



Publisher

<http://jssidoi.org/esc/home>



THE IMPACT OF ACCESS TO ELECTRICITY ON EDUCATION AND HEALTH SECTORS IN
NIGERIA'S RURAL COMMUNITIES*

Iyabo Adeola Olanrele ¹, Adedoyin Isola Lawal ², Samuel Olatunde Dahunsi ^{3*},
Abiola Ayopo Babajide ⁴, Joseph Ojo IseOlorunkanmi ⁵

¹*Economics and Business Policy Department, Nigerian Institute of Social and Economic Research (NISER), P.M.B. 5, U.I. Post Office, Ojoo, Oyo Road, Ibadan, Nigeria*

^{2,4,5}*Department of Accounting and Finance, Landmark University, PMB 1001, KM 4 Ipetu Road, Omu Aran, Nigeria*

³*Sustainable Management of Natural Resources and Environment Research Group, Faculty of Environment and Labour Safety, Ton Duc Thang University, District 7, Ho Chi Minh City, Vietnam*

E-mail:^{3*}dahunsi.olatunde.samuel@tdtu.edu.vn (Corresponding author)

Received 18 November 2019; accepted 20 February 2020; published 30 June 2020

Abstract. This study examines the impact of access to electricity on health and education measured by increased number of hours to study and reduced indoor air pollution of rural communities in Nigeria. Primary data from twelve (12) rural communities that have benefited from rural electrification since 1997 in Oyo State, southwest, Nigeria was collected. Key empirical findings revealed that children study hour reduces with household access to grid electricity, it decreases by 8 percent. Expenditure on electricity significantly decreases children study hour by 12 percent. Electrification decreases the rate at which indoor air pollution reduces by 1.1 percent. Household electricity expenditure increases with reduction in indoor air pollution, it decreases the rate of air pollution by 1.6 percent. Better illumination due from access to modern electricity reduces indoor pollution by 1.2 percent. To enhance the electrification benefits, the adoption of the mini-grid option is inevitable, which requires government commitment for sustainability. The off-grid solution, which is usually renewable solution, with strong supporting legislation is equally required for rural electrification strategy. The efficiency of the existing electricity system entails the implementation of the gas master plan, which is crucial in paving way for increasing supply reliability, coverage, and then higher social benefits.

Keywords: education; health; electrification; Nigeria

Reference to this paper should be made as follows: Olanrele, I.A., Lawal, A.I., Dahunsi, S.O., Babajide, A.A., IseOlorunkanmi, J.O. 2020. The impact of access to electricity on education and health sectors in Nigeria's rural communities. *Entrepreneurship and Sustainability Issues*, 7(4), 3016-3035. [https://doi.org/10.9770/jesi.2020.7.4\(30\)](https://doi.org/10.9770/jesi.2020.7.4(30))

JEL Classifications: C22, D21, G12, G22

Additional disciplines: Electricity, Education

*We appreciate Landmark University, Nigeria for paying the Article Processing Fee to support the Open Access for this article.

1. Introduction

The provision of electricity is meant to facilitate inclusive growth and development by increasing spread and coverage (Zhang, Shi, Zhang & Xiao, 2019; Phadke, Park & Abhyankar 2019; Lawal, Somoye, & Babajide, 2017; Mazur, Hoegerie, Brucoli, Dam, Guo, Markides & Shah, 2019; Dahunsi, Adesulu-Dahunsi, Osueke, Lawal, Olayanju, Ojediran, & Izebere, 2019). The development impacts of electrifying rural communities enhance greater output for household members engaged in income-generating activities, such as sewing, knitting, and other handcrafts activities (World Bank, 2002; Silva, Soares & Pinho, 2018; Bairoliya, Canning, Miller & Saxena 2018; Lawal, Babajide, Nwanji, & Eluyela, 2018; Enslev, Mirsal & Winthereik 2018; Dang & Lan 2019; Dahunsi, Osueke, Olayanju & Lawal 2019; Diao, Magalhaes & Silver, 2019; He, 2019; Palit & Bandgopadhyay, 2017).

