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Research Article

Determinant of Household Accessibility to Alternative Sources of Electricity Supply in Nigeria: A Case Study of Ekiti State

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Abstract

Regular supply of electricity especially is an important factor influencing human capital development as well as elongating life expectancy in a developing country like Nigeria. However, the perennial problems of epileptic supply of electricity to various household in Nigeria have made all these benefits in a mirage. To this end, this research was conducted to investigate the determinant of household accessibility to alternative sources of electricity supply in Nigeria using Ekiti State as a case study. The study examined the households across the 16 local the 16 local government area which was randomly selected with use of a questionnaire. The collected data were analyzed by using both descriptive and multivariate analysis. Results from the study showed that income and necessity are prominent factors that determine the choice of Alternative Sources of Electricity Supply (ASES) by households in the study population. This was further confirmed by the outcome of the logistic regression which depicts that four (i.e. social class, jobs, supply of electricity by the BEDC and income level of the households) out of the predictors exhibited a significant influence on the decisions of household regarding ASES respectively. The study also discovered that the low level of income as well as lack of proper awareness of the existence of some of the ASES was major factors that limit the accessibility of the various types of ASES. Evidence, from the study showed that there is the need for the government to embark on community-based solar electricity project this will have far reaching positive effect on the provision of a stable electricity supply which will enhance the socio-economic wellbeing of the households in Ekiti State. Finally, the study recommends the need for the government to embark on an awareness program across the state to sensitize the households on the various forms of ASES available and their use. This will improve household's accessibility to ASES and improve the socio-economic life of the households.

Keywords: ASES, Household, Logistic regression, Survey, BEDC

Introduction

Provision of low-cost, affordable and regular electricity is critical to industrial development, employment generation and poverty alleviation in Nigeria. Access to regular electricity supply especially for various households are a major and important factor to increase human capital development as well as elongating life expectancy in a developing country like Nigeria. This is because; it can translate to economic expansion and improvement in the well being of an average household in Nigeria. Unfortunately, the perennial problems of epileptic supply of electricity to various household in the country have made all these benefits in a mirage. Though, Nigeria is energy surplus in theory given the range of energy options in the country; it has been unable to convert its energy abundance into socio economic development, possibly

because of the policy environment and the nature of institutions put in place to drive activities in the energy sector. As a result account for the reason why socio economic development of Nigeria is still enmeshed in the nightmare of "darkness" occasioned by epileptic electricity generation and distribution as observed by (Popoola, Ponnle & Ale, 2010).

In recent times, the total electricity generation in Nigeria has dropped drastically. Precisely from about 5000MGW in June 2015 to less than 2000MGW in April 2016. Evidently, the problem of electricity generation in Nigeria can be described to be multifaceted with the advent of gas based electric power plant. For instance, in the 70s and 80s most of the power plants in Nigeria were hydro based but the upsurge in electricity consumption has led to the construction of alternative gas based plants since Nigeria has a comparative advantage in gas production. However, despite how applauded this initiative might be, the incessant gas pipeline vandalization has made most of the plants to be operating far below installed capacity as pointed by (NERC, 2014).

Furthermore, NERC (2016), pinpointed that the current the total installed capacity of all the power plants in Nigeria handled by the power generating companies GENCOS is around 10,000MGW with Egbin power plant contributing the highest of about 1300MGW whereas, GENCOS is only contributing about 30% installed capacity. In addition, to the aforementioned is the problem posed by the transmission companies. Ironically, the government still own 100% of the TCN, but the total capacity of power that can be transmitted to the national grid is just 5000MGW. The implication of this is that, even if the GENCOs operate at full capacity the TCN do not have enough facility to transmit all the power generated for distribution by the distribution companies (this includes the 60% DISCOs that is owned by private sector and 40 % owned by Government). Surprisingly, the discos on their part are still battling with the inherited dilapidated and moribund structures ranging from outdated wires and cables, obsolete transformers among others; which to a large extent have inhibited the capacity of the DISCOs to distribute electric power effectively.

For instance, Abdulahi, Akinsanmi and Muazu (2007) in their study noted that the low performance of the electric power sector of Nigeria in particular and other West African countries general have created the inevitable need for collaboration under the West African Power Pool Project (WAPPP). However, like typical initiative of the developing countries, the WAPPP is confronted with a number of logistical challenges. Notably, Nigeria tends to be a substantial player in the WAPPP initiative given its size and strategic position. The aim of the country is that the WAPPP scheme among others would complement or accelerate its power sector reforms, which began in March 2005 with the enactment of the Electric Power Sector Reform Act 2005 (the Act). But the realities on the ground showed that the pace of the reforms has been slow and seemingly unattractive to the private investors who still perceive the Nigerian electricity sector as significantly risky. Also, apparent inactive private sector involvement in the new electricity regime in Nigeria ranging from regulatory and operational overlaps, funding constraints, over-centralization of the electricity sector among others; are issues militating against the power sector in Nigeria.

Statement of Research Problem

It is from the above background that various households units in Nigeria as thought it wise to switch over and have continued to rely on diverse alternative sources of electric power generation in order to improve their living standard. It is obvious that leaving the electricity supply as an exclusive right of the government to provide is a complete misnomer in a developing country like Nigeria where virtually every sector of the economy is experiencing upsurge in corruption every day, thereby crippling virtually all infrastructures including electricity according to (Popoola, Ponnle & Ale, 2010).

Nonetheless, the drive by various households to provide an alternative source of electric power has resulted into a number of socio economic implications on the households. These range from cost, to convenience and noise pollution among others. Despite numerous alternatives to electricity supply by the government, a good number of the household are still uncertain about selecting the most appropriate choice of alternative electricity supply that will maximize their convenience at a reasonable cost. In Nigeria, the most common alternate sources of electricity supply are generating set, solar powered inverter, inverter and rechargeable electrical appliances (Awosope, 2014). Apart from knowing the available alternative electricity sources, the most certain is that has all the household in Nigeria as a whole been able to have access to all this electricity sources in order to improve well being or are there certain factors that determines household accessibility to these sources or not.

