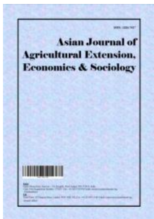

Asian Journal of Agricultural Extension, Economics & Sociology

38(1): 87-101, 2020; Article no.AJAEES.54550
ISSN: 2320-7027

Analysis of Green and Non-green Energy Poverty among Rural and Urban Households in Oyo State, Nigeria

O. A. Ajetunmobi[1*] and J. O. Oladeebo[1]

[1]Department of Agricultural Economics, Ladoke Akintola University of Technology, Ogbomosho, P.M.B. 4000, Oyo State, Nigeria.

Authors' contributions

This work was carried out in collaboration between both authors. Author OAA designed, analyzed, interpreted and prepared the manuscript. Author JOO supervised the manuscript. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJAEES/2020/v38i130301
Editor(s):
(1) Dr. Fotios Chatzitheodoridis, Professor in Regional Economic-rural Development and Policy, University of Western Macedonia, Greece.
Reviewers:
(1) Miguel Guzman-Rivero, Universidad Mayor de San Simón, Bolivia.
(2) Junir Antônio Lutinski, Universidade Comunitária da Região de Chapecó, Brazil.
(3) Preeya Puangsomlee Wangsomnuk, Khon Kaen University, Thailand.
Complete Peer review History: http://www.sdiarticle4.com/review-history/54550

Short Research Article

Received 06 December 2019
Accepted 12 February 2020
Published 19 February 2020

ABSTRACT

In rural and urban areas of Nigeria where alternative fuels were available, shift away from domestic wood fuel use were not taking place on a very large scale. The urban dwellers that normally use kerosene and gas were now systematically shifting to using charcoals. If energy situation should continue this way, economic growth and human development will be hampered in Oyo State. This study therefore, analysed the green and non-green energy poverty among rural and urban households in Oyo State of Nigeria. Multistage random sampling technique was used to select samples of two hundred and forty (240) respondents with the aid of structured questionnaire. The result showed that the mean age of all the respondents was 49.3 years while 66% of them were women. The average household size was 5 and 39% of the respondents attended tertiary institutions. Their primary occupation was farming (57%). The major energy sources available to the respondents were kerosene and charcoal (54%). The energy expenditure approach result showed that, 55% of the rural respondents were energy non-poor, 58% of the respondents in the urban

**Corresponding author: E-mail: oyepejuajetunmobi@gmail.com;*

areas were energy poor. The relative measure of energy poverty result revealed that 70.8% of all the respondents were energy poor. The logistic regression results showed that household size (p≤0.01), education (p≤0.01), expenditure on food (p≤0.01) were variables which positively determined energy poverty of the rural households; age (p≤0.01), household size (p≤0.01), education (p≤0.01) and expenditure on food (p≤0.01) were positive significant variables which determined energy poverty of the urban households and household size (p≤0.01), expenditure on food (p≤0.01) were positive significant variables that determined energy poverty of the pooled data. In conclusion, there should be an awareness, affordable prices of various energy types, advancement in technology, maintenance practices and revitalization of energy projects in the study area.

Keywords: Fuel; energy mix; energy needs; fuel-wood; kerosene; charcoal; gas; solar and energy expenditure.

1. INTRODUCTION

The Millennium Development Goals (MDGs) are the international community's commitment to halving poverty in world's poorest countries by the year 2015. The MDGs primarily aimed at eradicating extreme poverty and hunger, achieve universal primary education, promote gender equality and empower women, reduce child mortality, improve maternal health, combat HIV/AIDS, malaria and other diseases, ensure environmental sustainability and develop a global partnership for development. World Summit for Sustainable Development (WSSD) in Johannesburg in 2002 recognized the access of energy services as a prerequisite to the achievement of all MDGs [1]. They adopted a new global agenda committed to people, planet, promoting peace, prosperity and partnerships. The 2030 Agenda for Sustainable Development which include seventeen [2] Sustainable Development Goals (SDGs) which are no poverty, zero hunger, good health and well-being, quality education, gender equality, clean water and sanitation, affordable and clean energy, decent work and economic growth, industry, innovation and infrastructure, reduced inequalities, sustainable cities and communities, responsible consumption and production, climate action, life below water, life on land, peace, justice, strong institutions and partnership [3]. Green energy is a renewable energy such as solar power, geothermal, hydro energy, solar radiation, and wind power which improve human wellbeing, social equity and significantly reduce risks, ecological scarcity with low carbon and resource efficient [4]. Non–green energy is a non-renewable energy with high carbon emission, non-resource efficient, significantly increasing risk and depleting the eco-system such as fuel-wood, charcoal, kerosene, bitumen, tar sand, asphalt, coal, crude oil and natural gas.

In macro-economic models, differences in labour productivity between urban and rural areas and income effects of urbanization influence urban and rural consumption pattern. A key process is that fuel choices in urban and rural households tend to be rather different. The process of urbanization is important for economic development, environmental pressure and human wellbeing especially in developing countries like Nigeria. The economic structure and income levels of urban and rural areas are different, household behavior, resource use diverges and exposure of people to indoor air pollution from traditional fuel use also differs [5,6].

Unsustainable production of charcoal in response to urban demand, particularly in Nigeria and in sub-Saharan Africa places a strain on biomass resources. Charcoal production is often inefficient and can lead to localized deforestation and land degradation around urban centres. Scarcity of wood typically leads to greater use of agricultural residues and animal dung for cooking. When dung and residues are used for fuel rather than left in the field or ploughed back into fields, soil fertility is reduced and propensity to soil erosion is increased. Urbanization can affect energy use and emission through three channels; direct influences on the preferences of households for energy or other goods consumed, influences on income which directly affects the level of consumption or influences the energy supply infrastructure and in particular electricity access which also directly affects consumption. These consumption effects in turn influenced the types and quantities of fuels used in energy production [7].