From the social point of view, modern electricity decreases health hazard by reducing exposure to indoor air pollution from the use of dangerous, expensive fuels such as wood, coal and paraffin, a situation that also leads to improved lighting that can benefit education (Jin et. al., 2006). This role of electrification amongst others birthed the National Nigerian Rural Electrification (RE) Programme in 1981, but fully and formally became operative in 1989.

In further recognition of the importance of RE at ensuring inclusive development, the Federal Government of Nigeria (FGN) came up with the first RE policy which was encapsulated in the 2001 National Electric Power Policy (NEPP), and the 2003 National Energy Policy and; with the objective of rapidly expanding rural electrification access, at an affordable and cost-effective manner. In the same vein, the FGN adopts RE policy in 2009 meant to facilitate the extension of electricity services to all Nigerians, irrespective of where they live and work. And, to facilitate the promotion of private sector participation in providing electricity to the rural communities, either through the on-grid, off-grid solution, or the combination of both.

Some of the specific objective of the program as relating to social outcomes include:

- Raise the living standards of rural populations through the improved water supply, lighting, and security;
- Promote cheaper, more convenient and more environmentally friendly alternatives to the prevalent kerosene, candle, and vegetable oil lamps and fossil fuel-powered generating sets;
- Protect the nation's health and the environment by reducing indoor pollution and other energy-related environmental problems.

Nonetheless, the electrification rate in rural Nigeria has remained low to the rate of urban electrification. Between 2007 and 2016, the average rate of rural electrification was about 33.1 percent, while 84 percent of the urban population are electrified (WDI, 2017). The implication is that the majority of the rural dwellers (66.9 percent) without access to electricity far greater than the electrified (Lawal, Oye, Toro & Fashina, 2018; Lawal, Asaleye, IseOlorunkanmi & Popoola, 2018; Asaleye, Popoola, Lawal, Ogundipe & Ezenwoke, 2018). At the root of this problem that has bedevilled Nigeria's electricity sector is the huge infrastructural gap. At nominal, the country's electricity capacity stands little above 12,000 Mega Watts (MW), but the availing provision, for consumption after accounting for distributional and transmission losses, hovers around 3500MW to 4000MW. The electricity needs of developing country was estimated at about 1,000MW per million people (www.financialnigeria.com, 13 Jan 2016), as such, Nigeria will require about 180,000MW electricity generation for its population of over 180 million (Lawal, Olayanju, Ayeni, & Olaniru, 2019).

This indicates that supply has remained grossly inadequate to meet up with the required demand, a situation that has implication on the level of electricity consumption for the rural population that constitutes more than 50

percent of the Nigerian population WDI, 2016; Fashina, Asaleye, Ogunjobi & Lawal 2018; Lawal, Nwanji, Adama and Otekunrin, 2017). With the existing electricity infrastructure in Nigeria, educational indicators like adult and youth literacy rates stood at about 55 and 69 percent, evident that the country's illiteracy rate is high. This has implication on the level of individual's productivity and the societies. The country's life expectancy is put at 52 years, ranking 178th in 2016 (WHO, 2017). Among the fifty leading causes of death in the country is lung disease, which is usually associated with residential, commercial and public pollution.

Furthermore, investment on electric infrastructure in Nigeria has been biased towards the urban areas, leaving the rural areas with little or no opportunity for development (Asaleye, Isoha, Asamu, Inegbedion, Arisukwu & Popoola, 2018; Ayopo, Isola, & Olukayode, 2016b; Ayopo, Isola & Olukayode 2015; Lawal, Nwanji, Asaleye & Ahmed 2016). Statistics from the Federal Ministry of Power and Steel (2010) show that over a ten-year period (1989-1998), N2.5 billion (US\$1.4 million) was expended on RE projects. In 2001-2009, a total of N5.6 billion (US\$ 437 million) was equally expended on 189 projects. Spending between the periods of 2001-2009 translates to about N557million (US\$ 4.4million) per year or N15million (US\$ 0.12million) per each federating state in a year. This amount is considered inadequate given the huge infrastructural deficit mirrored by less than 50 percent rural electrification rate in the country. Additionally, a large number of projects were abandoned across rural communities for more than five years due to poor funding, poor planning amongst other factors (REA, August 2017; Ayopo, Isola, & Olukayode, 2016a; Lawal, Olayanju, Salisu, Asaleye, Dahunsi, Dada, Omoju, & Popoola, 2019).