It is consistent with the above raised questions that this current research intends to investigate the determinants of household accessibility to alternative electricity sources in Nigeria. Consequently, the objective of this study is to consider empirically the determinant of household accessibility to alternative electricity sources in Nigeria using Ekiti State as a case study. This study is timely because across the country there has been an infrastructure deficit most especially power outage which has led to declining in household productive capacity vis-a-vis small business umbrella of entrepreneurship innovation. Furthermore, the study is very germane because it will pave the way for government agencies, NGOs and other donor agencies to participate in the community based electricity provision for various households in Nigeria and especially in Ekiti State which is our case study. In the same vein, the outcomes of this study will go a long way to identifying the particular form of alternative electricity supply suitable for a particular segment of household; various cost analysis and cost implications in order to bring about optimization in terms of usage by the households.

Rest of the paper will be organized in this manner, following the introduction; section 2 highlights the conceptual framework and some selected reviews of literature. Data and methodology is discussed in section 3, section 4 shows estimation and results while Section 5, concludes the study and give some policy implications.

Conceptual framework and Literature review

Some of the alternative energy (electricity) supplies are renewable energy resources which possess minimal or zero threat to global warming and also possesses slight supply logistic problems (Jekayinfa & Omisakin, 2005). Some of the alternative electricity supplies in Nigeria are: solar, inverters, generators and Electrical rechargeable.

Solar Energy

Solar energy is part of the major options for the supply of sustainable electricity supply to households. Solar power system is environmentally friendly, safe, and has no gas emissions nor generates noise (Al-Salaymeh, Al-Hamamre & Firas, 2009) with strong support for its use from World Bank, UN and other international agencies (Oladokun & Adeshiyan, 2012; Karekezi & Kithyoma, 2002; Villavicencio, 2002). Electricity generation from solar energy is rapidly spreading in Nigeria; this is because the country is endowed with an annual average daily sunshine of 6.25 hours, ranging between about 3.5 hours at the coastal areas and 9.0 hours at the far northern boundary and an annual average daily solar radiation of about 5.25 kW/m2/day at the coastal area and 7.0 kW/m2/day at the northern boundary. This is equal to about 1.082 million tons of oil equivalents per day; about 4 thousand times the current daily crude oil production and about 13 thousand times that of natural gas daily production based on energy unit. This huge energy resource from the sun is available for about 26% only of the day (Bala et al. 2000).

In addition, Chendo (2002) stressed that based on the land area of 924 x 103km2 for the country and an average of 5.535kWh/m2/day, the Nigerian economy has an average of 1.804 x 1015kWh of incident solar energy annually. This annual solar energy isolation value is about 27 times the national total conventional energy resources in energy units and over 117,000 times the amount of electric power generated in the county in 1998. Invariably, about 3.7% only of the national land area will be used in a bid to annually collect from the sun an amount of energy equal to the nation's conventional energy reserve. Solar energy has been utilized in Nigeria in various forms: namely, solar PV for rural electrification, solar cooker, solar crop dryer, solar manure dryer, solar water pump, solar water heaters, solar chick brooders etc (Oladeji, 2014).

Inverters

Inverters are commonly a part of both grid-connected and stand-alone renewable energy systems. Inverters convert DC power from batteries or solar modules into usable AC power, normally 240V AC (single phase) or 415V AC (three phase). Inverters are complex electronic device and must be mounted in relatively clean areas. Standard inverters include AS 4777-2005, Grid connection of energy system via inverters; AS/NZS 4763:2011, safety portable inverters; and AS/NZS 5603:2009. Inverters may either be wall or shelf mounted. They can be large and heavy -5kW unit weighs as much as 60kg. Inverters can become very warm when operating at larger power outputs and need suitable ventilation and cooling airflow.

Generators

Generators are useful appliances that supply electrical power during a power outage and prevent discontinuity of everyday activities or disruption of business operations. Generators are available in different electrical and physical configurations for use in a different application. The modern-day generator works on the principle of electromagnetic induction found by Michael Faraday in 1831. Faraday found that the flow of electric charges could be induced by moving an electrical conductor, such as a wire that contains electric charges, in a magnetic field. This movement creates a voltage difference between the two ends of the wire or electrical conductor, which in turn causes the electric charges to flow, thus creating an electric current.

Policy Agenda of the Government on Renewable Energy Resources

The federal government of Nigeria's commitment towards development of the renewable energy is evident in the country's drafting of the renewable energy master plan project for Nigeria. Nigeria's National Economic Empowerment and Development Strategy (NEEDS) strongly emphasized the need for rapid and sustainable development of the energy sector. It envisaged an increased role of electricity in spreading the development network into rural and semi urban areas. The Federal Government of Nigeria has in several policy documents clearly articulated its support for rural electrification and the imperative of establishing a comprehensive framework for rural electrification and renewable energy policy options. In 2001, the Federal Government of Nigeria outlined a National Electricity Power Policy (NEPP) with emphasis on encouraging a "full menu of rural electrification options – grid, off-grid, mini-grid, non-thermal and renewable energy".

The NEPP was backed by the Electric Power Sector Reform Act enacted, in March 2005. To accelerate rural development, the Federal Government was strongly committed to expanding access to electricity in rural and semi urban areas. A comprehensive framework for rural electrification policy and strategy that meets international standards and best practices was developed by the Federal Ministry of Power and Steel. In recent time, the Energy Commission of Nigeria (ECN) has finalized the development of a Renewable Energy Master Plan (REMP) for the country which was presented and discussed during a national workshop in August 2005 (Good, 2005). The plan was supposed to set-out a 20-year vision and roadmap for renewable energy to play an increasingly important role in the Nigerian economy. The convergence of resource abundance (including large and small hydro potential, solar radiation, biomass, and wind), advances in technology and expanding market opportunities for renewable energy generated electricity, underscores Nigeria's drive to develop a framework and appropriate business models to deliver power to the over 100 million Nigerians without access today.

In the First National Communication under the United Nations Framework Convention on Climate Change (UNFCCC), the federal government of Nigeria clearly articulated the potential role of renewable energy in meeting Nigeria's global commitment to managing future emissions of Greenhouse gases (Efurumibe, Asiegbu & Onuu, 2014).

