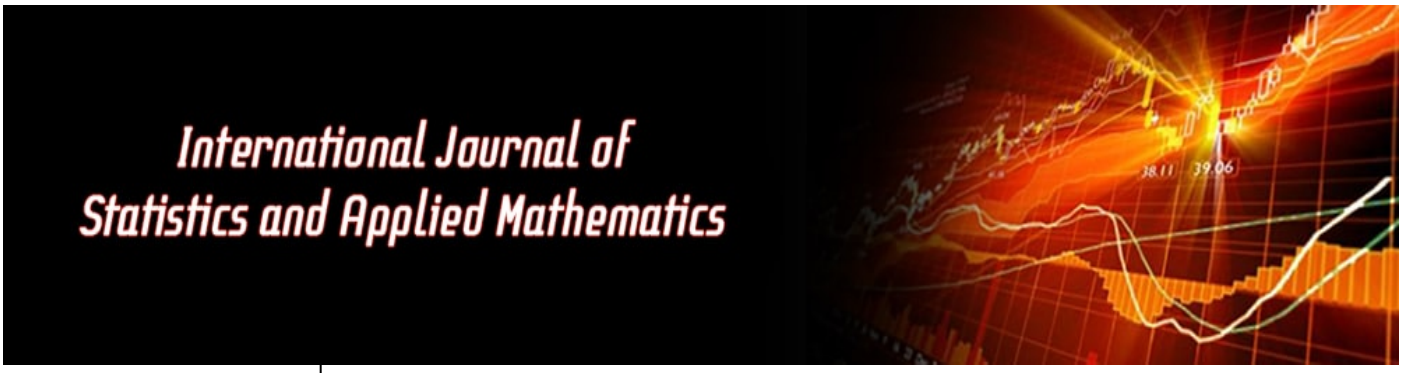

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Characteristic indoor air pollutions by choices of household fuel consumptions in a typical Nigerian sub-urban settlement: The case of Afikpo North, Ebonyi State, Nigeria

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Abstract
This research project is designed to explore the status of indoor and ambient air pollutions emanating from household consumptions of various kinds of fuel for cooking, heating and lighting in Afikpo North Local Government Area of Ebonyi State. The research seeks to determine the types of fuel used by different households for cooking and the factors (socio-economic, environmental and demographic) which influence the choice of fuel consumed. The relationship between the types and quantities of fuel used for cooking and the indoor and ambient air qualities were critically evaluated. Quantitative data were collected using well-structured questionnaire administered to randomly selected households in the study area using the lists of enumeration areas as sampling frame. Means, frequencies, percentages and charts were used in data presentation and analysis. The findings of the study will help to create awareness on the consequences of continued exposure to hazardous pollutants and alternative energy sources forsafer household consumption and cleaner, healthier environment.

Keywords: Ambient air quality; household fuel consumption; indoor air quality; alternative renewable energy; types of fuel

1. Introduction
The use of firewood and other types of fuel for domestic purposes, especially for cooking, heating and lighting, has significantly contributed to the global aggregate carbon emissions in the atmosphere (see Duflo *et al*., 2008 and Akpalu *et al*., 2011) [8, 3]. According to Rahut, Ali and Behera (2017) [15], this trend has severe adverse consequences on the environment and human health. Therefore, access to and use of clean modern fuel is critical for the improvement of human health and the environment (see Muller and Yan, 2016 and Rahut, Behera and Ali, 2017) [12, 15]. AGECC (2010) [1] has clearly stated that sustainable development is directly linked to the quality of household energy consumption. Yet, many households in developing countries, especially in sub-Saharan Africa, and Nigeria, in particular still embark on the use of traditional sources of energy for their cooking, heating and lighting, damaging both the environment and human development despite the clean and renewable energy revolution in recent years (see Rahut, Behera and Ali, 2017) [15].
According to Crousillat, Hamilton and Antmann (2010) [7], sub-Saharan Africa has the lowest global electricity access at the respective rates of 58% and 12%, forcing many households without access to electricity to resort to kerosene and dry-cell batteries, which have hazardous health and environmental effects, for light. As succinctly captured by Rahut, Behera and Ali (2017) [15], many provinces in sub-Saharan Africa have significant proportion of the households that still rely on the use dirty fuels such as firewood, straw, manure, sawdust, charcoal and kerosene as sources of energy for light and cooking. Only a small fraction of these households use electricity for light, and the number of households using solar energy is quite minimal.