One of the targets of Sustainable Development Goal (SDG)-7 is to ensure universal access to affordable and reliable modern energy by 2030. This target is subsumed into Nigeria's recent RE strategies as outlined in the Power Sector Recovery Programme (PSRP), Isola, Frank, & Leke, 2015. This, among other things, is to facilitate inclusive growth and development for over 50 percent of the rural population (Rural population data in Nigeria sourced from the World Bank estimates of the United Nations World Urbanisation prospects, 2017). As such, access to electricity is expected to impact on rural development, as well as improve household social welfare outcomes such as school performance, health among others (Khandker et. al. 2008, 2012 and 2013). Studies on this thematic are few and mostly in favoured of the economic impact of electrification strategy. This study seeks to investigate the effects of RE on health and education indicators of rural household in Oyo state. All states, Oyo state inclusive, were incorporated into the national grid rural electrification scheme. The Oyo State RE scheme, which began in 1997, covers all the thirty (33) local government areas (LGAs) of the state. Thus, for the purpose of this analysis, primary data collected from a household survey in the twelve (12) rural communities within six (6) LGAs of the state will be adopted for the analysis.

Foreshadowing our results, it can be deduced that children study time-educational outcome - increases with the educational level of the household head by 21%. Children study time reduces with household access to grid electricity, it decreases by 8%. A better explanation for this relationship was established by the alteration of electricity benefits due to frequent outages. In addition, the effect of electrification on reduction in air pollution turns out perverse. A 1 percent increase in electricity access reduces the rate at which indoor air pollution decreases. Specifically, increase electrification rate decreases the rate at which indoor air pollution reduces by 1.1 percent. This could infer from the frequent non-availability of electricity supply in spite of the access. Better illumination due from access to modern electricity brings about a reduction in indoor pollution by 1.2 percent since households do not have to rely solely on traditional sources of energy which are more detrimental to health. The remaining part of the study is structured as follows: Section two presents the literature review; section three deals with data and methodology; section four presents the results; while section five concludes the study.

2. Literature Review

Several empirical literatures have been put forward to discuss the relationship among health infrastructure, access to electricity and rural development. Some of these studies are briefly reviewed in this section.

Empirical note:

To understand the barriers to access affordable but adequate healthcare facilities in rural South Africa, Neely & Ponhunmugam (2019) employed a chain of documentary analysis, household survey and in-depth interview to examine the dichotomy of treatments available to the urban vis-à-vis rural dwellers in South Africa. The study noted that socio-political traits that characterizes South African' cultural life such as resource scarcity, transportation, kinship networks, social segregation among others impact on access to healthcare facilities.

Titus, Adebisola & Adeniji (2015) examined health care access and utilization among rural households in Nigeria based on primary data sourced from 200 rural households in the rural part of Ogun state, Nigeria. The study employed a combination of descriptive statistics and health care accessibility indexes to analyse its data and observed that the accessibility indices in the study area shows existence of unequal access to modern health facilities. The study thus suggests that rural development policies should promote equitable access to health care facilities by rural dwellers.

Benedict (2010) investigated the Nigeria poverty index with a focus on human capital component. The study noted that though health play critical role in economic development, little attention has been paid to the health sector with a consequential effect on life expectancy and labour productivity. The study stressed that an unhealthy work force is key to enhanced productivity sector. The study therefore suggests a comprehensive reform of the health sector with the intension of strengthening the national health system within affordable cost to Nigerians.

Dang & La (2019) employed a three-round panel data set comprises of over 3,000 households in rural Viet Nam to examine the impacts of electricity reliability improvement on welfare and economic decisions. The study observed that household income as well as changes in income composition as demonstrated by ownership improved electrical devices response positively to higher electricity quality. The study also noted that improved electricity supply promotes household investment in land and farming activities; and provokes upward shift in demand for bank credit for farming activities.