Rural households without access to conventional energy sources like electricity and natural gas use combinations of different energy sources to meet their household energy needs. These combinations are often referred to as the energy mix. Cooking in a household involves the use of solid and non-solid fuels. The solid fuel consists of coal which is a fossil fuel and biomass fuel (BMF) like wood, charcoal, dung and crop residues. More than three billion people worldwide depend on solid fuels, including biomass (wood, dung and agricultural residues) and coal to meet their most basic energy needs for cooking, boiling water and heating. The non-solid fuel consists of kerosene, liquefied petroleum gas (LPG) and electricity [8]. Therefore, energy carriers such as electricity and other fuels facilitates job creation, industrial activities, agricultural outputs and micro-enterprises and thus helps alleviate poverty and hunger. Provision of energy services also improves health care facilities and its delivery. Cleaner energy systems contribute to environmental sustainability by addressing adverse impact of energy production, distribution and consumption. Yet, there are millions of energy poor in the world who lack access to clean and modern energy sources for their very basic activities of life. Worldwide about 2.4 billion people still lack access to safe and reliable energy and about 1.6 billion people do not have access to electricity. The problem of energy poverty is found to be acute in developing countries. Inability to provide adequate energy for Nigerian citizen is a major problem. Energy use may be in its raw form (primary energy) or in its transformed state (secondary energy). When both forms are subjected to combustion to release their stored energy it is called fuel. Energy poverty is a state of insufficient energy sources for basic living. It is also a state where households are spending more than 10% of their income on energy use. Energy Poverty can further be defined as an absence of sufficient choice in assessing adequate, affordable, reliable, high quality, safe and environmentally benign energy sources. Energy poverty has also been defined as the state of deprivation where a household or indeed an economic agent is barely able to meet at most the minimum energy requirement for basic needs [9;10]. Energy poverty line is the minimum quantity of physical energy needed to perform such basic task of cooking and lighting. It is also defined as the threshold point at which energy consumption begins to rise with increase in household income [11]. Millennium Development Goal defines energy poverty as the minimum needs corresponding to about 50 kilograms of oil equivalent (kgoe) of annual commercial energy per capita. This estimate was based on the need for approximately 40 kgoe per capita for cooking and 10 kgoe used as fuel for electricity. Energy is intricately linked to every aspect of economic life. It is the fundamental engine that drives industrialization, fosters economic growth, meeting commercial and domestic needs. Energy is the live wire of any economy. Energy is not only needed for domestic consumption, its availability creates an enabling environment for small-scale businesses to thrive. The hair barber, the hairdresser, fish hawkers by the roadside, sachet water sellers, fishermen, farmers and corn or rice millers. All of these needs one form of energy or the other to foster their businesses. Thus, energy is not only an end but a means to an end.

The Nigeria Vision 20:2020 was of the intention that Nigeria should be among the top 20 economies in the world with a minimum GDP of $900 billion and a per capita income of nothing less than $4000 per annum. The Vision was based on two broad objectives namely; optimising human and natural resources to achieve rapid economic growth and translating that growth into equitable social development for all citizens by the year 2020. Also, that Nigeria would have a large, strong, diversified, sustainable and competitive economy that effectively harnesses the talents and energies of its people and responsibly exploits its natural endowments to guarantee a high standard of living and quality of life to its citizens. Going by these objectives, In September 2000, the World Bank, the International Monetary Fund, members of the Development Assistance Committee of the Organisation for Economic Cooperation and Development (OECD) and many other agencies adopted the Millennium Development Goals. These goals set targets for reductions in poverty, improvements in health and education, and protection of the environment. Improved access to energy services was an underlying component linked to the achievement of these goals [12]. Incomplete combustion of biomass fuels in poorly functioning stoves often leads to the emission of toxic gases and particulate matters which may have serious health implication on the live of the people. Such negative consequences associated with solid biomass fuel claimed the attention of several researchers and environmentalists to probe into the prospects of improving the economic status of rural households so as to enable them enjoy the fruit of clean modern fuels. Also, 2.5 billion people in developing countries rely on biomass, such as fuel wood, charcoal, agricultural wastes and animal dung, to meet their energy needs for cooking. In many countries these resources accounted for over 90% of households' energy consumption. In the absence of new polices, the number of people relying on biomass will increase to over 2.6 billion by 2015 and to 2.7 billion by 2030 because of the population growth. That is, one-third of the world's population will still be relying on these fuels.

1.1 Energy Gap

On a fundamental level there is simply not enough electricity generated to support the entire population of Nigerians [13].

Energy Supply in Nigeria: Total Nigerian primary energy supply was 118,325 Kilotonne of Oil Equivalent (ktoe) excluding electricity trade in 2011. Biomass and waste were dominated with 82.2%. Renewable energy sources only accounted for a small share of the energy supply. For instance hydropower only accounted for 0.4%. Wind and solar are also utilized but at an insignificant level at present.

Energy supply by source in 2011 (in %).

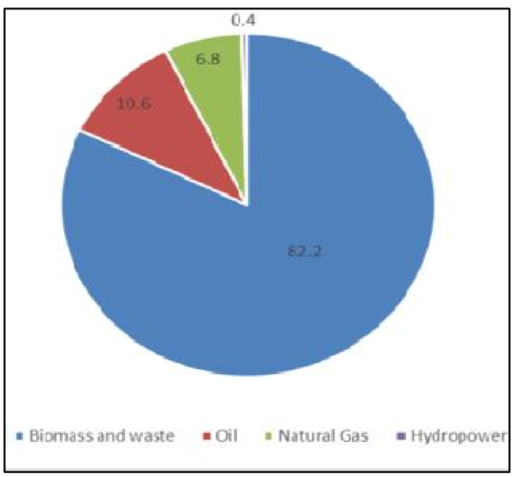

Fig. 1. Energy distribution

Biomass is the dominant energy source in Nigeria due to the huge reliance on the energy source for cooking and heating purposes by majority of the Nigerian people. According to the global initiative on accessible, clean and efficient energy, little progress has been made with regards to providing non-solid cooking fuels since 1990. In 2010 only 26% of the population had access to non-solid cooking fuels with a big difference between urban and rural areas [14].

Cooking fuels in rural and urban areas of Nigeria 2010 (in %).

According to the Nigeria Energy Policy report 2003, it was estimated that the population connected to the grid system was short of power supply over 60 percent of the time. In addition, less than 40 percent of the population is even connected to the grid [12].

