households' use of energy in developing countries such as Nigeria (Arowola *et al.,* (2018). Given its significance for environmental protection, public investments, and household welfare, household energy consumption is a need. The pattern of household energy consumption indicates the state of welfare and economic development of an individual and of a particular country (Arowosoge and Faleyimu, 2011). The need for wood fuel damages forests around urban and semi-urban settlements in many developing nations, including Nigeria, as a result of ineffective and unsustainable management techniques. This leads to a loss in biodiversity, soil erosion and a decline in water and air quality (Wang *et al.*, 2019).

Deforestation is the loss of the vegetation cover usually as a result of forests being cleared for agriculture and other land practices resulting in global warming, climate change and loss of biodiversity. In Nigeria, most disturbance of forest is linked to fuel wood availability and cost, were others depend directly on forest for their livelihood, among them are a high number of forest and wood workers (Gana and Sa'id, 2022).

Human development is severely limited by the lack of access to dependable, secure, and, for the most part, ecologically friendly energy sources. In developing countries like Nigeria most of the rural as well as urban communities have less access to modern and clean energy sources and mostly depend on biomass fuels (woods, leaves, twigs, animal dung, charcoal and crop waste) for virtually all their energy needs (Bello, 2010). Urban household's energy is a significant concern for emerging nations due to population growth and urbanization. Urban households' excessive reliance on biomass fuels in sub-Saharan Africa causes deforestation, forest degradation, and land degradation. The widespread use of unhealthy, inefficient cooking techniques, especially by women and children who cook most often at home, worsens the demand for firewood. Due to indoor air pollution, using firewood for cooking contributes to the causes of several serious health issues in underdeveloped nations (Bruce *et al.,* 2000).

The World Health Organization (WHO) estimated that 7.3 million people worldwide die annually due to indoor air pollution, the use of solid fuels and approximately 60% of these deaths are attributable to household exposure to smoke from dirty cook stoves and fuels (WHO, 2018). This is equivalent to 4,000 deaths per day. In addition, it has been estimated that there are 40, 000 new cases of chronic bronchitis yearly due to exposure to soot and smoke from biomass fuels. Other health effects includes: acute respiratory infection, eye problems, chronic obstructive pulmonary disease, high blood pressure and lung cancer in adults, pneumonia in children, and even cataracts and low birth weight in Africa (WHO, 2010; Wang *et al.*, 2019).

Cooking gas refers to Liquefied Petroleum Gas (LPG) is recovered from natural gas (gas with considerable heavy petroleum compound) by absorption. The removed product has a low boiling point and must be distilled to remove the higher fractions and then be treated to remove hydrogen sulfide carbon dioxide and water, the finished product is transported by pipeline know as cooking gas. LPG; reaches the domestic consumer in a cylinder under relatively low pressure. The largest usage of the liquefied petroleum gas that

is cooking gas apart from domestic usage is the industrial usage (Gordon, 2020).

Charcoal is a solid biofuel obtained through the carbonization of wood. During the carbonization process – also called pyrolysis – high temperatures induce the absorption of heat which leads to the complete decomposition of the biomass, separating it into volatile gases, vapors and solid char. At 400°C, the transformation of the wood into charcoal is complete. At this stage, however, the charcoal still contains a considerable amount of tar which must be reduced through additional heating in order to achieve a final carbon content of around 80% (FAO and FMECD, 2014). The most significant commercial fuel made from wood is charcoal. It is suitable for a wide range of home and industrial uses, particularly for usage in urban environments. It is smokeless, can be used in a tiny, inexpensive stove, and can produce more heat than wood. Additionally, charcoal is safer to use than wood because it is more readily handled during shipping and distribution, requires less area for a given amount of heat output, and doesn't decay (Eniola *et al*., 2018). Therefore this study was aimed to assess the Cost of Liquefied Petroleum Gas (LPG) and Charcoal, Effect on Consumers' Health and Their Environmental Impacts; in some selected communities in Damaturu, Yobe State Nigeria.