Riva, Ahlborg, Hartvigsson, Pachauri & Colombo (2018) examine the linkages between electricity access and development on rural economies and observed that the nexus between electricity and development in the studied rural economies are characterized by dynamic and endogenous complexities; and that the nature of the relationship between the two could be represented by a causal loop diagram. The study noted that for electricity to impact on development, other infrastructural facilities are essential.

Kennedy, Mahajan & Urpelainen (2019) focused on the factors that influences willingness by electricity consumers in rural areas to pay for electricity consumed in rural India. The study employed a Heckman selection approach and noted that the quality of service delivery is key to willingness to pay. The study also noted that electricity has positive impact on growth in the rural communities of India.

Zou & Luo (2019) examined the characteristics and determinants of rural household's energy consumption in China based on data from 1472 rural households drawn from the Chinese General Social Survey of 2015. The study employed Tobit model and observed that age and health status of the household head tends to have reduced share of coal consumption. The size of the household also affects consumption as large households tends to consume higher electricity than households with little population size.

Enslev, Mirsal & Winthereik (2018) employed an ethnographic research technique to examine the impact of expansive electricity grid to rural villages in Kenya exerts on households energy consumption practices. The study noted that impact of anticipatory participation is key in the study of electricity access and consumption in rural economies.

Ohiare (2015) identified lack of cogent electrification plan as the main challenge to access to electricity for both urban and rural dwellers in Nigeria. The study noted that a master plan with least cost electrification model is key to sustainable electrification of both the rural and urban sectors of the Nigeria economy. The study also submitted that every stakeholder in the energy sector should be involved in drafting a sustainable master plan for the electricity industry.

Oyedepo (2012) reviewed the existing interventions in the energy sector with a focus on the electricity sub-sector. The study noted that more than 60% of Nigerians are cut off from electricity supply. Thus, there is urgent need for the government to diversify the energy sector to accommodate the domestic, commercial and industrial demand. The study further stressed the need to adopt technologies that tends to reduce wastage and are cost effective.

3. Methodology and Data

3.1 Methodology

The ADB (2009) describes a clear framework for evaluating the overall households' welfare effects of electrification. This is modified in Figure 1.

Access to electricity is explained to have impact on education through lighting that can be used for reading, leisure, and entertainment while providing access to information that leads to non-formal education. Access to electricity also increases the chances of knowledge build up, arising from the video/sounds, about health and hygiene, especially among women.

In some cases, the productivity of teachers is enhanced through the use of electronic teaching media while teachers are encouraged to reduce absenteeism (Nepal & Paija, 2019) and hold night classes with better space lighting.