The National Energy Policy: In 2003, the Federal Government approved the National Energy Policy developed by the Energy Commission of Nigeria. The key objectives of the National Energy Policy are:

(a) To ensure the development of the nation's energy resources with a diversified energy resources options for the achievement of national energy security and an efficient delivery system with an optional energy resource mix.
(b) To guarantee increased contribution of energy productive activities to national income.
(c) To guarantee adequate, reliable and sustainable supply of energy at appropriate costs and in an environmentally friendly manner to the various sectors of the economy and for national development.
(d) To guarantee an efficient and cost effective consumption pattern of energy resources.
(e) To accelerate the process of acquisition, diffusion of technology, managerial expertise in the energy sector and indigenous participation in energy sector industries for stability and self-reliance.
(f) To promote increased investments and development of the energy sector industries with substantial private sector participation.
(g) To ensure a comprehensive, integrated, well informed energy sector plan and programmes for effective development.
(h) To foster international co-operation in energy trade and project development in both the African regions and the World at large.
(i) To successfully use the nation's abundant energy resource to promote international Cooperation.

From the above energy policy, there is no sufficient energy delivery system, adequate, reliable, sustainable supply of energy at appropriate costs and in an environmentally friendly manner. No efficient and cost effective consumption pattern of energy resources. No increased investments and development of the energy sector industries. No acceleration of the process of acquisition and diffusion of technology. No managerial expertise in the energy sector and indigenous participation in energy sector industries for stability and self-reliance. In essence, the energy policy was adequately formulated but not implemented. Therefore, there was the need to research into green and non-green energy poverty status of Oyo State, Nigeria with a view to improve on their economic and developmental growth through their energy status.

Energy carriers such as electricity and other fuels facilitates job creation, industrial activities, agricultural outputs and micro-enterprises and thus helps alleviate poverty and hunger. Provision of energy services also improves health care facilities and its delivery. Cleaner energy systems contribute to environmental sustainability by addressing adverse impact of energy production, distribution and consumption. Yet, there are millions of energy poor in the world who lack access to clean and modern energy sources for their very basic activities of life. Worldwide about 2.4 billion people still lack access to safe and reliable energy and about 1.6 billion people do not have access to electricity. The problem of energy poverty is found to be acute in developing countries [15]. One of the major problems facing Nigeria today is her inability to provide adequate energy for her citizen. Energy use may be in its raw form (primary energy) or in its transformed state (secondary energy). When both forms are subjected to combustion to release their stored energy it is called fuel. Energy poverty is a state of insufficient energy sources for basic living. It is also a state where households are spending more than 10% of their income on energy use. Energy Poverty can further be defined as an absence of sufficient choice in assessing adequate, affordable, reliable, high quality, safe and environmentally benign energy sources. Energy poverty has also been defined as the state of deprivation where a household or indeed an economic agent is barely able to meet at most the minimum energy requirement for basic needs. Energy poverty line is the minimum quantity of physical energy needed to perform such basic task of cooking and lighting. It is also defined as the threshold point at which energy consumption begins to rise with increase in household income. Millennium Development Goal defines energy poverty as the minimum needs corresponding to about 50 kilograms of oil equivalent (kgoe) of annual commercial energy per capita. This estimate was based on the need for approximately 40 kgoe per capita for cooking and 10 kgoe used as fuel for electricity. Energy is intricately linked to every aspect of economic life. It is the fundamental engine that drives industrialization, fosters economic growth, meeting commercial and domestic needs. Energy is the live wire of any economy. Energy is not only needed for domestic consumption, its availability creates an enabling environment for small-scale businesses to thrive. The hair barber, the hairdresser, fish hawkers by the roadside, sachet water sellers, fishermen, farmers, corn or rice millers etc. All of these needs one form of energy or the other to foster their businesses. Thus, energy is not only an end but a means to an end.

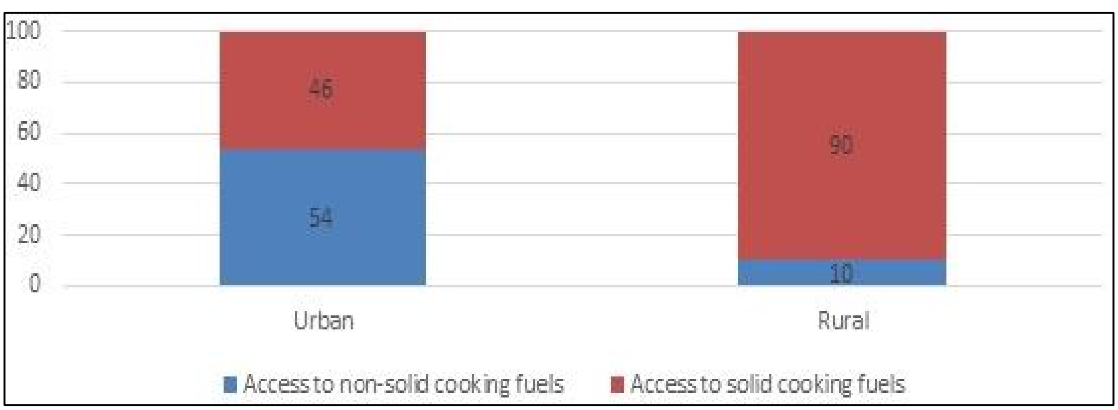

Fig. 2. Distribution of solid and non-solid cooking fules

The Nigeria Vision 20:2020 was of the intention that Nigeria should be among the top 20 economies in the world with a minimum GDP of $900 billion and a per capita income of nothing less than $4000 per annum. The Vision was based on two broad objectives namely; optimising human and natural resources to achieve rapid economic growth and translating that growth into equitable social development for all citizens by the year 2020. Also, that Nigeria would have a large, strong, diversified, sustainable and competitive economy that effectively harnesses the talents and energies of its people and responsibly exploits its natural endowments to guarantee a high standard of living and quality of life to its citizens.