The household cooking sector is the largest consumer of energy in Nigeria, using around 80% of the total, 90% of which is derived from biomass, particularly fuel wood, according to Gujba, Mulugetta and Azapagic (2015) [10]. Although other sources of cooking energy are available and used in Nigeria, which include liquefied petroleum gas (LPG), kerosene, and electricity, they are expensive compared to firewood, sawdust, charcoal, animal dung and other local sources of energy which are readily available at little or no cost. The Nigeria poverty index indicators released by the National Bureau of Statistics (2020) [13] stated that about 40% of the Nigerian population live below the country's poverty line of $1 per day (see also Bello and Roslan, 2010) [5]. Therefore, the firewood and other local sources of energy become the preferred source of household cooking energy in Nigeria. Moreover, the availability of electricity is also a major challenge, especially in rural areas. For instance, record shows that only about 40% of the Nigerian population is connected to the national grid (see Babatunde and Shaibu, 2009 and Sambo, 2009) [4, 16] with 90% of rural areas having unreliable or no electricity at all (Obadote, 2009) [14].

The dependence on wood fuel for domestic energy supply has aggravated deforestation, which is also a pointer to desertification and erosion in different parts of the country (FAO, 2006) [9]. The annual deforestation rate is estimated at around 3% per year, which is equivalent to the loss of about 410,000 hectares of forested land annually (FAO, 2006) [9]. Another major source of concern is the indoor and ambient air pollution which emanate from the burning of firewood, sawdust, charcoal, woods, etc. in open fires with or without chimneys. These have led to serious forms of respiratory infections and premature deaths (Smith and Mehta, 2003) [17]. The World Health Organization (2020) [18] estimates that respiratory related diseases are among the top 10 causes of death globally and there are 114, 000 deaths in 2018 in Nigeria from indoor air pollution, mainly caused by fuel combustion (Chasant, 2018) [6]. Onitsha, which is a highly industrialized city, few miles from Afikpo North, the study area, recorded the world's worst levels of PM pollutants, which were 30 times higher the WHO recommended guideline, in 2016, according to Chasant, (2018) [6]. Deaths from acute lower respiratory infection in children younger than five years account for about 90% of the total number of deaths from indoor air pollution, with chronic obstructive pulmonary disease in adults of 30 years and above accounting for the remaining 10%. Furthermore, constant search for firewood and other local fuels for domestic energy represents a large burden and danger for women and children, especially in the rural and semi-urban areas like Afikpo North.

Afikpo North Local Government Area in Ebonyi State of Nigeria has all the attributes described above by Rahut, Behera and Ali (2017) [15]. The heavy reliance on locally abundant fuels for cooking, heating and light exposes the environment to unprecedented air pollution which is highly detrimental to the health and well-being of the people and as well impact on their socio-economic activities. Therefore, this study aims to examine the most frequently used fuels to generate energy for cooking, heating and lighting, examine the factors that influence household use of fuels and available and affordable sources of alternative healthy sources of energy for healthy society.

2. Methodology

2.1 Study Area

The study area is Afikpo North which is a Local Government Area of Ebonyi State, Southeast Nigeria, occupying an area of 240 square kilometers and has a 2020 population of 222, 241 people, projected from the 2006 population census data. The local government is located on latitude 6 degrees North and Longitude 8 degrees East, has average annual rainfall of 198 cm and is mainly of tropical forests. The headquarter of Afikpo North local Government Area is Ehugbo (Afikpo) and the other major towns include Unwana, Itim, Ohaisu, Nkpoghoro, Ugwuegu/Amaizu, Ozizza, Amasiri and Ibii/Akpoha.

2.2 Study Sample

The sampling frame was the list Enumeration Areas (EAs) in Afikpo North used for the 2006 Population Census which served as the primary sampling units. The use of EAs is vital since the study is focused on household fuel consumption and indoor air pollution and each EA is a cluster of households. Four EAs were randomly selected from each of the 9 towns that make up the local government area. Each EA has an average of 47 households (National Bureau of Statistics, 2017 and International Energy Agency) [12, 11]. Since there are no clearly defined list of the households in the EAs within the locality to necessitate further sampling of households, all the households in each of the 4 selected EAs will be included in the study in a single-stage cluster sampling procedure. In total, 36 EAs and 1692 households were involved in the survey.