Nigeria's Renewable Energy Master Plan

Nigeria is the most populous country in Africa, with an oil-dominated economy. Renewable energy has not played a major role in its developmental efforts so far, in spite of the abundance of this energy in Nigeria. In order to restructure its power sector in a more efficient manner, and provide a sound basis for economic development, Nigeria has embarked on a large scale energy sector reform program that includes widening the range of options for generation with increased use of gas resources and renewable, and enabling the expansion of access to urban and rural areas (Good, 2005). Draft Renewable Energy Master Plan proposed the setting up of a National Renewable Energy Development Agency (NREDA), to oversee the development of renewable energy in Nigeria. The master plan project is in the custody of the Energy Commission of Nigeria under the Federal Ministry of Environment. This project was established in motion in fulfillment of the Federal Republic of Nigeria's obligation as part of African strategy on emission reduction (FME, 2010). The long term renewable energy master plan for Nigeria was to address the challenges of moving towards clean, reliable, secure and competitive energy supply which is long overdue (FME, 2005; Efurumibe, Asiegbu and Onuu, 2014).

Literature Review

A plethora of literature exists on issues relating to alternative sources of electricity supply in Nigeria. Omotayo, Olawuni, Oyajide and Babalola (2015) examined the economic effect of connecting solar power system to grid station, based on existing but non-operational solar panels; and to present a cost-effective autonomous energy system, with a good reliability. The performance of a solar power plant was evaluated based on a developed model which comprised photovoltaic array, battery storage, controller and converters. The model was implemented using MATLAB/SIMULINK software package. Perturb and observe (P&O) algorithm was used for maximizing the generated power based on maximum power point tracker (MPPT) implementation. The outcomes of the developed model were validated and supported by a case study carried out using operational 28.8kW grid-connected solar power plants located in Bayelsa state, Nigeria. Measurements were taken over 21 month's period; utilizing hourly average irradiance and cell temperature. The study observed that system degradation could be clearly monitored by determining the residual (the difference) between the output power predicted by the model and the actual measured power parameters. The study concluded that solar power is a cost-effective energy source, for countries with much solar insulation and a weak grid. However, the study noted that it is extremely important that the system is designed for the specific facility and that the required maintenance is communicated with the operator in order to get a reliable system that will be in operation throughout its expected lifetime.

Oladeji (2014) evaluated the renewable energy resources available in Nigeria and their capabilities. The study also examined various factors militating against effective utilization and harnessing of these vast and abundant energy resources. His study concluded that renewable energy resources were well abound in the country, but they were not effectively utilized and if properly harnessed will be a solid solution to perennial energy shortage in the country.

Efurumibe, Asiegbu and Onuu (2014) examined the existing renewable energy resource in Nigeria; the amount available and the possible use of such renewable sources in Nigeria. This aims at promoting the adoption of renewable sources of energy in Nigeria. From the findings of the study, it was observed that Nigeria is blessed with so many renewable energy sources which can be regenerated naturally, such as wind, solar, hydro, bio and agro. The study recommended that government should encourage more researches in the area of renewable energy sources since Nigeria is blessed with these. Further, the study recommended the need for foreign investors in the energy sector, particularly in the area of renewable energy since these sources hold good for the future of the world.

Oghogho et al. (2014) looked at solar energy potential for sustainable energy generation in Nigeria. Also, the study examined the numerous issues involved in harnessing solar energy and clearly articulates a road map to enable Nigeria taps into this huge potential. The study observed that the lying of Nigerian economy in the tropics, receives abundant sunshine where about 1500PJ (about 258 million barrels of oil equivalent) could be available to Nigeria annually from solar energy if solar appliances with 5% conversion efficiency were used over only one percent of the total land area of the country for about six months of a year. Due to the numerous disadvantages of conventional fuel sources when compared with solar energy and the recent giant strides in improving solar cell efficiency using a photovoltaic (PV) device that converts 40.8% of light that hits it into electricity, Nigeria needs to reposition herself by investing in this invaluable resource to secure the energy future of our economy.

Uzorh and Nnanna (2014) investigated two power supply conditions in Nigeria, namely: (i) Cost of Power supply backed-up by energy from the generator set and (ii) Cost of Power supply backed-up by solar energy. The data used for the study were collected through a questionnaire and personal interview. The findings of the study showed that the average cost per unit of power consumption per KWh is between N59.29 for solar energy; N20.88 for grid electricity and N83.50 of energy from the generator. Comparatively, the results obtained showed that it is much cheaper and safer to provide reliable power for manufacturing activities using power supply backed up by solar energy as a better alternative to solve the problem of power shortages in Nigeria.

Aliyu, Sani, Muhammed and Yakaka (2013) assessed the power sector reforms from the Obasanjo Administration (1999) to date with a view to getting out the problems and prospects, challenges and defects associated with the reforms. The study explored better ways of ensuring the success of the reforms by identifying certain key issues that must be handled by government. The study employed documentary analysis method for sorting out relevant information. The study found

that, the government needs to aim at overhand rather than severing with existing situations in the energy and power sector respectively as well as the overall national socio-economic and political order.

Abdulsalam, Mbamali and Mamman (2012) assessed the availability (a measure of readiness) of the source through field survey and experiments. In this work, historical trends of solar radiation pattern of some locations were collected, studied and analysed. The yearly mean of monthly global solar radiation is 22.88MJ/m2/day, 18.29MJ/m2/day and 17.08MJ/m2/day for high, medium and low zones respectively. While 12.06 Hrs/day, 12.04 Hrs/day and 12.03 Hrs/day were found to be the solar sunshine duration for high, medium and low zones respectively. It also demonstrates that, by tracking the length of the sunny period for a day is about 13 hour, about 1½ hour longer when no tracking is used. This would provide potentials and indispensable aid for sustainable development in design and installation of photovoltaic systems in Nigeria.

Oladokun and Adeshiyan (2012) employed demand management based design approach for reducing the capital cost of residential solar power supply system. Utilities and energy demands of thirty randomly picked homes in selected residential areas were studied. The houses were classified into one, two and three room' residential apartments. New energy efficient appliances that can deliver the same or higher utility values as those already in use in these houses were identified and proposed as a replacement to cut energy demand. Cost analysis of replacement with these energy star appliances was performed. Solar system designs and associated cost models were developed for both the existing demand system and the proposed energy efficiency demand system.