2. METHODOLOGY

The study was carried out in Oyo State. Primary data was used in the study. The data were obtained by personal administration (as well as the use of enumerators) of well-structured questionnaire designed to obtain information on the socio-economic characteristics of the respondents such as age, marital status, level of education, sex among others. Information on various sources of green and non-green energy sources available to the respondents and the cost implications or amounts spent on the different energy source were obtained. The Oyo State Agricultural Development (OYSADEP) structure was used to select the appropriate sample for this study. OYSADEP was divided into four (4) Zones, namely, Saki, Ogbomoso, Oyo and Ibadan/Ibarapa zones. Multistage sampling technique was used to select the respondents in the study area. The first stage was the purposive selection of Ogbomoso and Oyo Zones. The second stage was the simple random selection of three Local Government Areas (LGAs) from each zone. Thus, Ogbomoso South, Orire and Surulere LGAs were selected from Ogbomoso zone and Afijio, Oyo East and Oyo West LGAs were selected from Oyo zone. The third stage involved the random selection of four villages each. Hence, Ibapon-Farm Settlement and Adu-Temidire were selected from the rural areas of Ogbomoso. Sunsun and Arowomole were selected from the urban area of Ogbomoso; Abogunde and Ile-Nla were selected from the rural area of Surulere LGA; Oko and Gambari were selected from the urban areas of Surulere LGA; Egbejoda-Obamo and Tewure were selected from the rural areas of Orire LGA; Iluju and Ikoyi were selected from the urban areas of Orire LGA; Oba- Dapo and Dijo were selected from the rural areas of Afijio LGA; Fiditi and Awe were selected from the urban areas of Afijio LGAs; Ajagba and Agboye were selected from the rural areas of Oyo East LGAs; Tokun and Apiti were selected from urban areas of Oyo East LGAs; Elede and Baale Ojongbodu were selected from the rural areas of Oyo West LGAs and Obanako and Fasola-Soku were selected from the urban areas of Oyo West LGAs. The final stage was the random and proportional selection (proportionate sampling model [16] was used) of the respondents using proportionality factor, from each village. Thus, a total of two hundred and forty (240) respondents were sampled. Since 240 copies of questionnaire were administered, a proportionality factor was introduced to determine the number of respondents that were to be sampled from each of the Local Government Area (LGA) selected. Thus:

$$S = \frac{K^*}{K} 240 \qquad (1)$$

Where;

S = Number of respondents to be sampled from each LGA selected
K^* = Population of LGA selected
240 = The desired number of respondents for the study area and
K = The total population of all LGAs
S = 6/33* 240=43

These implied 43 questionnaires per LGAs but 40 questionnaires were used per LGAs.

2.1 Analytical Techniques

2.1.1 Descriptive statistics

Descriptive statistics, energy expenditure approach and logistic regression were used.

2.1.2 Energy expenditure approach

Energy Expenditure Approach was used to analyse objective four.

$$EEX_{ij} = ETPT_{ij} + APC_{ij} \qquad (2)$$

Where:

EEX_{ij} = Total expenditure on green and non-green energy use i by household j in naira
$ETPT_{ij}$ = Transport expenses incurred on green and non-green energy use i by household j in naira

APC_{ij} = The actual purchase cost of the energy use i by household j in naira.

2.1.3 Logistic regression model

Following the works of Betchani, et al. [17] the logistic regression model was used to measure objective five. The energy utility that the economic agent (households) obtained from alternative j was represented as:

$$U_{nj} = V_{nj} + \varepsilon_{nj} \quad (3)$$

Where,

Unj = Total energy utilised
Vnj = Type of energy used
ε_{nj} = Stochastic utility

The logistic function was obtained by assuming that each ε_{nj} is independently and identically distributed as extreme values.

The density for each unobserved component of energy utilised was:

$$f(\varepsilon_{nj}) = e^{-\varepsilon_{nj}} e^{-e^{-\varepsilon_{nj}}} \quad (4)$$

and the cumulative distribution of the energy use was given as:

$$F_{(\varepsilon_{nj}) = e^{-e^{-\varepsilon_{nj}}}} \quad (5)$$

The logistic regression analysis was re-written as;

f(Energy Poverty) = ($X_1, X_2, X_3, X_4, X_5, X_6, X_7, \mu$)
that is, f(EPVY) = (Age, Sex, Household size, Household education, Cost of transport, total income, Expenditure on food, ε)

$$L_i = ln\left(\frac{P_i}{1-P_i}\right) = \beta_1 + \beta_2 X_1 \ldots \beta_7 X_7 + \mu \quad (6)$$

Where,

L_i = Logistic Regression Model (0, 1)
P_i = Probability of using an energy source (1 = used, 0 = not used)
1-P_i e probability of not using an energy source (0)
$\frac{P_i}{1-P_i}$ = the odd ratio in favour of using an energy source
$ln\left(\frac{P_i}{1-P_i}\right)$ = log of the odd ratio or the probability of using an energy source

β's = parameters to be estimated
X's = regressors
μ = the stochastic error term
EPVY = Energy poverty
F = function
X_1 = Age in years
X_2 = Sex
X_3 = Household size
X_4 = Respondent Education in years
X_5 = Cost of Transportation in naira
X_6 = Total Income in naira
X_7 = Expenditure on food in naira

3. RESULTS AND DISCUSSION

3.1 Socio-economic Characteristics of the Rural and Urban Households in the Study Area

The result in Table 1 showed that, the rural green and rural non-green energy users mean ages were about 50 and 49 years respectively. About 33% of the pooled rural household were between 51 and 60 years of age while those of the pooled urban was about 19%. The mean ages of the pooled respondents were about 52 and 47 years in the rural and urban areas respectively. This implied that, the respondents in the study area were in their youthful ages and make efficient use of energy types. This result was in accordance with [18] who revealed that as households head grow older their demand for charcoal and kerosene significantly increased.

About 74% and 58% of the pooled rural and urban household energy users were women while 26% and 42% of the pooled rural and urban household energy users were men. This implied that women were responsible for the purchase and sourcing for the green and non-green energy types used in their homes. About 93% and 95% of the pooled rural and urban respondents were married. Only about 7% of the pooled rural households energy users as well as 5% of the urban household energy users were single in the study area. This suggested that married households used more of both green and non-green energy than the single households.

The mean household size for both pooled rural and urban households' energy users sizes were 4 and about 5 people respectively. This implied that a minimum of four people were to a household in the study area. Therefore, green and non-green energy use was inevitable at all times in the study area. Thus, 29% of the pooled rural households and 48% pooled urban household green and non-green energy users had tertiary education. This implied that the respondents in the study area needed more education. The descriptive results of where the respondents were living before showed that 53% of the pooled rural households energy users were still living in the villages and were not ready to move out for any reason because of their farming activities and 64% of the pooled urban households energy users lived in their corresponding locations. This suggested that those who lived in both the rural and urban areas were using one type of green, non-green or both energy sources.