MATERIAL AND METHODS

Study Area

The area of this study is Damaturu Local Government Area (LGA) of Yobe State. Its lies between latitude 11°39' 30'' – 11° 47' 00'' N and longitude 11° 54' 00'' – 12° 02' 00''E (Figure 1). The State Headquarters occupies a land mass of 2, 366 square kilometers and a population of 88, 014 (NPC, 2006). The Damaturu Town shares boundary with Tarmuwa Local Government Area from the North, Kaga Local Government Area of Borno State from the East, Gujba Local Government Area from South and Fune Local Government Area from the West. Damaturu town comprises of multi-ethnic groups including Kanuri, Fulani, Kare-kare and Badawa and other related tribes. The predominant occupations of the people are civil servants, farmers and other related businesses (Gana and Sa'id, 2022).

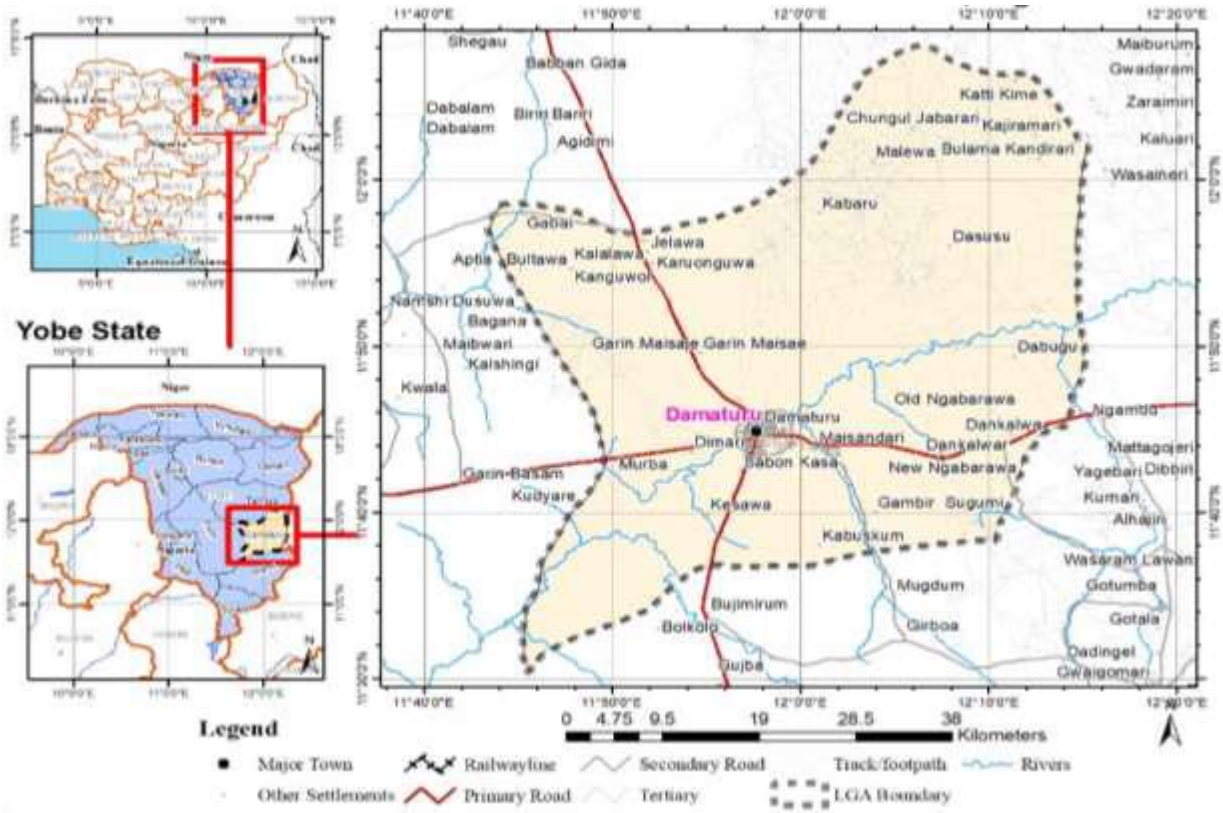

Figure 1**:** Map of Yobe State Showing Damaturu Town **Source**: Gana and Sa'id, 2022

Population and Sampling Techniques

Descriptive survey design and purposive sampling technique was adopted for this study. The data used for the study were obtained with the use of well-structured questionnaires.