For comparative analysis, appliances replacement cost was factored into the associated solar system capital cost. The average total energy demands were 1255W, 1785W, and 2185 for one, two, and three bedroom flats respectively while equivalent demands for energy efficient system are 389W, 820W, and 851W respectively. The cost of designing and installing a solar power with the replaced appliances exhibits a significant reduction of 64.88%, 64.5% and 62.16% for the one, two and three room residential set up respectively. The study concluded that an integrated demand management design approach is very useful in reducing the capital cost of residential solar systems.

Ismail, Ajide and Akingbesote (2012) rated the performance of in-stalled Solar PV system in Oke-Agunla, Akure local government of Ondo State in Nigeria. Visits were conducted to the village; equipment on the ground was examined while the people were interviewed. Both functional and non-functional facilities were traced to their manufacturers using the identification data on them and rated to ensure their efficiency. Energy demands were also prorated, and observed the need to improve on the present energy supplied. The results of the assessments showed that PV facilities used were inadequate, trained technicians were not obtainable giving room for quacks working on the facilities occasionally resulted in further complications and poor facilities maintenance. Also, the assessment result showed that just 14.52% of the 4.5kW installed solar PV was utilized due to significant malfunctioning and deterioration in performance. The study concluded that the installed solar PV systems were inefficient as a result of poor maintenance, lack of technical know-how and inability of the project contractors or managers to take these factors into consideration while embarking on the solar PV installations.

Dikko and Yahaya (2012) evaluate the wind power potential of some selected towns in the north eastern part of Nigeria (Gombe, Maiduguri and Yola) based on the Weibull and Rayleigh models using 12 years monthly wind speed covering the period of 1994 to 2005. The findings of the study showed that Weibull is the best-fit model that describes the wind speed data at 10m height. The reference mean power density (based on the measured probability distribution.) was reported to those obtained based on the Weibull and Rayleigh model. In calculating the percentage error, results showed that Weibull provided better power density estimation in all twelve month than the Rayleigh model. From the evaluation, the study observed that the north eastern part of Nigeria have higher wind power density for the generation of wind energy and the highest power density (377W/m2) was found to be in Gombe State.

Data and Methodology

Various methods of data collection were used in this study but the principal material for the study is obtained through the use of questionnaire survey technique and focussed group discussion.

Design of Study

This study is ex-post factor in nature. Furthermore, the study is intended to identify problems of electricity supply to households in Ekiti State and assess various alternative source of electricity supply to them and make an appraisal.

Study Population / Area

The entire households in the urban centers in Ekiti State which comprise of all the households in the entire sixteen local governments in the state. This constitutes the population of this study. A cross section of households from all the sixteen-local government in the State was examined. Empirical studies in the past have shown that most households that have access to alternative electricity supply reside in the urban areas. Consequently, the attention of this study was driven towards the households in the headquarters of each of the local governments in Ekiti State. Table 1 gives the overview of the population for study.

Table 1: Study Population

S/N	Local government	Headquarters	Population	Number of households	Households percentage
1	Ado Ektit	Ado Ekiti	308,621	61,723	12.94%
2	Ekiti East	Omuo Ekiti	137,955	27,591	5.79%
3	Gbonyin	Ode Ekiti	148, 193	29,638	6.22%
4	Ekiti South West	Ilawe Ekiti	165,277	33,056	6.93%
5	Ekiti West	Aramoko	179,892	35,978	7.55%
6	Efon Alaaye	Efon-Alaaye	86,941	17,388	3.65%
7	Emure	Emure	93,884	18,776	3.94%
8	Ise/Orun	Ise Ekiti	113,754	22,750	4.77%
9	Ido/Osi	Ido Ekiti	159,114	31,822	6.67%
10	Ijero	Ijero Ekiti	221,405	44,281	9.29%
11	Ikere	Ikere Ekiti	147,355	29,471	6.18%
12	Ikole	Ikole Ekiti	168,436	33,687	7.06%
13	Irepodun/Ifelodun	Igede Ekiti	129,149	25,829	5.42%
14	Moba	Otun Ekiti	146,496	29,299	6.14%
15	Ilejemeje	Iye Ekiti	43,530	8706	1.83%
16	Oye	Oye Ekiti	134,210	26,842	5.63%

Source*: National Population commission, 2014*

However, the study intends to use only questionnaires in this research work. Nonetheless, the entire selected sample of respondents was administered with questionnaires through a random selection of questionnaires from the entire sum.

Sample Size and Sample Selection

Since it is not possible to cover all the households in the entire 16 local governments, the famous Yamane sample selection technique was adopted by the study. The calculation of the sample size was done as follows:

$$n = \frac{N}{1+N*(e)^2} \qquad (1)$$

Where n = the sample size

N = the population size (Total number of households in each local government)

e = acceptable sampling error

* 95% confidence interval is assumed (p=0.5)

By substitution in the formula for each of the local government, table 3.2 shows the sample size per local government

Table 2: Sample Size

S/N	Local government	Sample size using Yammne
1	Ado Ekiti	397
2	Ekiti East	394
3	Gbonyin	395
4	Ekiti South West	395
5	Ekiti West	396
6	Efon Alaaye	391
7	Emure	392
8	Ise/Orun	393
9	Ido/Osi	395
10	Ijero	396
11	Ikere	395
12	Ikole	395
13	Irepodun/Ifelodun	394
14	Moba	395
15	Ilejemeje	384
16	Oye	394
	Total	5906

Sources: Authors survey 2017

The implication is that approximately, 5906 households across the 16 local governments of the state were dealt with in this study.

Research Instruments

Questionnaires were utilized to collect responses from the households for the study. The questionnaire was developed by the researcher based on ideas obtained from the interactions with the households on the level of satisfaction received currently from electricity supply by the (Benin Electricity Distribution Company) BEDC which is the DISCO distributing electricity in Ekiti State. The questionnaire used in the study consists of five component parts.

The first parts consist of the demographic characteristics of each of the household heads to be collected. This part of the questionnaire elicits information about the sex, age, and working category and employment duration of the respondents. The other part of the questionnaire containing the dependent variables is divided into 2 sections. The first section dealt with questions that delved on ownership of alternative source of electricity. The second section contained questions that have to do with the type of alternative source of electricity supply possess by each household and the last aspect contained questions addressing issues on the extent and the frequency in use of this alternative source of electricity.