About 54% and 74% of rural and urban green households energy users respectively believed that energy could be a factor for moving from one place to another while about 93% and 35% of rural and urban non-green households' energy users believed that energy could be a factor for moving from one place to another. In conclusion, 25% of the rural pooled household energy users as well as 38% of the urban pooled household energy users do not believe that energy could be a factor for moving from one place to another. The findings suggested that energy is very important to all the respondents in the study area. Also, 68% and 45% respectively of the pooled rural and urban households' energy users engaged in farming while 25% and about 42% of the pooled rural and urban households' energy users engaged in civil service as their primary occupation. Other sources of their income were; tailoring, petty trading, hair dressing/barbing, grinding, milling, agro-dealing, carpentry, welding, patent stores, night guards, driving, bricklaying and garri processing.

3.2 Energy Sources Available in the Study Area

According to Table 2, the result of the types of energy sources available to all the respondents in the study area are presented. The result in the Table indicated that among the rural households' energy users sampled 49% of them used mainly kerosene and charcoal while about 28% used kerosene, crop residue and firewood. Only 20% used kerosene, charcoal and firewood and only about 3% of the respondents used kerosene, petrol, engine oil and fire wood. The study also showed that about 58% of the urban household energy users used kerosene and charcoal, 25% of them used kerosene, charcoal and firewood, about 10% of the respondent used kerosene, crop residue and firewood while about 2% of them used kerosene and gas as well as kerosene, petrol, engine-oil and firewood; kerosene, gas and electricity and only about 1% of the respondents used kerosene, charcoal, and petrol. About 54% of the pooled data used kerosene and charcoal, about 23% of them used kerosene, charcoal and firewood, about 20% used kerosene, crop residue and firewood, about 2% used kerosene, petrol, engine oil and firewood, about 1% of them uses both kerosene and gas, kerosene, gas and electricity and about 42% of them used kerosene, charcoal and petrol. This suggested that the respondents in the study area mostly got their energy from non-green energy sources which are kerosene and charcoal. However, charcoal processes and fuel-wood might cause desert encroachment or depletion of valuable and economic forest trees.

Green and non-green energy sources used by rural, urban and pooled households' data in the study area: The results in Table 3 revealed the various green and non-green energy sources available in the study area. For green energy

Table 1. People relying on traditional biomass (million) [24]

Energy performance index	2004	2015	2030
Sub-Saharan Africa	575	627	720
North Africa	4	5	5
India	740	777	782
China	480	453	394
Indonesia	156	171	180
Rest of Asia	489	521	561
Brazil	23	26	27
Rest of Latin America	60	60	58
Total	2528	2640	2727

Table 2. Socioeconomic characteristics of the rural and urban green and non-green energy used households in the study area

Age	Rural green	Rural non-green	Urban green	Urban non-green
21- 30	03 (5.6)	05 (7.6)	04(3.33)	02(5.4)
31-40	11(20.4)	10(15.2)	22(26.5)	10(27.0)
41-50	11(20.4)	23(34.9)	30(36.2)	08(21.6)
51-60	24(44.4)	16(24.2)	13(15.7)	10(27.0)
61-70	05(9.25)	09(13.6)	12(14.5)	05(13.5)
71-80	-	03 (4.6)	02(2.41)	02(5.4)
Mean	50.17	49.05	48.49	50.16
Sex				
Male	13(24.1)	18(27.3)	35(42.2)	15(40.5)
Female	41(75.9)	48(72.3)	48(57.8)	22(59.5)
Marital status				
Married	51(94.4)	61(92.4)	79(95.2)	35(94.6)
Single	03(5.5)	05(7.6)	04(4.8)	02(5.4)
Household size				
1-3	16(29.6)	07(10.6)	18(21.7)	14(37.9)
4-6	34(63.0)	47(71.2)	55(83.3)	20(54.1)
7-10	04(7.4)	12(18.2)	10(12.1)	03(8.1)
Mean	4.33	5.11	4.88	4.08
Education status				
No Formal	11(20.4)	16(24.2)	13(15.7)	14(37.8)
Primary	13(24.1)	13(19.7)	11(13.3)	01(2.7)
Secondary	12(22.2)	20(30.3)	16(19.3)	07(18.9)
Tertiary	18(33.3)	17(25.8)	43(51.8)	15(40.5)
Total	54(100)	66(100)	83(100)	37(100)
Migration as a result of energy				
Yes	29(53.7)	61(92.4)	61(73.5)	13(35.1)
No	25(46.3)	05(7.6)	22(26.5)	24(64.9)
Primary occupation				
Farming	29(53.7)	53(80.3)	37(44.6)	17(46.0)
Civil Servant	21(38.9)	09(13.6)	38(45.8)	12(32.4)
Others	04(7.4)	04(6.06)	08(9.6)	08(21.6)
Source of Income				
Farming	25(46.3)	57(86.4)	42(50.6)	25(67.6)
Salary	02(3.7)	04(6.1)	34(41.0)	03(8.1)
Trading	02(3.7)	01(1.5)	01(1.2)	01(2.7)
Others	25(46.3)	04(6.1)	06(7.2)	08(21.6)
Awareness of green and non-green energy				
Yes	34(63.0)	42(63.6)	59(71.1)	24(64.9)
No	20(37.0)	24(36.4)	24(28.9)	13(35.1)
Green and non-green energy used				
Green energy used	54 (45.00)		37 (30.83)	
Non-green energy used	66 (55.00)		83 (69.17)	

sources, solar street lights were found to be available in both the rural and urban areas of Oyo state but at a very low percentage of about 7% and 4% respectively. Gas and electricity 3%, solar street lights and boreholes were about 7%, about 2% of solar lamps and none of biogas, solar radio, solar television and windmill was found in the study area.

For non-green energy sources, kerosene was indeed a household energy saviour because about 29% and 28% of it was being used by the respondents in the study area. Charcoal was found to be the next fuel used 13% and 19% respectively. About 15% and 16% of both the rural and urban respondents used petrol and engine oil. None of the urban respondents used either animal dung or sawdust. Only 0.5%, about 2% and 3% of the respondents used crop residue in the study area. This implied that the respondents in the study area have both green and non-green energy sources at their disposal but not adequately harnessed to reduce energy poverty. The result was in agreement with [19].