Population of the Study

The estimated population from this study comprised of 1000 adults from different households across five political wards in Damaturu metropolitan namely; Bindigari (Ali Marami), Damaturu Central (Abasha), Maisandari/ Waziri Ibrahim (Waziri Ibrahim estate), Nayinawa and Njiwaji/Gwange (Pomoomari). The researcher, through the help of some research experts from the university identifies the targeted population from the various localities within the study area.

Sampling

The sample size for this study is 100 respondents. This number comprises twenty (20) respondents from the five (5) selected wards.

Instrument for the Study

For the purpose of this research, one instrument was developed and used by the researcher. That is a 26-item questionnaire was designed for this study. Questionnaire was based on a 5-point rating scale of Strongly Agreed (SA);

Agree (A); Undecided (UD); Disagree (D); and Strongly Disagree (SD).

Validation of the Instrument

The instrument was subjected to face validation by three experts from the Department of Biological Science, Faculty of Science; Yobe State University Damaturu.

Method of Data Collection

The questionnaire was administered by the researcher directly to various households and charcoal/gas sellers, and with the help of research assistants it was distributed to the Health Workers at various health clinics. The same method was adopted for the retrieval. The questionnaires were successfully administered and retrieved from the respondents.

Method of Data Analysis

The data generated was analyzed using frequency table and simple percentages. The data was presented in tabular form and percentages shows the level of significance of each response. The data was analyzed and discussed.

Formula:

$x = \frac{f}{n} * 100$

Where x = percentage of response

F = number of responses

N = total number of collected questionnaires.

RESULT

This data gathered was presented, analyzed and discussed through the following tables.

Table 1 below, seeks to present the perceived consequences of using gas and charcoal in cooking among residents of Damaturu. In item 1 which shows the most suitable fuel among gas and charcoal as they affects the environment revealed that 25.58% of the respondents strongly agreed with the statement, 34.88% agree, while 23.26% of the respondents disagreed, where 16.28% remained undecided.

Item 2 of the table which shows perception of the respondents in preferring charcoal as environmentally harmless energy for cooking shows 29.07% as strongly agreeing with the statement, 23.26 agreed, and another 23.26 were undecided while 12.79 and 11.63 strongly disagreed and disagreed respectively.

Item 3 is on the statement that gas produced mild impact to the environment which usage causes damages such as contamination of water, and excessive warming; 44.19% strongly agreed, 24.42% agreed, 11.63% were undecided on this, 5.81% strongly disagreed and 13.95% disagreed.

Item 4 in the table, charcoal produced mild impact to the environment which usage such as contamination of water, and excessive warming. On this, 40.70% strongly agreed, 20.93% agreed, while 11.63% were undecided. 12.79% strongly disagreed and 13.95% disagreed with the statement.

Table 1: Perception on the environmental impact of using gas and charcoal for cooking in Damaturu.

S/N	Statement	SA	%	A	%	U	%	D	%	SD	%
1	Gas is the most suitable energy for cooking that do not affect the environment.	22	25.58	30	34.88	14	16.28	10	11.63	10	11.63
2	Charcoal is the most preferable energy for cooking which remain harmless to the environment.	25	29.07	20	23.26	20	23.26	11	12.79	10	11.63
3	Gas produced mild impact to the environment while usage such as flammability which results in high risk of fire outbreak.	38	44.19	21	24.42	10	11.63	5	5.81	12	13.95
4	Charcoal produced mild impact to the environment which usage such as contamination of water,and excessive warming.	35	40.70	18	20.93	10	11.63	11	12.79	12	13.95

Table 2 is on the perception on consequences of using gas and charcoal towards human health. The table is made up of six items.

Item 1: gas usage in cooking promote radiation of gases which infect the respiratory system shows 34.88% of the respondents responding to the statement as true and 65.12% sees it as false.

Item 2: Charcoal usage contaminate water, land and promote occurrence of waterborne diseases. This statement is agreed by 69.77% of the respondents while the remaining 30.23% sees it as false.

Item 3: the statement that says charcoal when contact with body, stain cloth and result in itching with formation of rashes is confirmed as being true by 41.86% of the respondents and 58.14% falsify it.

Item 4: says "gas, when there is leakage from the cylinder will eventually distribute to the environment, causing irritable and chocking smell." 80.23% of the respondents agreed with the statement as true while 19.77% says it is false.