The second section contained questions that have to do purely with the independent variables. This aspect is separated into five sub-sections. The first contained questions that delve on the social status of the each household. The subsequent subsection contained questions that address the awareness of the households of the existence of various alternative source of electricity supply. The third subsection included questions that address employment status of the households and availability of alternate sources of income. The last aspect of this section contained questions on other factors that have either immediate or remote influence on the accessibility of households to alternative supply of electricity.

Instrument Scoring Scale

The scale of response to the questionnaire tilted towards the nature of estimating techniques used for the study. Majorly, logistic regression is utilized to achieve most of the objectives. Therefore the dependent variable is coded in binary format. That is, “yes” or “no” response was more appropriate for scoring the responses to the questions that address the dependent variable.

However, for the questions that address the independent variables, descriptive statistics were employed coupled with the fact that they were included in the logistic analysis. Apart from questions that required specific answers like age, income etc, scales for other questions were utilized from strongly Agree, Agree, Undecided, Disagree to Strongly Disagree. The

calibrations for the positive items were such that they were scored: 5, 4. 3. 2 and 1. The negatively structured items were scored as follows: 1, 2, 3, 4, and 5. Depending on the way the questions were entered.

Validity and Reliability

The study adopted a method of testing the validity, reliability and consistency of the research instruments and questions by including a few extra questions to those deemed essential for the study. The study utilized a technique of putting in two roughly equivalent or closely related questions but well separated in the questionnaire. With this, it proved possible to measure the consistency of answers. The study also adopted the split ballot technique by constructing two parallel forms of questionnaires that were used with equivalent samples of our population.

The two forms had some of their questions in common, but certain additional questions were worded in different ways in order that the effects of the differences were measured. At the end of this exercise, the study was able to re-examine and revise some of the questions and their sequence drawing from the results of the technique above as well as outside criticisms.

Pre-testing of the Questionnaire.

Pre-tests were performed to see how the questionnaires worked out and whether changes were necessary before the start of the full-scale study. The people used for the pretest exercise were similar in grade and characteristics to those sampled in the final study.

Model Specification

To examine the determinants of use of Alternative Source Electricity Supply (ASES) among the households in Ekiti State, a model that expresses ASES usage as a function of some factors as identified in the literature is specified.

ASES=f(AW,FS,JOB,BEDC,SC,INCOME,EDU)……(3.2)
Where ASES is the use of Alternative source electricity supply
AW is awareness of the alternative sources of electricity supply
FS is family size
JOB is the nature and type of job
BEDC is the supply of electricity by the Benin Electricity Distribution Company (National grid)
SC is Social class
INCOME is level of income
EDU is level of education.

Statistical Analysis of Data

Two basic analytical tools were used in the analysis. This includes logit regression analysis and some other simple descriptive analysis such as simple percentage, summary of statistics and the chi-square method of hypothesis testing.

The Logistic Regression

In literature logit and probit models were developed to resolve the problem associated with linear probability model LPM. Some of the problems associated with LPM were based on the fact that it cannot be used for a non-linear model (Soderborn, 2009). Also nonsense prediction is very possible under LPM since there is nothing that binds the dependent variable to the binary response (0, 1). Instead, logit model considered a class of binary response model of the form:

$$Pr(y = 1/x) = G(\beta_1 + \beta_2 x_2 + \cdots + \beta_k x_k) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.3)$$

$$Pr(y = 1/x) = G(x\beta) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.4)$$

Where G is a function taking strictly values that range between zero and 1 that is $0 \leq G(z) \leq 1$ for all real numbers z in the model. Equation (3.3) is often referred to as the index model because $Pr(y = 1/x)$ is a function of vector x only through the index. That is:

$x\beta = \beta_1 + \beta_2 x_2 + \cdots + \beta_k x_k$……(3.5)

Equation 3.5 is simply a scalar. However, since $0 \leq G(x\beta) \leq 1$ this ensures that the estimated response probabilities are strictly between zero and one, which thus addresses the main worries of using LPM. G is usually a cumulative density function (cdf), monotonically increasing in the index z (i.e. $x\beta$), with probabilities for responses to the dependent variables as:

$Pr(y = 1/x) \rightarrow 1 \; as \; x\beta \rightarrow \infty$……(3.6)

$Pr(y = 1/x) \rightarrow 0 \; as \; x\beta \rightarrow \infty$……(3.7)

It follows that G must be a non-linear function, and hence we cannot use OLS. Various non-linear functions for G have been suggested in the literature. By far the most common ones are the logistic distribution, yielding the logit model, and the standard normal distribution, yielding the probit model. In the logit model,

$G(x\beta) = \frac{exp(x\beta)}{1+exp(x\beta)} = A(x\beta)$……(3.8)

which is between zero and one for all values of $x\beta$ (recall that $x\beta$ is a scalar). This is the cumulative distribution function (CDF) for a logistic variable. The logit and probit functions are both increasing in $x\beta$. Both functions increase relatively quickly at $x\beta$ = 0, while the effect on G at extreme values of $x\beta$ tends to zero. The latter result ensures that the partial effects of changes in explanatory variables are not constant, a concern we had with the LPM.

Empirical Results and Discussions

This section of the research is concerned with the presentation and the analysis of the collected data for the purpose of achieving the objective(s) of this study as stated earlier. From the methodology, a total of 5906 households were involved in the survey and the analyses of their responses are presented below.

Response rates

From the 5906 questionnaires distributed, 4758 questionnaires were duly filled and returned, translating to about 81% of the respondents. Thus, the response rate is in order and enough to commence empirical analysis. The response rate per local government is also analyzed. The numbers of questionnaires allotted to each of the 16 local governments are shown in table 3. Also, the number of questionnaires completed and the percentages are also reported on the table.