2.3 Data Collection and Research Instrument

Data collection was done using well-structured questionnaire constructed for the study following international standards for household surveys on air pollution. Prior to the main survey, a pilot study was carried out to ascertain the efficiency and effectiveness of the survey tool and make modifications were necessary. The pilot study was carried out with 20 selected households in Afikpo South Local Government Area which has similar geographic/demographic attributes as the study area. From the pilot study, difficult and ambiguous segments of the questionnaire were identified and addressed. In general, the pilot study prepared the entire survey framework for the main study. Two research assistants, familiar with the terrain, culture and dialect of the locals, were co-opted into the study after one-week training for data collection, to minimize hostilities and non-coverage. It was expected that most of the respondents may not be educated enough to complete the questionnaire; in this case, the research assistants helped in recording the information provided by the respondents. This helped in reducing errors, non-responses and omissions associated with survey. The research assistants also participated in the pilot study to enhance their understanding of the intricacies of the survey and their participation lasted through the periods of pilot study, the main survey and callbacks.

The questionnaire for data collection was categorized into four components. The first component comprised the socio-economic and demographic characteristics of the respondents. The second component comprised the type (s), quantity, cost and choice of fuel for domestic use. The third component sought information on the experiences while using the preferred fuel for household consumption; while the fourth component sought information on the awareness level of alternative clean energy, intention to use it, constraints to using clean energy and ways to minimize use of hazardous fuel sources. Data collection lasted for a period of one month, from October 11, 2022 to November 11, 2022 while callbacks lasted for one week.

3. Results

3.1 Level of Exposure to Household Air Pollution

The factors considered in the human exposure to the pollution of the indoor air qualities are the place of cooking and the size of the household. The place of cooking points is the major sources of indoor air pollution while the size of the household points is the number of persons exposed to the indoor air pollutants. Bar chart of Figure 1 shows the distribution of households based on the place of cooking. Majority, that is, 976 (64.59%) of the households cook in a separate room which is within the same house where they live while 34 (2.25%) cook in the same room where the sleep. This shows that almost 67% of the households cook in the same house in which they live, indicating high level of exposure to pollution of the indoor air qualities in the study area. Generating these harmful pollutants in the house ensures higher exposure since studies have revealed that the pollutants do not dissipate easily when trapped indoors (Alsbou and Omari, 2020) [2]. The households that cook in a separate building are 374 (24.75%), which is almost three times less than the number that cook in the same house but in a separate room. Also, as much as 127 (8.41%) of the households cook in the open, which contributes to the rise in the quantity of pollutants affecting the ambient air quality in the study area.