Item 5 is on the statement that the risk associated with handling charcoal in cooking is highest than that of the gas which was agreed by 93.02% of the respondents and disagreed by 6.98% of them.

Item 6 shows the perception of the respondents on the risk associated with handling gas is highest than that of the charcoal. 88.37% of the respondents agreed, while 11.63% disagreed with the statement.

Table 2: Perception on Consequences of Using Gas and Charcoal towards Human Health

S/N	Statement	TRUE	%	FALSE	%
1	Gas usage in cooking promote radiation of gases which infect the respiratory system.	30	34.88	56	65.12
2	Charcoal usage contaminate water, land and promote occurrence of waterborne diseases.	60	69.77	26	30.23
3	Charcoal when contact with body, stain cloth and result in itching with formation of rashes.	36	41.86	50	58.14
4	Gas, when there is leakage from the cylinder will eventually distribute to the environment, causing irritable and chocking smell.	69	80.23	17	19.77
5	The risk associated with handling charcoal in cooking is highest than that of the gas.	80	93.02	6	6.98
6	The risk associated with handling Gas is higher than that of the charcoal.	76	88.37	10	11.63

Table 3 Looks at the barriers, cost and rate of using gas and charcoal for cooking in Damaturu. Item 1 shows results of the responses on lack of knowledge on how to operate gas cylinder are the factors that prevent you to use gas as a cooking energy. This statement is confirmed by 53.49% while 46.51 debunked it.

Item 2 shows how lack of adequate supply of charcoal at the selling point as what prevent users from using charcoal in cooking. This statement was maintained by 11.63% while 88.37% did not agreed with it.

Item 3 is on the expensiveness of gas and gas cylinder as factors which prevent the use of gas as cooking energy. On this shows, 93.02% said yes while 6.98% said no.

Item 4: Expensiveness of charcoal is the factors that prevent using charcoal as a cooking energy. This statement was agreed by 18.60% while 81.40% did not agree.

Item 5 seeks response on the statement that costs a lot and do not take longer time to be utilized than charcoal which is agreed by 58.14% and disagreed by 41.86% of the respondents.

Item 5, on the cost-effectiveness of charcoal shows 47.67% agreeing with the statement and 52.33% disagreeing with it.

Items 6 and 7 on the sustainability of gas and charcoal show the following result. Five (5) (Kg) kilogram of gas sustain cooking demand for one month in use; agreed by 33, 72% and 66.28% say no.

The statement that one bag/sac of charcoal will sustain one's energy demand for cooking for about one month was agreed by 26.74% and was disagreed by 73.26% of the respondents respectively.

Items 8 and 9 access the cost incurred by the respondents in month purchase of gas and charcoal respectively. About 56.98% spend between ₦1000 to ₦5000 in purchase of gas, 23.26% spend ₦ 6,000 to ₦10,000 monthly while 19.77% spend between ₦11,000 to ₦15,000.

In the case of cost of using charcoal monthly, 59.30% spent about ₦1,000 to ₦5,000, and 25.58% spend ₦6,000 to ₦10,000 while 15.12% spend between ₦11,000 to ₦15,000.

Table 3: Barriers, cost and rate of using gas and charcoal for cooking in Damaturu

S/N	Statement	YES	%	NO	%
1	Lack of knowledge on how to operate gas cylinder are the factors that prevent you to use gas as a cooking energy.	46	53.49	40	46.51
2	Lack of adequate supply of charcoal at the selling point is what prevents you from using charcoal as a cooking energy.	10	11.63	76	88.37
3	Expensive of gas and gas cylinder are the contributory factors which prevent you from using gas as a cooking energy.	80	93.02	6	6.98
4	Expensiveness of charcoal is the factors that prevent you from using charcoal as a cooking energy.	16	18.60	70	81.40
5	Gas costs you a lot and do not take longer time to be utilized than charcoal.	50	58.14	36	41.86
6	Charcoal costs a lot and do not last longer than gas.	41	47.67	45	52.33
7	Five (5) (Kg) kilogram of gas sustain your cooking demand for one month in use.	29	33.72	57	66.28
8	One bag/sac of charcoal will sustain your energy demand for cooking for about one month.	23	26.74	63	73.26