Table 3: Analysis of Response Rate by Local Government

S/N	Local government	Sample size	Questionnaire returned	Percentage %
1	Ado Ekiti	397	390	98.2
2	Ekiti East	394	291	73.9
3	Gbonyin	395	286	72.4
4	Ekiti South West	395	295	74.7
5	Ekiti West	396	302	76.2
6	Efon Alaaye	391	305	78.0
7	Emure	392	249	63.5
8	Ise/Orun	393	267	67.9
9	Ido/Osi	395	306	77.5
10	Ijero	396	288	72.7
11	Ikere	395	372	94.2
12	Ikole	395	300	75.9
13	Irepodun/Ifelodun	394	301	76.4
14	Moba	395	252	63.2
15	Ilejemeje	384	267	67.7
16	Oye	394	287	72.8
		Total	4758	

Table 3 showed that the response of the respondents was higher in Ado-Ekiti local government recording about 98% response rate. This is followed by Ikere local government, Ikole local government in that order. The reason for this might not be unconnected with the level of awareness of the people about ASES. During the survey, it was discovered that Ado-Ekiti being the state capital accommodates the largest percentage of the elites in the state thus granting the local government the dominance in terms of the response rates. Ilejeme and Moba local government areas have response rates of 67% and 63% respectively thus making them the least response rate recorded during the survey. An important factor noticed during the survey attributable to this is that the farther away from the local government from the state capital (Ado-Ekiti) the lesser their response rate. For instance, Ikere is about the closest town to the Ado-Ekiti and it enjoys the second highest response rate after Ado-Ekiti.

Table 4: Demographic Characteristics of the Respondents

Variables	***Frequency***	***Percentage (%)***	Total
Gender			
Male	1300	27.3	4758
Female	3458	72.7	
Age Distribution of Households			
30years-40years	2132	44.8	4758
40years-60years	2210	46.4	
60years and above	416	8.7	
Total	4758	100.0	
Employment Distributions of Households			
Farming	442	9.3	4758
Trading/Artisan	1768	37.2	
civil servants	2548	53.6	
Total	4758	100.0	
Family Size of Households			
2	26		4758
3	728	.5	
4	1300	15.3	
5	1014	27.3	
6	1040	21.3	
7 & Above	650	21.9	
Total	4758	100.0	
Qualification of the Households			
No formal education	52	1.1	
Primary School Cert	728	15.3	4758
Secondary School Cert.	1196	25.1	
Higher Institution Cert	2262	47.5	
Post Graduate Cert.	520	10.9	4758
Total	4758	100.0	
House Ownership			
Tenant	1612	33.9	4758
Landlord	3146	66.1	
Total	4758	100.0	
Employment Status			
Employed	132	11.7	4758
Self Employed	559	49.4	
Retired	357	31.5	
Unemployed	84	7.4	

Source: Output of Author's Data Analysis (2017)

From the above table it was discovered that 73% of the respondents were male while 27% were female, indicating that most of the household's heads in Ekiti state were male. Notwithstanding, the results also showed that some of the homes in Ekiti state were headed by females. Of the 4578 households surveyed, 1300 representing about 27% are female. Similarly, the age distribution of the households in Ekiti State was dominated by youth and young adults. Surprisingly, the youth and young adults accounted for about 91% of the overall households in the survey. However, 8.7% of the households surveyed were headed by elders with age above 60 years. The survey revealed that about 54% of the respondents were civil servants while the rest were categorized / employed as farmers and traders / artisan accounting for 37% and 9% respectively. The implication is that Ekiti State is a civil servant state as evidence from the data. A survey of the family size of household shows that those with family size of 4 is 27.3%, follow by those with 6 and 5 with 21.9% and 21.3% respectively. Knowing quite well that, the family size is an important factor used as part of the variables in the determinants of ASES in the study. The table also reflected that more than 85% of the households were educated, that is they possess secondary school certificate and above. Out which about 48% of the households were higher institution graduates. Households with just primary school certificate or with no record of formal education are less than 18% of the overall households. This category can be attributed to mostly the farmers which are just about 17% of the entire population of household surveyed. The survey also showed that approximately 66% of the household heads were landlords, only 34% are tenants. This feature is necessary for determinants of ASES usage.

Factors Responsible for Selection of a Particular ASES

Having identified four different types of ASES among the households in Ekiti State, the choice of any of the four among the households is undoubtedly influenced by a number of factors. This is different from factors that are responsible for the usage of an ASES because these sets of households have been confirmed to be using ASES but among the varieties of the ASES available, different factors may be attributed for the choice of a particular one amongst the four ASES identified in the study. The result of the investigation is presented in table 5 and figure 1.

Table 5: Factor Affecting Choice of ASES

Factor Affecting Choice of a Type of ASES	Frequency	Percent
Income	1300	27.4
Necessity	1404	29.5
Nature of Job	338	6.1
Environment	728	13.5
Cost	988	23.5
Total	4758	100.0

Source: *Output of Authors' Data Analysis (2017)*

The study has shown that there four prominent types of ASES among the households in Ekiti State namely, rechargeable appliances, electricity generating set, battery/inverter and solar/inverter. It is notably, that there certain salient factors that necessitate the choice of any type of ASES. Observably, it was discovered that income and necessity are the most important factors responsible for determining the choice of a particular type of ASES among the households. For instance, 27.4% and 29.5% of the households identified income and necessity respectively as the major factors that influence their choice of a particular ASES which accounted for approximately 57% of the households. This can be represented in the below bar chart.

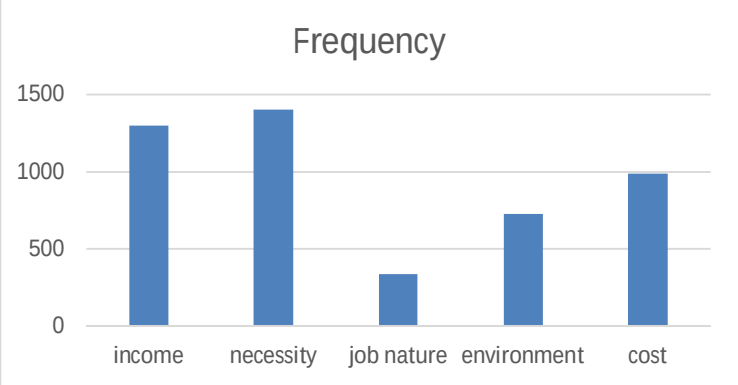

Figure 1: Factors Influencing the Choice of ASES

Source: *Output of Authors' Data Analysis (2017)*

Furthermore, the cost of the ASES is another inevitable factor that household considers before making the choice of a particular ASES. No wonder, 24% of the households opined that the cost of ASES is the major factor that necessitates its choice. In the same vein, the nature of their jobs and environment might not be important factors that influence their choice of ASES as they only account for 6.1% and 13.5% respectively of the entire households in the study.