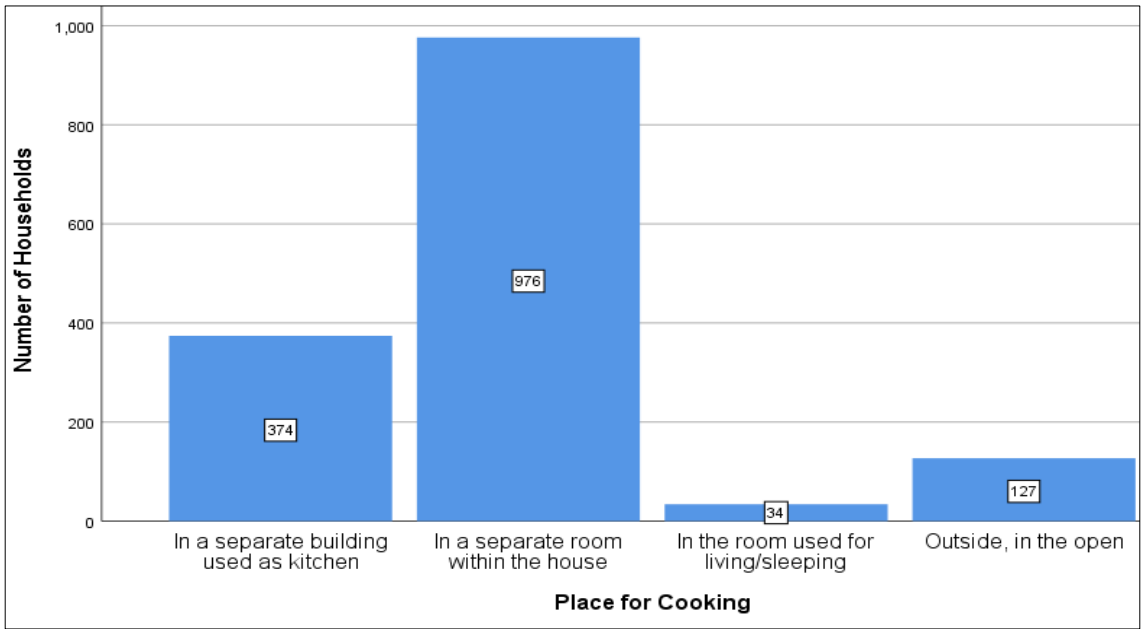

Fig 1: Bar Chart for Place of Cooking Among Households in Afikpo

The level of exposure to indoor air pollution by family size is presented in Table 1. The results show that 49.5% of the households with at least 4 persons have their place of cooking in a separate room within their house while 1.5% of the households cook in the same room used for sleeping and have a family size of at least 4 persons. This shows that as much as 51.0% of the households in the study with large family sizes of at least four persons used fuel for cooking in the same house in which they live. There is therefore high human exposure to air pollution among most f the households in the study area.

Table 1: Exposure to Indoor Air Pollution by Family Size

Where you cook	Family Size			Total
	1-3 persons	4-6 persons	7-10 persons	
In a separate building used as kitchen	78(5.2%)	226(15.0%)	70(4.6%)	374(24.8%)
In a separate room within the house	228(15.1%)	557(36.9%)	191(12.6%)	976(64.6%)
In the room used for living/sleeping	11(0.7%)	14(0.9%)	9(0.6%)	34(2.3%)
Outside, in the open	30(2.0%)	70(4.6%)	27(1.8%)	127(8.4%)
Total	347(23.0%)	867(57.4%)	297(19.7%)	1511(100.0%)

3.2 Factors that influence the choice of fuel/energy source for cooking, heating and lighting

The regularly used fuel for cooking and heating in the semi-urban area is charcoal and firewood is the regularly used fuel in the rural areas (See Tables 2 and 3). These two fuel types are high sources of emission of the criteria pollutants. Most of the respondents considered the economic factor and the easy availability of the prominent fuels used as the driving factors for their choice of fuel and energy for cooking, heating and lighting. From the bar chart in Figure2, more than half (59.6) of the respondents indicated that the economical factor is the major influence in the choice of type of fuel for cooking and heating. Firewood is cheap, easily affordable and often gathered freely from the forest, as indicated by some of the respondents. Charcoal is also relatively cheap but not as cheap as firewood. The second major factor which influenced the households' choice of fuel type is that the fuel is easily available. From Figure 2, 32.8% of the households admitted that the fuel is easily available. Only 5.0% consider the health benefits as the major driver in their choice of type of fuel. Households influenced by convenience and aesthetics constitute only 2.6% of the entire households.

Table 2: Fuel Choice and Frequency of Use (Semi-Urban)

Fuel/Energy Type	Regular	Very often	Often	Not applicable
Electricity (Lighting)	0(0.0%)	392(23.2%)	1123(66.15%)	174(10.3%)
Electricity (Cooking)	0(0.0%)	16(1.0%)	86(5.1%)	1587(94.0%)
Generator (Lighting)	456(27.0%)	721(42.7%)	406(24.0)	106(6.3%)
Rechargeable devices (Lighting)	1062(62.9%)	292(17.3%)	247(14.6%)	88(5.2%)
LPG (Cooking)	183(10.8%)	351(20.8%)	477(28.2%)	678(40.1%)
Kerosene (Lighting)	46(2.7%)	207(12.3%)	545(32.3%)	891(52.7%)
Kerosene (Cooking)	448(26.5%)	582(34.5%)	555(32.9%)	104(6.2%)
Charcoal (Cooking)	486(28.8%)	427(25.3%)	501(29.7%)	275(16.3%)
Firewood (Cooking)	227(13.4%)	372(22.0%)	536(31.7%)	554(32.8%)
Sawdust (Cooking)	22(1.3%)	69(4.1%)	108(6.4%)	1490(88.2%)