3.3 Energy Expenditure Approach

Department for International Development (DFID) [20], Fahmy [21] stated that households that spent more than 10% of his or her income on energy use are energy poor. Therefore, 10% of the respondents average income = ₦11, 078. So, 0 implied energy poor spending > 10% of the respondent's average income. 1 implied energy non-poor spending < 10% of the respondents average income.

Summary statistics of relative energy poverty for rural, urban and pooled households data in the study area: The result in Table 4 showed that the mean expenditure on non-green energy sources for the rural and urban households were ₦4,918.28 and ₦3,336.38 and green energy sources for the rural and urban households were ₦853.08 and ₦5,589.27 respectively while the mean expenditure for pooled green and non-green energy sources were ₦4,127.3 and ₦3,221.2 respectively in the study area. This implied that the households in the study area spent more money on non-green energy sources.

Summary statistics of relative energy poverty for rural, urban and pooled households in the study area: The result in Table 5 revealed that about 72%, 70% and 71% of the rural, urban and pooled data respectively were energy poor because they spent below the means of ₦5,771.4 ₦8,925.65 and ₦7,348.5 respectively on their energy types used. This implied that the respondents in the study area were experiencing green and non-green energy poverty. Comparing the energy expenditure approach and relative energy measurement approach about 65% and 71% respectively of the respondents were energy poor.

The result was in accordance with Betchani, et al. [17] studies because the rural households were still energy poor but the percent poor (62%) was greatly lower than energy expenditure approach (about 81%) used.

3.4 The Result of the Logistic Regression Analysis of the Rural and Urban Households in the Study Area

The result in Table 6 revealed a positive statistical significant relationship with sex (p<0.05). This implied that married households have higher probability of using non-green energy sources for cooking and lighting. A positive statistical significant relationship occurred between household size and non-green energy households (p<0.05). This implied that as households' size increases there is the probability of using more energy for more cooking in their homes. There was a positive statistical significant relationship between rural non-green energy households and transport expenditure (p<0.05). This implied that as transport cost increased there was the probability of increase in non-green energy use of the households. There was also a positive statistical significant relationship between expenditure on food and energy poverty (p<0.01). This implied that as more food is bought there was the probability of spending more on non-green energy source used. The odd ratio of approximately 1.0000 indicated that a percent increase in food expenditure would increase energy poverty by 0.018 percent. The result agreed with the apriori expectation except for transportation cost which was positive instead of being negative. Also, the result was in line with Betchani, et al. [17] but in contrast with [22] that total households' expenditure or income level was the most explanatory variables causing variation in energy requirement across households. Logistic analysis relies on other statistics to analyse the reliability of any model. The log `Likelihood Ratio test which was distributed to test the overall performance of the model was also used. The parameters are statistically significant as revealed by the Log Likelihood value of 65.38 (p<0.10). This implied that the model produced a good fit for the data on rural non-green households. A further goodness of fit test carried out for logistic regression according to Ping, et al. [23]. Pearson Chi –Square statistic was used for the rural non-green households' energy poverty. The result showed the Pearson Chi Square value of 58.07 and probability of 0.4357 (about 44%). This implied that the model was a good fit for the data. Also, there was a positive statistical significant relationship between rural green energy poverty and household size (p<0.01). This implied that as household size increased there was the probability of increase in the energy type used for more food will be cooked. There was a positive statistical significant relationship between energy poverty and rural green household education ($p<0.10$). This implied that as years of education increases there are probabilities of improved cooking using more green energy sources. The odd ratio of 1.0000 was in favour of transport expenditure, total income and expenditure on food to increase energy poverty in the study area. There was also a positive statistical significant relationship between expenditure on food and energy poverty ($p<0.05$). This implied that as the household increases their food purchases there was the probability of energy poverty increase by 0.044.

The result agreed with the apriori expectation except for transportation cost and in agreement with Betchani, et al. [17] who also used primary source of data and logistic regression model to analyze energy poverty reported that household size, household education level, household expenditure on transportation are important factors explaining the state of energy poverty in South Lunzu Township. The Log Likelihood Chi Square statistical test value of 34.78 ($p<0.01$) make the model to be a good fit and confirmed the endogenous characteristics of the choice of the variables that caused rural green energy poverty of the households. A further goodness of

Table 3. Types of non-energy sources available to rural and urban households in the study area

Energy sources	Rural households	Urban households	Pooled data
Kerosene and Charcoal	59 (49.17)	70 (58.33)	129(53.8)
Kerosene, Charcoal and Firewood	24 (20.00)	30 (25.00)	54 (22.5)
Kerosene and Gas	-	02 (1.67)	02 (0.8)
Kerosene, Petrol, Engine-oil and Firewood	03 (2.50)	02 (1.67)	05 (2.1)
Kerosene, Crop residue and Firewood	34(28.33)	13 (10.30)	47 (19.6)
Kerosene, Charcoal and Petrol	-	01 (0.83)	01 (0.4)
Kerosene, Gas and Electricity	-	02 (1.67)	02 (0.8)
Total	120 (100)	120 (100)	240 (100)

Table 4. Green and non-green energy sources used by rural, urban and pooled households data in the study area

Energy sources	Rural households	Urban households	Pooled households
Green energy sources			
Gas	10 (2.5)	11 (2.7)	21(2.6)
Electricity	11 (2.75)	10 (2.4)	21(2.6)
Biogas	-	-	-
Solar –radio	-	-	-
Solar street light	26 (6.5)	17 (4.2)	43 (5.3)
Solar borehole	28 (7.0)	17 (4.2)	45(5.6)
Solar stove	-	-	-
Solar refrigerator	-	-	-
Solar lamp	06 (1.5)	09 (2.2)	15 (1.9)
Solar television	-	-	-
Modern biomass	-	-	-
Windmill	-	-	-
Non-green energy sources			
Kerosene	114 (28.5)	116 (28.4)	230 (28.4)
Charcoal	53 (13.25)	77(18.8)	130 (16.1)
Diesel	06 (1.5)	08 (2.0)	14 (1.7)
Petrol	58 (14.5)	64 (15.7)	122 (15.1)
Engine-oil	30 (7.5)	44 (10.8)	74 (9.2)
Fuel wood	41 (10.2)s	34 (8.3)	75 (9.3)
Animal dung	04 (1.0)	-	04 (0.5)
Sawdust	-	-	-
Crop residue	12 (3.0)	02 (0.5)	14 (1.7)
Total	400 (100)	409 (100)	809 (100)

fit test carried out for logistic regression. The Pearson Chi – Square was 33 for the rural green energy poverty. This implied that the overall explanatory power of the model could be relied upon and that the predictor in the logistic regression was important in explaining the behavior of rural green energy poverty in Oyo State.