Determinant of ASES

An investigation of the factors that determines the use of ASES among the households in Ekiti State is the major task to be achieved in this study. As a matter of fact, some variables have been identified under the methodology as very germane in determining household usage of ASES. These variables are the independent variables in the logistic regression model and they are; nature of job, irregularity in the supply of electricity by the BEDC (national grid), level of awareness, income level, social class, family size and level of education of the households. Before the analysis, some pre-estimation analyses were done such as summary of statistics and the correlation matric of the variables.

Descriptive Statistics on Determinant of ASES

Both the summary of statistics and covariance matrix were computed for the variables used in the logistic regression model. The summary of statistics includes: the mean of the distribution, the standard deviation and the maximum and minimum limits.

Table 6: Summary of Statistics

Variable	Observation	Mean	Standard Dev	Min	Max
Usage of ASES	4758	.8953342	.3959742	0	4
Awareness	4758	3.52459	.7950106	0	4
Family Size	4758	2.355191	1.19646	0	4
Job	4758	2.819672	1.079096	0	4
BEDC	4758	3.136612	1.253727	0	4
Social Class	4758	3.043716	1.065335	0	4
Income	4758	.704918	.5017742	0	2
Education	4758	2.519126	.9165013	0	4

Source: *Output of Authors' Data Analysis (2017)*

Both the means and the variances of the variable distribution were shown on table 6. The mean of the variables showed a relatively high value in its distribution across the households. Virtually all the figures under the mean for each of the variables are relatively closer to the maximum limit than the lower limit and they are all positive. For instance, the means of awareness is 3.52459, irregular supply of electricity is 3.136612, social class is 3.043716, and education is 2.519126

among others. All these values are closer to their respective maximum limit than the minimum limit thus, indicating some relatively high affirmative responses to some questions used to capture the variables in the model.

However, this is different from what we obtained under the correlation matrix as the figures were relatively low and closer to the minimum level than the maximum level. This showed a high degree of uniformity in the responses of households to the questions used to capture the variables. It showed that the data were not widely dispersed since they have relatively low variances. It is obvious from the table that none of the figures under the standard deviation is up to 2 and the maximum limit for most of the variable is 4. This showed that variance value distribution across the households were relatively low.

Table 7: Covariance/Correlation Matrix

Variable/ Variable	Usage of ASES	Awareness	Family Size	BEDC	Social class	Income	Job	education
Usage of ASES	1.0000							
Awareness	0.0696	1.0000						
Family Size	-0.0602	-0.1270	1.0000					
BEDC	-0.0044	0.0981	0.1025	1.0000				
Social Class	0.0279	0.0375	0.1722	0.1674	1.0000			
Income	0.1475	-0.0092	-0.0257	0.0554	-0.0986	1.0000		
Job	0.0086	-0.1306	-0.0192	0.0990	-0.0198	-0.1010	1.0000	
Education	0.0470	-0.0138	-0.1333	0.0524	-0.0177	-0.0590	0.3894	1.0000

Source: *Output of Authors' Data Analysis (2017)*

Table 7 showed that majority of the variables show positive relationship with the usage of ASES. However, two of the independent variables demonstrated negative relationship with usage of ASES. Family size and supply of electricity by the BEDC are the only variables that show inverse relationship with the usage of ASES. The correlation between supply of electricity by the BEDC and usage of ASES is -0.0044. The implication is that the more regular there is supply of electricity from the BEDC the less the tendency of usage of ASES by the households. Similarly, that of family size is -0.0602 which also showed that the larger the size of the family the lesser the tendency of usage of ASES by the households. Other variables such as income, social class, awareness among others showed positive correlation coefficient between them and usage of ASES. This is means that high level of income increases the tendency of usage of ASES, the same thing with level of awareness among others.

Logistics Regression Estimation on Determinants of ASES

Both the coefficient and the odd ratio of the variables were presented in tables 8 and 9. Their levels of significance were also shown in order to determine the degree of importance of each of the variable in determining the usage of ASES.

Table 8: Logistic Regression Results of Determinants of ASES

Variable	Coefficient	Standard Error
Awareness	.0378355	.0567616
Family Size	-.007632	.0388171
Job	.2856401***	.0411666
BEDC	-.01002***	.0394822
Social Class	-.2451072 ***	.0501418
Income	.8085115***	.0908769
Education	-.0820933	.0561191
Constant	1.499548	.3442408

Source: *Output of Authors' Data Analysis (2017)*

Table 9: Logistic Regression Results (Odd Ratios) of Determinants of ASES

Variable	Odd Ratio	Standard Error
Awareness	1.03856	.0589503
Family Size	.9923971	.038522
Job	1.330613	.0547768
BEDC	.99003	.0390885
Social Class	.7826206	.039242
Income	2.244565	.2039792
Education	.921186	.0516961
Constant	4.479664	1.542083

Source: *Output of Authors' Data Analysis (2017)*

Tables 8 and 9 presented the results of the logistic regression in terms of the coefficients and odd ratios. Both results showed that the predictors have different and varying degrees of effects on ASES. Each of the variables used as determinants of ASES had different coefficients in both model explaining their individual impact on the tendency of the households in having ASES. From both tables, the results showed that four out of the variables used as predictors had significant impact on the decision of the households to have ASES, these are type and nature of job of households, the supply of electricity by the BEDC, the social class of the households and the level of income of the households.

Firstly, the coefficient of nature and type of job in the estimated logistic regression is 0.286, implying that if we hold other predictors constant; a unit change in job nature of household will have about 29% impact on household decision to have ASES. Again, since the job ranking is done from the most unskilled to skilled jobs and the coefficient being positive, indicates that the more skilled job a household has the higher the tendency to have ASES. The odd ratio of 1.33is significant at 5% level thus showing that the nature and type of job of households is an important factor determining the tendency of a household in having ASES.