Table 3: Fuel Choice and Frequency of Use (Rural)

Fuel/Energy Type	Regular	Very often	Often	Not applicable
Electricity (Lighting)	0(0.0%)	339(20.1%)	777(46.0%)	573(33.9%)
Electricity (Cooking)	0(0.0%)	0(0.0%)	26 (1.5%)	1663(98.5%)
Generator (Lighting)	241(14.3%)	420(24.9%)	462(27.4%)	566(33.5%)
Rechargeable devices (Lighting)	991(58.7%)	327(19.4%)	256(15.2%)	115(6.8%)
LPG (Cooking)	32(1.9%)	198(11.7%)	415(24.6%)	1044(61.8%)
Kerosene (Lighting)	123(7.3%)	266(15.7%)	619(36.7%)	681(40.3%)
Kerosene (Cooking)	199(11.8%)	304(18.0%)	382(22.6%)	804(47.6%)
Charcoal (Cooking)	517(30.6%)	447 (26.5%)	579(34.3%)	146(8.6%)
Firewood (Cooking)	668(39.6%)	341(20.2%)	603(35.7%)	77(4.6%)
Sawdust (Cooking)	167(9.9%)	301(17.8%)	215(12.7%)	1006(59.6%)

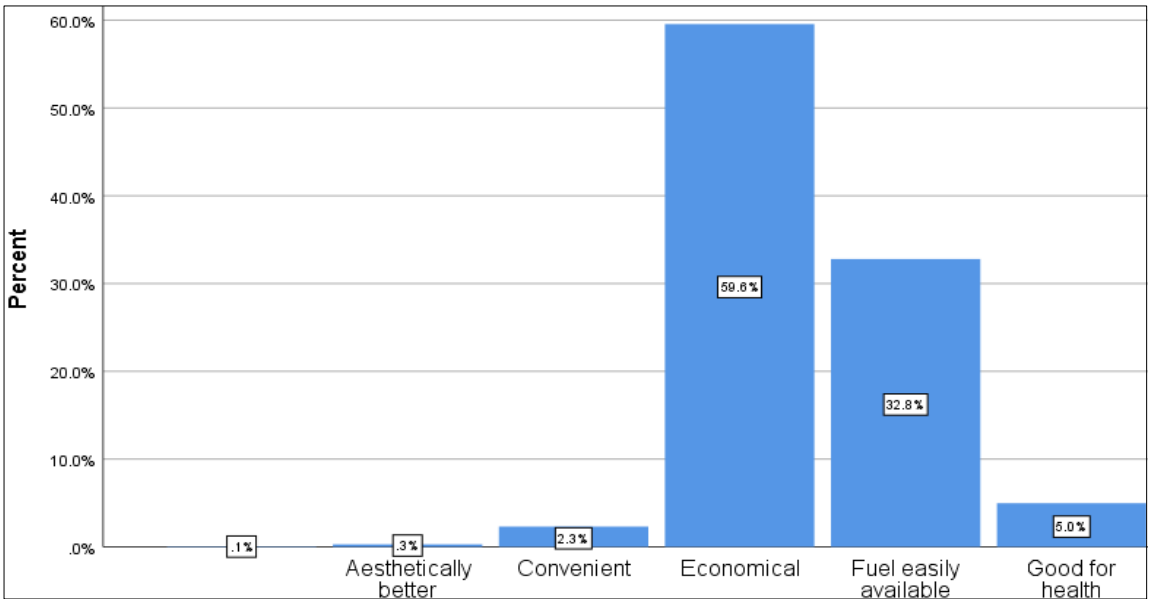

Fig 2: Bar Chart of Factors Influencing Choice of Fuel

3.3 The level of awareness of alternative renewable energy sources

The level of awareness of the sources of alternative renewable energy such as solar panel, biogas, biofuel and bioethanol are presented in Table 4 for the respondents in the semi-urban and rural areas of Afikpo North study area. With 95.5% response rate in the semi-urban and 85.6% response rate in the rural area, solar panel has the highest level of awareness in both the semi-urban and rural areas. The awareness of solar panel as source of alternative renewable energy is higher in the semi-urban areas than in the rural areas. The proportion of respondents who are not aware or not sure of the awareness of solar panel as source of alternative energy is 4.5% of the semi-urban respondents and 10.6% of the rural respondents. The level of awareness of biogas, biofuel and bioethanol is very low in both the semi-urban and rural areas. The proportion of respondents who are not of aware of biogas, biofuel and bioethanol in the semi-urban areas are 70.0%, 89.4% and 90.6%, respectively. Similarly, the proportion of the respondents who are not aware of are 81.2%, 91.1% and 96.2%, respectively. These are evidences that the alternative renewable energy sources are far more less popular in the rural areas. Bioethanol is the least popular in both the semi-urban and rural areas.