Table 5. Summary statistics of relative energy poverty for rural, urban and pooled households in the study area

Energy expenditure	Rural households	Urban households	Pooled data
Total Expenditure on all Energy types used	₦ 692,564	₦ 1,071,078	₦1,763,642
Average Expenditure on all Energy types used	₦ 5,771.4	₦ 8,925.65	₦ 7,348.5
Total expenditure on non-green energy	₦590,194	₦ 400,366	₦ 990,560
Average expenditure on non-green energy	₦ 4,918.28	₦ 3,336.38	₦ 4,127.3
Total expenditure on green energy	₦ 102,370	₦ 670,712	₦ 773,082
Average expenditure on green energy	₦ 853.08	₦ 5,589.27	₦3,221.2
Total Income of the respondents	₦18,951,100	₦ 7,635,201	₦26,586,301
Average income of the respondents	₦ 157,925.8	₦ 63,626.68	₦ 110,776.3
10% of average total income	₦ 15,792.58	₦ 6,362.67	₦ 11,078

Source: Authors calculation

Table 6. Relative energy poverty: Summary statistics of rural, urban and pooled households' data in the study area

Relative energy poverty	Rural households	Urban households	Pooled data
Energy Poor	86 (71.67)	84 (70.00)	170 (70.83)
Energy Non-Poor	34 (28.33)	36 (30.00)	70 (29.17)
Total	120 (100)	120 (100)	240 (100)
Mean	₦ 5,771.4	₦ 8,925.65	₦7,348.5

Note: Figures in parenthesis are percentages

Table 7. Logistic regression and marginal effect results of rural non-green and green energy poverty of the households in the study area

Variables	Non-green rural households			Green rural households		
Energy poverty	Odds ratio	P-values	Marginal effects	Odds ratio	P-values	Marginal effects
Age	0.9979	0.942	0.942	1.0199	0.718	0.723
Sex	0.9979	0.064**	0.942	2.1723	0.355	0.380
Household size	0.1429	0.023*	0.021*	0.4755	0.021*	0.021*
Household education	0.2642	0.883	0.883	2.4221	0.086***	0.093***
Transport cost	0.0025	0.049**	0.050**	0.9960	0.243	0.237
Total income	0.9999	0.658	0.658	1.0000	0.259	0.260
Expenditure on food	0.9998	0.016*	0.018*	0.9998	0.043**	0.044**
_cons	7.1022	0.001*		2.4019	0.497	
No of observation	120			75		
LR chi2(7)	65.38			34.78		
Prob > chi^2	0.0000***			0.0000*		
Pseudo R^2	0.4320			0.3548		
Log likelihood	-42.977624			-31.6172		
Goodness-of-fit test						
Observation	65			34		
Pearson chi^2	(57) = 58.07			(23) = 33.13		
Prob>chi^2	0.4357			0.0788		

*Where *, **, *** means statistical significant at 1%, 5%, and 10% level of significance respectively*

3.5 Urban Non-green Households

3.5.1 Logistic regression and marginal effect results of urban non-green energy used by the households in the study area

The result in Table 7 showed that there was a positive statistical significant relationship between urban non-green energy poverty and household size ($p<0.01$). The marginal effect result revealed that an increase in household size will increase urban non-green poverty energy by 0.021. The odd ratio of 1.0020 for urban non-green households was in favour of transport expenditure ($p<0.01$) to increase energy poverty in the study area. There was also a positive statistical significant relationship between expenditure on food and energy poverty ($p<0.01$). The results were in accordance with their apriori expectation and with the submission of Betchani, et al. [17]. The Log Likelihood Chi Square Test value was 35.17 and statistically significant at ($p<0.01$) 1 percent level of significance. This implied that the model was a good fit for the data and the variables that caused energy poverty of the urban non-green households energy used. Pearson Chi –Square test value of 85.17 and statistically significant ($p<0.01$). This implied that the overall explanatory power of the model could be relied upon and that the predictors in the logistic regression were important in explaining the behavior of the urban non-green energy poverty households. There was a positive statistical significant relationship between urban green energy poverty households and sex ($p<0.05$). This implied that as married households' increases there is the probability of green energy poverty to increase by 0.0002. A positive statistical significant relationship occurred between household size and green energy poverty ($p<0.05$). The marginal effect result revealed that for an increase in household size there is the probability of 0.038 increase in urban green energy used. The odd ratio of approximately 1.0000 for urban green households was in favour of transport expenditure to increase energy poverty by 0.039 in the study area.

There was also a positive statistical significant relationship between expenditure on food and energy poverty ($p<0.10$). This implied that as more food is bought the probability of green energy used was increase by 0.062. The results agreed with their apriori expectation except for transportation cost which though significant but positive. The study further revealed that sex was also an important variable determining energy poverty among households which was in contrast to Betchani, et al. [17] study. The Log Likelihood Chi Square Test value of 36.98 and statistically significant at 10 percent level of significance($p<0.10$) indicated that the model was a good fit for the urban green energy poverty in the study area. A further goodness of fit test

Table 8. Logistic regression and marginal effect results of urban non-green and green energy poverty households in the study area

Variables	Non-green rural households			Green rural households		
Energy poverty	**Odds ratio**	**P-values**	**Marginal effects**	**Odds ratio**	**P-values**	**Marginal effects**
Age	0.9821	0.481	0.942	1.0248	0.483	0.477
Sex	0.6697	0.487	0.942	0.1160	0.027**	0.002*
Household size	0.6697	0.053*	0.021*	0.4990	0.042**	0.038**
Household education	0.8615	0.544	0.883	1.0688	0.838	0.838
Transport cost	1.0020	0.227	0.050**	0.9936	0.040**	0.039**
Total income	0.9999	0.949	0.658	0.9999	0.336	0.344
Expenditure on food	0.9999	0.003*	0.018*	0.9999	0.059***	0.062***
_cons	7.1022	0.001*		7.7375	0.001*	
No of observation	120			65		
LR chi2(7)	35.17			36.98		
Prob > chi^2	0.0000***			0.0000*		
Pseudo R^2	0.2201			0.4191		
Log likelihood	-62.297933			-25.6269		
Goodness-of-fit test						
Observation	86			55		
Pearson chi^2	(78) = 85.17			(44) = 47.617		
Prob>chi^2	0.2708			0.3280		

*Where *, **, *** means statistical significant at 1%, 5% and 10% level of significance respectively* carried out on logistic regression. The Pearson Chi –Square value was 47.62 ($p<0.10$) for urban green energy poverty. This implied that the overall explanatory power of the model could be relied upon and that the predictors in the logistic regression were collectively important in explaining the behavior of urban green energy poverty households' in Oyo State.