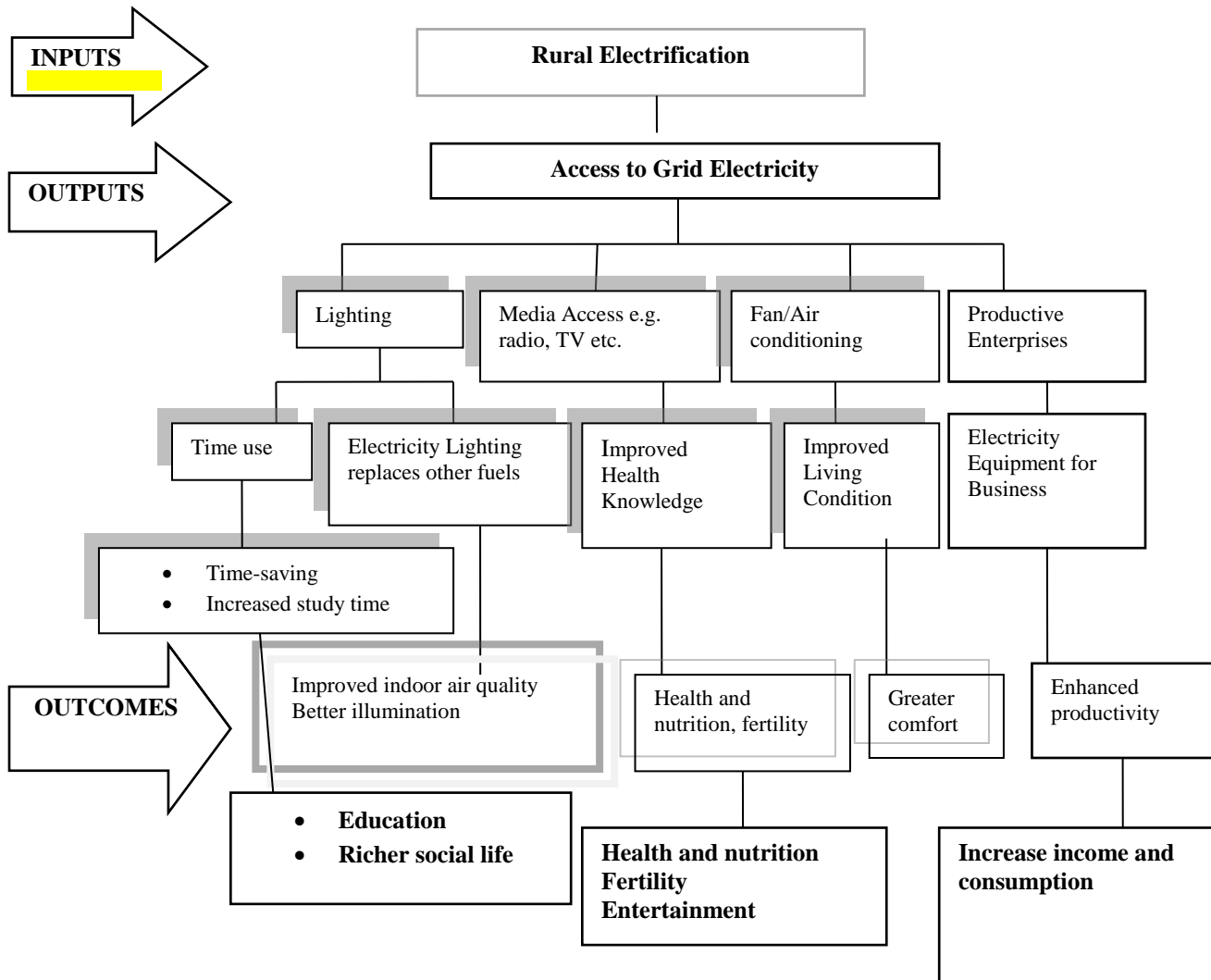


Figure 1. Conceptual Framework

Source: Author's depiction with modifications based on ADB's (2009) Framework.

The use of electric stoves for cooking substitute the use of fuelwood. Thus, improve indoor air quality. The productivity of medical staff is improved with the use of electronic medical equipment while working hours are extended with better space lighting (Bairoliya *et al*, 2019). Electrification increases the chances of modern water supply facilities that enhance health and hygiene, decreases the time for water collection especially among children and women resulting in better education (i.e., lower absenteeism, longer study time) then productivity.

Our model specification follows the input, output and outcome conceptual framework in figure 3. In this case, the input is the community's rural electrification, while the households' access to on-grid electricity is the output. The outcomes are the social welfare indicators, like education and health- that are impacted as a result of electrification.

First, based on the conceptual framework the following dependent variables were selected: increase study hours (education) and decrease indoor air pollution (health), while the main independent variable is the electrification indicator measured by access to rural electrification. Second, the choice of education and health indicator is informed by the relevant objectives of Nigeria's rural electrification programme. Specifically, the choice of education indicator is anchored on the objective designed to raise the living standards of rural populations through improved lighting. In the same vein, the health indicator adopted herein is selected to assess the role of electrification in reducing indoor pollution and other energy-related environmental problems as encapsulated in the Nigerian RE strategy.

Other explanatory variables were also included to control for household and community characteristics. This is because households' characteristics influence access to infrastructure services, while community characteristics also influences access to resources. According to Ahmad (2012) and Ahmad et al. (2013) marginalized sections of the society (communities living without access to infrastructure; such as access to good roads) often have fewer physical capital and, hence, are able to realize lower levels of human well-being.