Table 4: Awareness of Alternative Renewable Energy (Semi-Urban and Rural)

Location	Solar panel	Biogas	Biofuel	Bioethanol
Semi-Urban Yes	961(95.5%)	302(30.0%)	107(10.6%)	94(9.3%)
No	16(1.6%)	176(17.5%)	698 (69.4%%)	611(60.7%)
Not sure	29(2.9%)	528(52.5%)	201(20.0%)	301(29.9%)
Rural Yes	589(85.6%)	129(18.8%)	61(8.9%)	26(3.8%)
No	32(1.9%)	401(58.3%)	429(62.3%)	404(58.7%)
Not sure	67(9.7%)	158(22.9%)	198(28.8%)	258(37.5%)

3.4 Constraints to Renewable Energy Sources

The multiple response analysis of the constraints to the use of alternative renewable energy sources, solar panel, biogas, biofuel and bioethanol are presented in Table 5 below for the semi-urban areas of Afikpo North Local Government Area of Ebonyi State. The most prominent constraint for use of solar panels is because it is expensive to install. The result shows that 92.1% of the respondents would like to have solar panels installed but would not do so because of the cost of installation. Another constraint is that the respondents admitted that they do not know how to maintain and operate the alternative renewable energy sources, which indicates lack of adequate technical knowledge of the sources. Other constraints include lack of knowledge of the dangers of using these sources for renewable energy in the household. Only biofuel has less than 50.0% which does not indicate knowledge of the dangers of use but rather stems from the lack of awareness of the renewable source. This also true for the 20.1% who indicated that they are not sure if bioethanol will last. More than 78.0% do not know anything about bioethanol and biofuel.

Table 5: Multiple Response Analysis of the Constraints to Use of Alternative Renewable Energy (Semi-Urban)

Constraint	Solar panel	Biogas	Biofuel	Bioethanol
I would like to use it but it is expensive to install	926(92.1%)	230(22.9%)	133(13.2%)	97(9.6%)
I do not know how to operate and maintain it	654(65.0%)	823(81.8%)	657(65.3%)	841(83.6%)
I do not know the dangers of using it	689(68.5%)	741(73.7%)	479(47.6%)	592(58.9%)
I am not sure if it will last when I buy it	833(82.8%)	655(65.1%)	509(50.6%)	202(20.1%)
I do not know anything about it	47(4.7%)	423(42.5%)	829(82.4%)	791(78.6%)

The constraints in the rural areas are the same as the constraints in the semi-urban areas but the constraints are higher in the rural than semi-urban areas, as shown in Table 6. Those who would like to install solar panel but constrained by the cost of installation are more in the semi-urban than the rural areas. The small percentage who indicated that that they do not know anything about solar panel is evidence of the popularity of solar panel as source of alternative energy in both the rural and semi-urban areas. On the other hand, more than 85.0% of the respondents in the rural areas indicated that they do not know anything about biogas, biofuel and bioethanol, which also shows that lack of awareness of these three as viable sources of renewable energy. Other major constraints in the rural areas include lack of knowledge of how to operate and maintain the sources; apprehension about the dangers of use and uncertainty about the durability of the energy sources.

Table 6: Multiple Response Analysis of the Constraints to Use of Alternative Renewable Energy (Rural)

Constraint	Solar panel	Biogas	Biofuel	Bioethanol
I would like to use it but it is expensive to install	521(75.7%)	91(13.2%)	105(15.3%)	74(10.8%)
I do not know how to operate and maintain it	467(67.9%)	446(64.8%)	523(76.0%)	502(73.0%)
I do not know the dangers of using it	311(45.2%)	396(57.6%)	438(63.7%)	530(77.0%)
I am not sure if it will last when I buy it	569(82.7%)	404(58.7%)	244(35.5%)	387(56.3%)
I do not know anything about it	190(27.6%)	623(90.6%)	597(86.8%)	627(91.1%)