S/N	**Fuel Used**	**₦1000 ₦5000**	**%**	**₦6000 ₦1000**	**%**	**₦11000 ₦15000**	**%**
9	How much do you spend on the purchase of gas for your cooking monthly?	49	56.98	20	23.26	17	19.77
10	How much do you spend on the purchase of charcoal for your cooking monthly?	51	59.30	22	25.58	13	15.12

DISCUSSION

Based on the analysis of findings regarding the Environmental consequences of using gas and charcoal, it was revealed that both of the cooking energy sources under discussion have devastating consequences on the environment of Damaturu Local Government such as fire outbreak, excessive heat, contamination of water, ETC. The result of this findings indicate Gas as the most suitable energy for cooking that do not affect the environment. The statement is agreed with 43.88 from the respondents. This is in consistent with the finding of Ozoh, *et al*., (2018); Baiyegunhi, and Hassan, (2014) who said that LPG is a cleaner burning fuel with several advantages over other source of energy; it has been demonstrated to reduce indoor air pollution and greenhouse emissions compared to kerosene and others. LPG emits negligible amounts of black carbon or other pollutants that contribute to global warming and each canister of LPG substituted for kerosene reduces the carbon dioxide emissions by 2.8 kg. LPG use has also been demonstrated to save cooking and cleaning time which has the potential to increase productivity especially among women. This reflect the finding of Onyekuru *et al.,* (2020), who determined cooking energy use and preferences among households in Enugu State, Nigeria. In order to ascertain the differences in the quantities of cooking energy sources used by households, determine the preferences of each of the energy sources by the households, reasons for preferences for each of the energy sources, and the problems associated with the use of each of the energy source. The likert-type scale result showed that the cooking energy with the highest perceived level of efficiency was liquefied petroleum gas (LPG), while the energy with the highest level of preference was kerosene. The major reasons for the preference for LPG was because it cooks fast and clean, that of kerosene was lower chances of fire accident than LPG. For fuel wood, preference was due to fast cooking and better taste of food, while that of charcoal was due to clean cooking and reduced cases of fire accident. The major constraints militating against the use of different cooking energy sources, even when they are preferred, were scarcity, expensiveness and risk of fire outbreak for LPG and kerosene, while for fuel wood and charcoal, they were pollution and the fact that it produces a lot of black soot. There is need to implement incentive-based policies to encourage the use of LPG and kerosene, through targeted subsidies and cost reduction. The study also is in contrast with the finding of Ozoh, *et al*., (2018), who reported that Kerosene was the most frequently used cooking fuel (n = 475, 91.5%; primary use n = 364, 70.1%) followed by charcoal (n = 159, 30.6%; primary use n = 88, 17%) and LPG (n = 86, 16.6%; primary use n = 63, 12.1%). The study was conducted in one the most densely populated areas in the city of Lagos in Nigeria and over 60% of its populace live in densely populated area. The studies found that kerosene was used as cooking fuel in nearly all households surveyed either as primary or secondary cooking fuel. In another study conducted by Arowola *et al.,* (2018), in rural households' cross sectional data in Ogun State, south western Nigeria to analyze households' choice of cooking energy. The study found that well above half (63%) of the rural households rely on fuel wood as their primary cooking energy, with about 21% of the remaining part of the population using kerosene, 12 percent using gas, while only 4 percent use electricity as their main source of energy for domestic cooking. The result of the present study revealed that Gas produced mild impact to the environment while usage such as flammability which results in high risk of fire outbreak with 44.19% which is strongly agreed by the respondents. However, another study carried out on households access and preference to cooking fuels in Abuja, Nigeria by the Author Ajah, in 2013 the result showed that most accessible and preferable cooking fuel was firewood with mean access and preferable value of 3.25 and 2.69, respectively while the least accessible preferable cooking fuel was cooking gas (LPG) (0.22) the finding of the previous research is in contrast with present studies. This is because citizens from developing countries like Nigeria have very limited access to modern energy system and services. Deforestation is seen as the largest threat to biodiversity in the country (CBD, 2015) and have led to several species of fauna and flora to be rendered extinct or in danger of extinction, Okolo and Haoran (2017).