Secondly, another variable that has significant impact on ASES is the supply of electricity by the BEDC. The coefficient is -.21 indicates an inverse relationship between the two. Going by the coding of the questionnaire, it shows that the more regular the supply of electricity from the BEDC the less the tendency of the household in having ASES. The implication of the result is that households in Ekiti state are significantly affected by the low supply of electricity from the BEDC to their homes and this is one of the prime factors motivating them to have ASES. The odd ratio is 1.99 and its significant shows that the supply of electricity by the BEDC to the households is an important factor influencing their decisions to have ASES.

Thirdly, the household social class is another variable that has significant impact on the ASES. The coefficient of social class is 0.25 indicates a direct relationship between household social class and the desire to have an ASES. Precisely, a unit increase in the social class of a household will increase his tendency of having ASES by about 25%. This shows that a household that belong to high social class have more tendency of having ASES. The odd ratio is .78 indicates that the social class of household is an important factor that determines ownership of ASES by a household in Ekiti State.

Again, the level of income of household is also one of the variables that have significant impact on the ASES. The coefficient in the estimated logistic regression is 0.81, showing that a unit rise in household level of income will lead to about 81% rise in the ability of the households to possess ASES. The odd ratio of 2.24further affirmed that the income level of household is an important factor affecting household tendency of having ASES. It is important to emphasize that income level comparatively appeared to be the most important factor influencing ASES. Therefore, rich households are more likely to have ASES than the poor households.

However, other variables such has level of awareness, education and family size are less important factor that determine household tendency of having ASES in Ekiti State. These three variables failed to have significant impact on ASES. The implication of this is that households in Ekiti State might not attach significant importance to these three predictors before taking the decision to have ASES.

Post-Estimation Test for Logistics Regression on Determinant of ASES

The post estimation tests include the overall significance or test of goodness of fit of the logistic regression model and the classification test. The results of these tests are presented in tables 10 and 11.

Table 10: Test of Overall Significance of the Logistic Regression Model

LR Chi2(8)	179.93
Prob > chi2	0.0000
Pseudo R2	0.0514

Source: *Output of Authors' Data Analysis (2017)*

The test of overall significance of the model on the logistic regression estimated presented on table 10 showed a chi square value of 179.93 and the probability of 0.0000. This implies that the estimated logistic regression model is statistically significant at 1%. This further showed that all the variables used as determinants of ASES are all desirable and can jointly influence the decision of a household in Ekiti State to have ASES. Hence, household level of income, social class of households, nature and type of job, regularity in the supply of electricity by the BEDC, level of awareness of the existing ASES, level of education and family size jointly influenced the decision of a household in Ekiti State in having ASES.

Table 11: Classification Test for the Logistic Regression

Classified	True …….		Total
	D	~D	
+	4185	573	4758
-	0	0	0
Total	4185	573	4758

Sensitivity	Pr(+/D)	100.00%
Specificity	Pr(-/~D)	0.00%
Positive Predictive Value	Pr(D/+)	87.96%
Negative Predictive Value	Pr(~/-)	.%
False + rate for true ~D	Pr(+/~D)	100.00%
False – rate for true D	Pr(- / D)	0.00%
False + rate for classified +	Pr(~D/ +)	12.04%
False – rate for classified -	Pr(D/ -)	.%
Correctly Classified		87.96%

Source: *Output of Authors' Data Analysis (2017)*

Table 11 showed that the estimated logistic regression model is correctly classified to about 87.96%. The classification of the model is an indication that the model is rightly specified and the predictors are all desirable in the model, thereby supporting the results obtained under the test of overall significance.

Conclusions

The study identified four major types of ASES in Ekiti State namely; rechargeable appliances, electric power generating set (Generator), battery/inverter and solar/inverter. These four types of ASES are predominantly in use among the households in Ekiti State though, their use varied across different communities, levels of work and social status among others. Furthermore, the usage of some of these ASES is regularly among the households. In other words, the use of ASES is very common among the households. Furthermore, households identified that low level of income as well as lack of proper awareness of the existence of some of the ASES as the major factors that limit their accessibility to the various types of ASES identified in the study. According to the finding of the study, all the households loved to have solar type of ASES but the constraints imposed by their levels of income and proper awareness of use are a major snag preventing them from using it?

On the determinants of ASES, the study concluded that nature of household's job, level of income, supply of electricity by the BEDC and social status/class of the households were the most important factors influencing the use of ASES. Finally, findings from the study showed that households in Ekiti State believed that government can assist in provision of ASES in two major ways - regular payment of workers' salaries and provision of community based solar powered electricity for the households. This according to the households will ensure regular supply of electricity to various homes when there is a shortage in the supply of electricity by the BEDC. In addition, a few of the households believed in long run approach which has to do with removal of the provision of electricity from the exclusive list of the government and allow various state government to be able to generate electricity for various households in their respective states.

Recommendations

Based on the findings of this study, the following recommendations were offered.

(i) Regular payment of workers salary: A good number of the households covered in the survey were civil servants and the irregular payment of their salaries has been identified as the major factor preventing them from using ASES. Consequently, Ekiti State government should ensure prompt payment of their workers' salaries as this will improve their access to ASES and improve their socio-economic wellbeing

(ii) Provision of community-based solar powered electricity supply: Findings from the study have shown that the solar type of ASES is the most suitable for the households in the state. It has been rated the most regular, requiring moderate maintenance and moderate capacity among other ASES. However, solar is rated low only in affordability and this is where the government can come in to assist the households. Since the most important ingredient of an ASES is its regularity, Ekiti State government can embark on community-based solar electricity project this will have far reaching positive effect on the socio-economic life of the households in Ekiti State.

(iii) Distribution of rechargeable appliances and solar accessories: The study has shown that the most widely used ASES are the rechargeable appliances like bulbs and lamps. The use of these appliances can be encouraged by the government by providing households with rechargeable appliances at subsidized rates or for free. Again, since solar offers the steadiest supply of electricity, efforts should be made by government to encourage the use by providing some of the accessories to the households in the state at subsidized rates. These accessories include the inverter machine, the solar panels, batteries and solar bulbs among others. This will go a long way in encouraging the use of solar powered electricity supply and consequently improve the socio-economic wellbeing of the households in Ekiti State.

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