3.5 Ways to minimize the use of dangerous fuels as household sources of energy

The most identified way (90.7%) to minimize the use of sawdust, firewood, charcoal, and others is to make the sources of alternative energy available in commercial quantities. In this way, different households will have viable clean alternative to the use sawdust, charcoal, firewood. This will also reduce the stress and difficulties required to in the use these dangerous fuels as household energy source. The more environmental-friendly alternative renewable energy sources being available in commercial quantities will also make them easily accessible to the public. The second way to minimize use of dangerous energy sources, as identified by 82.8% of the respondents, is to create adequate awareness on the safety and durability of the alternative sources of energy as this will eliminate uncertainties surrounding the safety and durability of these energy sources. This will create needed trust of the public/households to shift from the dangerous household energy sources to the more family and environmentally friendly alternatives.

The study also revealed that technical awareness of how the alternative renewable energy sources functions is another way of minimizing the use of dangerous sources of energy as sources of household energy. This implies that providing adequate information on how to use the alternative sources of energy like biogas, biofuel and bioethanol will make them more attractive to households. The lack of sufficient information on the technicalities and seamless use of these energy sources does not make them attractive to the public and hampers interest in accepting them as household energy sources. The respondents also identified reduction in energy tariff as a catalyst to motivate households to seek the alternative renewable energy sources. The tariff on energy like electricity and others makes them not affordable and accessible for an average household. The dangerous sources of household energy such as charcoal, sawdust and firewood

have already been revealed in this study to be readily available, easily accessible, affordable and sometimes freely available. This means that the alternative renewable energy sources should be also made readily available, accessible and affordable and removing or reducing energy tariff will facilitate these. Making the renewable energy sources affordable was also identified in this study as a way of minimizing the use of dangerous household energy sources.

Table 7: Multiple Response Analysis of ways of Minimizing Use of Dangerous Fuels as Sources of Household Energy

Constraint	Frequency	Percentage
The government should enact polices that will make solar panels and other renewable energy sources affordable	972	57.4
Proper awareness needs to be created on the dangers of the use of firewood, sawdust, charcoal, etc. as sources of household energy	1231	72.7
The alternative renewable energy sources should be made available in commercial quantities	1537	90.7
There should be proper awareness of the availability and use of the renewable energy sources	790	46.6
Technical awareness on the operationalities of the renewable energy sources should be adequately provided	1392	82.5
Adequate awareness of the safety and durability of the renewable energy sources will eliminate fears of the unknown	1404	82.8
Tariff on electricity and other less dangerous sources of energy should be reduced or removed for easy access to the energy sources	1059	62.5

The least way of reducing or minimizing the use of the dangerous energy sources among households, as identified by 46.6% of the respondents, is to ensure adequate awareness of the of the availability of the alternative renewable energy sources. This implies that while efforts are made to make these family friendly energy sources available in commercial quantities, adequate sensitization should be embarked on to bring the availability to the attention of the public. This will ensure that the attention of the masses are drawn to these family friendly energy sources and enhance utilization.

4. Conclusions

The study utilized survey method to obtain quantitative data on the level of airpollution through the use of hazardous sources of household fuel such as firewood, sawdust, charcoal and kerosene in cooking, lighting and heating in Afikpo North Local Government Area, Ebonyi State, Nigeria. The findings of the study revealed that charcoal is the most used fuel type for cooking in the semi-urban areas, followed by firewood and then kerosene while firewood is the most used fuel type in the rural areas, followed by charcoal and then kerosene. Firewood is easily available and accessible in rural areas and can be gotten free from the nearby forests. In the urban areas, firewood is not available for free but can be purchased at affordable prices. The results from the quantitative survey showed that almost 60.0% of the households who use these hazardous sources of fuel took in the same house in which they live, which indicates high level of exposure to pollution of the indoor air qualities in the study area. Also, the remaining 40.0% of the households cook in the open air or in a separate house used as kitchen, thereby polluting the outdoor air quality in the area. There is, therefore, high level of human exposure to the indoor and ambient air quality in the semi-urban and rural areas but exposure is more predominant in the semi-urban areas than in the rural areas.