Pertaining the Health consequences of utilizing gas and charcoal in cooking, it was revealed that using charcoal usage causes contamination of water which promotes waterborne diseases; while using causes has minimal effect on human health. It went on to further reveal that using gas leads to leakage, which distributes to the environment and cause irritation and chocking smell. It was also revealed that the risk of handling both substances is high.

Tiamiyu *et al.,* (2021). Reported a study carried in Ogbomoso zone of Oyo State, Nigeria people suffer from one ailment or the other ranging from acute to chronic diseases such as head ache, respiratory diseases, cough, sputum production, dyspnea, and hemoptysis as a result of their involvement in charcoal production. Studies have linked smoke from the use of fuel wood with conditions such as acute respiratory infection, low birth weight, chronic obstructive pulmonary disease, cancers and eye infections. Smoke caused by burning of fuel wood is estimated to cause 95,000 deaths annually in Nigeria (UNDP, 2015). Women and children suffer physical damage from collecting stacks of firewood which normally weighs up to 35kg and this time-consuming task limits their opportunity to engage in income-generating tasks and receiving education according to Okolo and Haoran (2017).

On the Barriers and cost implication of using gas and charcoal for cooking, it shows that lack of knowledge on how to operate gas prevents people from using gas as a cooking energy. Also, expensiveness of gas and gas cylinder was revealed as one of the factors limiting its usage among the people of Damaturu. The result is similar with the finding of Ozoh *et al.,* (2018); Anozie *et al.,* (2006) who reported that over 90% of non-LPG users were willing to switch to LPG

but cited safety issues and high cost as potential barriers to switching. Our findings suggest that misinformation and beliefs regarding benefits, safety and cost of LPG are important barriers to LPG use. An educational intervention program could be a cost-effective approach to improve LPG adoption and should be formally addressed through a well-designed community-based intervention study. According to Adeyemi and Adereleye (2016) on his studies determinants of household choice of cooking energy in Ondo State, Nigeria, supposed Liquid petroleum gas if compared to kerosene or fuel wood, has clear heath, environmental and productivity benefit of course, choice of gas may be constrain by cost and not only fuel cost but also the start-up cost of connections, equipment and stoves. Despite its convenience, there is a great feeling of insecurity in relation to safety issues and the cylinder being stolen act as a barrier to the use of gas fuel. A fear about explosion is a concern raised by many people in relation to hazard and indoor air pollution effects. Present the distribution of households by energy type and by zone of residence.

On the cost implication of buying gas and charcoal. It shows that, a highest percentage of the respondents (56.98%) were sustained by between ₦1000 to ₦5000 gas and also 59.30% of charcoal users were able to be sustained by ₦1,000 to ₦5,000 charcoal.

CONCLUSIONS

This study shows that LPG production and utilization as cooking fuel may improve environmental quality. Therefore, if the cooking gas, cook stoves are designed to be more efficient and managed properly, substantial environmental gain could result. Although LPG has advantage over charcoal in terms of its overall global warming emissions, most of its global warming potential impact occurs during the cooking stage. The human toxicity potential, which is highest with LPG, is restricted to the upstream stage. This is comforting, because, unlike the other fuels, LPG is mainly used indoors, and the government has a program in place that is meant to promote its use. However, in terms of cost LPG, cost higher than charcoal, but its last longer while cooking, so its ability to last longer while cooking has repay it cost of buying.

Charcoal is by far the most dominant cooking fuel in Damaturu, and due to the expected increase in demand with urbanization, improvements are needed in its production methods. Policy makers need to consider the costs and social implications of using these fuels, in addition to the environmental data provided by this study. Readers of this study should be cognizant of the general limitations involving the lack of country-specific data on some life cycle stages and the assumptions made regarding the systems boundaries selected.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations were made:

i. People should be encouraged to adopt the use of high-efficiency LPG and charcoal stoves to reduce cooking-phase emission;
ii. Government should put policies in place to promote the use of high-efficient fuel such as LPG;
iii. Enlightenment campaign should be embarked upon by relevant stakeholders through effective channels such as radio, TV and other social media platforms to enlighten people on the need to be switching their cooking fuel systems off when not in use;
iv. Use of protective wears especially in industrial use of cooking fuels should also be encouraged;
v. Efficient means of charcoal production should be adopted to curb deforestation and other environmental degradation; also, the human toxicity potential, which is highest with LPG should be restricted to the upstream stage.

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