4. CONCLUSION

Conclusively, socio-economic characteristics had significant effect on energy poverty of the rural and urban households in the study area. Kerosene, Charcoal and Fuelwood are the most prominent energy sources in the study area. The relative analysis finally showed that Oyo State was energy poor because 72%, and 70% of rural and urban respectively were energy poor with the mean amount of ₦5,771.37 and ₦8,925.65 respectively. The factors responsible for the energy poverty in the study area include: sex, household size, household education, transport cost and expenditure on food. All the variables agreed with their apriori expectations. The study has found out salient facts which will be relevant and of great importance to the Nigerian Developmental Policies on energy supply to Oyo State. Knowing fully that energy sources either for cooking, lighting or business is indispensable. There is a need for people to be aware of green energy sources and use them because this will protect both the user and the environment. This could be done by the households forming groups or research institutions, governmental and non-governmental organizations. Since increase in household leads to more expenditure on energy sources, farmers are therefore advised to go on family planning. For the fact that expenditure on food items increases the respondents chances of being energy poor. Household heads are encouraged to source for green energy sources which will reduce their cost, health hazard, promote long life and strength. Finally, respondents in the study area are encouraged to have more education to be able to deliver them from energy poverty by making use of the natural endowments that will generate energy for them.

CONSENT

As per international standard informed and written participant consent has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. World Energy Outlook. OECD/IEA. (International Energy Agency), Paris; 2006.
2. UN Energy. The energy challenge for achieving the millennium development goals, United Nations; 2005. Available:www.uncsd2012.org/.../...Mahbub-ul-haq
3. International Energy Agency (IEA). Energy Balances of OECD Countries. International Energy Agency; 2010.
4. Modi V, McDade S, Lallement D, Saghir R. Energy services for millennium development goals. Energy Sector Management Assistance Programme, UN Millennium Project and World Bank; 2005. Available:http//www.unmillenniumproject.org/documentsMP-Energy-Low-Res.pdf
5. Pachauri S. An energy analysis of household consumption. Changing Patterns of Direct and Indirect Use in India. Springer-Verlag, Berlin, Germany; 2007.
6. Pachauri S, Jiang L. The household energy transition in India and China. Energy Policy. 2008;36:4022-4035.
7. Krey V, Brian C, O'Neill B, Van R, Vaibhav C, Vassilis D, Jiyong E, Leiwen J, Yu N, Shonali P, Xiolin R. Urban and rural energy use and carbon dioxide emissions in Asia. Energy Economics; 2012. DOI:10.1016/j.eneco2012.04.013
8. World Health Organisation. Multicentre growth reference study Group. WHO Child growth standards: WHO working group on infant growth. An evaluation of infant growth. Geneva: World Health Organisation; 2006.
9. Modi V, McDade S, Lallement D, Saghir J. Energy and the millennium development goals. New York: Energy Sector Management Assistance Programme, United Nations Development Programme, UN Millennium Project, and World Bank; 2006.
10. International Energy Agency (IEA). Energy Balances of OECD Countries. International Energy Agency; 2010.
11. Shahidur R, Khandker D, Barnes F, Hussain AS. Energy poverty in rural and urban India. Are the energy poor also

income poor''? Policy Research. Working Paper 5463; 2010.
12. World Health Organisation. Fuel for life: household energy and health, Geneva, World Health Organisation; 2006.
13. Nigeria Energy Policy report. Energy Commission of Nigeria (ECN), National Energy Policy, Federal Republic of Nigeria, Abuja.; 2003.
14. Sustainable Energy for All (SEAL). Global Tracking Framework. 2013;267.
15. UN. The United Nations. Transforming our world: The 2030 Agenda for Sustainable Development; 2015.
Available:https://sustainabledevelopment.un.org/content/documents/7891Transforming our world
16. Murray RS. Theories and problems of probabilities and statistics. Asian Student Edition. McGraws-Hills. Singapore. 1985; 155-210.
17. Betchani HM. Tchereni, Wynand Grobler and Steven, H. Dunga. Economic Analysis of Energy Poverty in South Lunzu, Malawi. Journal of Economics and Sustainable Development. 2013;4(4).
18. Adepoju AO, Oyekale AS, Aromolaran OA. Rural households demand for domestic energy in Odeda Local Government Area of Ogun State, Nigeria. J.Hum Ecol. 2012; 40(2):115-123.
19. Abayomi SO. Assessment of households access to electricity and modern cooking fuels in rural and urban Nigeria: Insights from DHS Data. Life Science Journal. 2012:9(4).
20. Department for International Development, (DFID). Energy for the poor: Underpinning the Millennium Development Goals. London; 2002.
Available:www.dfid.gov.uk/pubs/files/energyforthepoor.pdf
Drummond MF, Jefferson TO. Guidelines for authors and peer reviewers of economic submissions to the BMJ. British Medical Journal. 1996;313:275-283.
21. Fahmy E. The definition and measurement of fuel poverty. A briefing paper to inform consumers focus's submission to the Hills fuel poverty review. University of Bristol; 2011.
22. Torres-Duque C, Maldonado D, Perez-Padilla R, Ezzati M, Viegi G. Forum for International Respiratory Studies (FIRS). Task Force on Health Effects of Biomass Exposure. Proc. A Thorac. Soc. 2008;5(5): 577-590.
23. Ping CJ, Lee KL, Ingersoll GM. An introduction to logistic regression analysis and reporting. The Journal of Educational Research. 2002;96(1).
24. Shekhar D. Popularization of biomass briquettes: A means for sustainable rural development. Asian Journal of Management Research. 2011;2(1):457-473.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/54550