Economical factor and ease of availability are the two major drivers of the choice of type of fuel for cooking and heating. Most households consider the cheaper and easily available fuel types when making their choice. Firewood and charcoal are easily available and are the economically viable options at least on short-term basis. In terms of awareness, solar panel has the highest level of awareness in the semi-urban and rural areas but with higher awareness in the semi-urban areas. The level of awareness of for biogas, biofuel and bioethanol in the semi-urban and rural areas of Afikpo North is low. Most of the respondents do not have knowledge of these sources of renewable energy. Most of the respondents would like to install and use solar panels as source of household energy but could not afford it because of the high cost of installation.

5. Acknowledgement

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6. References

1. Agecc U. Energy for a Sustainable Future: Summary Report and Recommendations'. UN (United Nations)/The Secretary-General's Advisory Group on Energy and Climate Change New York, USA; c2010.
2. Alsbou Eid M, Omari Khaled W. BTEX Indoor Air Characteristic Values in Rural areas of Jordan: Heaters and Health risk assessment Consequences in Winter Season. Envorimental Pollusion. 2020;267:115464.
3. Akpalu W, Dasmani I, Aglobitse PB. Demand for cooking fuels in a developing country: to what extent do taste and preferences matter? Energy Policy. 2011;39:6525-31.
4. Babatunde MA, Shuaibu MI. The Demand for Residential Electricity in Nigeria: A Bound Testing Approach, In: Proceedings of Second International Workshop on Empirical Methods in Energy Economics, University of Alberta, Edmonton, AB, Canada; c2009.
5. Bello MA, Roslan AH. Has Poverty Reduced in Nigeria 20 Years After? European Journal of Social Sciences. 2010;15:7-17.
6. Chasant M. Air pollution in Nigeria: Causes, effects and solutions; c2018. Available at https://www.atcmask.com/blogs/blog/air-pollution-in-nigeria.
7. Crousillat E, Hamilton R, Antmann P. Addressing the electricity access gap, background paper for the World Bank group energy sector strategy. Washington, DC: World Bank; c2010. http://siteresourcesworldbankorg/EXTESC/Resources/Addressing_the_Electricity_Access_Gappdf
8. Duflo E, Greenstone M, Hanna R. Indoor air pollution, health and economic wellbeing. Survey Perspective and Integrated Environmental Society; c2008.
9. Food and Agriculture Organisation of the United Nations Global Forest Resources Assessment2005; FAO Forestry Paper, 2006 147. Available at http://ftp://ftp.fao.org/docrep/fao/008/A0400E/A0400E0.pdf.
10. Gujba H, Mulugetta Y, Azapagic A. The Household Cooking Sector in Nigeria: Environmental and Economic Sustainability Assessment, Resources. 2015;4:412-433. DOI: 10.3390/resources4020412.

11. International Energy Agency Energy Access Outlook 2017: From Poverty to Prosperity. World Energy Outlook Special Report; c2017. Available at http://www.iea.org/energyaccess.
12. Muller C, Yan H. Household fuel use in developing countries: review of theory and evidence, Marseille, France: Aix-Marseille School of Economics; c2016.
13. National Bureau of Statistics. Survey of Quality and Integrity of Public Services in Nigeria, Technical Report; c2017. Available at https://www.unodc.org/documents/data-and-analysis/Crime-statistics/Nigeria/NBS_-_technical_report_on_survey.pdf
14. Obadote DJ. Energy Crisis in Nigeria: Technical Issues and Solutions, In: Proceedings of the Power Sector Prayer Conference, Abuja, Nigeria; 2009.
15. Rahut DB, Behera B, Ali A. Factors determining household use of clean and renewable energy sourcesfor lighting in Sub-Saharan Africa, Renewable and Sustainable Energy Reviews. 2017;72:661-672.
16. Sambo AS. Strategic Developments in Renewable Energy in Nigeria. International Association of Energy Economics, Third Quarter; c2009. p. 15-19. Available athttp://www.iaee.org/en/publications/newsletterdl.aspx?id=75.
17. Smith KR, Mehta S. The Burden of Disease from Indoor Air Pollution in Developing Countries: Comparison of Estimates, International Journal of Hygiene and Environmental Health. 2003;206:279-289.
18. World Health Organization. Household Air Pollution and Health; c2020. Available at https://www.who.int/news-room/fact-sheets/detail/household-air-pollution