The estimable model is a micro-econometric model articulated by Khandker et al (2014). The model is specified as;

$$Y_{ij} = \beta_0 + \beta_1 X_{ij} + \beta_2 V_j + \beta_3 E_{ij} + \mu_{ij} \quad (3.1)$$

Where Y_{ij} denotes the outcome variables of interest, such as; log of increase educational performance of children measured by increase study hour (IEG, 2008), improved health condition due to decreased indoor air pollution in household i from community j; X_{ij} is a vector of household level observed characteristics (e.g. age of households head, education level, sex, and others as may apply to specific equation); V_j is the observed level community characteristics (access to infrastructure proxy by access to paved roads). The major determinant in the model E_{ij} , is electrification measured by access to electricity (Barnes, 2014). E_{ij} is access to electricity by household i living in community j proxy by grid connection, and μ_{ij} is the disturbance term. The core variable of interest is denoted by the coefficient β_3 and this measures the effect of rural electrification on household social welfare indicators.

To analyse equation (3.1) a logistic regression technique is employed. The logistic regression constraints estimate probabilities to values that lie between 0 and 1. A typical Logit function is specified as:

$$\ln \left[\frac{p}{(1-p)} \right] = a + \beta x + e \quad (3.2)$$

Where \ln is the natural log, e is exponential that carries the value of 2.71828, p is the probability that an event occurs, and $p/(1-p)$ is the odd ratio.

The logit function is used to specify two (3.2) estimable equations based on equation (3.1) above. These equations are model used in determining the effect of electricity access on the selected household social welfare indicators. These are specified accordingly.

$$\text{logit}(P(IST) = 0,1) = \delta + \beta_1 HHS + \beta_2 HEDL + \beta_3 CARD + \beta_4 HGEC + \beta_5 HEOE + \beta_6 HEED + \varepsilon \quad (3.3)$$

In equation (3.3) *IST* is increased children study hour. *HHS* household head sex, *HEDL*, household head educational level, *CARD*, community access to good road, *HGEC*, household grid electricity connection, *HEOE*, household expenditure on electricity, and *HEED*, is household expenditure on education. All for $i = 1, \dots, n$, where n is the number of households from community j . The β_i 's are the parameter estimates. It is also expected that $\beta_2, \beta_3, \beta_4, \beta_5, \beta_6$ exert a positive effect on children educational performance by increasing study time, while β_1 , a positive or negative effect.

$$\text{logit}(P(DAP) = 0,1) = \delta + \beta_1 HHS + \beta_2 HEDL + \beta_3 CARD + \beta_4 HGEC + \beta_5 HEOE + \varepsilon \quad (3.4)$$

All definition in equation (3.4) remained the same as obtained in (3.3), except for *DAP* which is decrease air pollution. $\beta_2, \beta_4, \beta_5$ are expected to have a positive relationship with expenditure, β_3 negative relationship, and β_1 , a positive or negative relationship

Equations (3.3) and (3.4) were used to analyse the welfare effect of electricity access on rural households as outlined in the objective. Charts and tables were used to describe the general characteristics of the data employed, while Ordinary Least Square (Logistic) regression technique was equally used for the estimation.

3.2 Data

Primary data are employed for the analysis and were collected through administered structured questionnaires. Through purposive sampling method, twelve (12) rural communities, across six (6) Local Government Areas in Ibadan (Akinyele, Iddo, Egbeda, Ona-Ara, Lagelu, & Oluyole), which benefitted from rural electrification in Oyo state, were selected (A list of communities that benefitted from the RE programme was provided by the Oyo state RE Board).

In each of these communities, the average number of households is hundred (100) making a total of 1200 households in all the 12 communities; hence, a simple random sampling technique was used to select 35 households per community, thus, giving us a total of 420 samples (This sample size was scientifically determined based on 90% confidence interval at 2.5% margin of error).

The distribution of the sample size of the respondents are presented in Table 1. Semi-Structured questionnaires were administered in the selected households to elicit information on the effect of RE on the key welfare indicators. Questions relating to educational performance, reduction in health hazard were asked.

Table 1. Distribution of sample size of respondents

S/N	LGA	Rural Community	Sample size
1	Egbeda	Alaaka	35
		Oko-Taapa	35
2	Oluyole	Aba Epo	35
		Akano	35
TFN 3	Iddo	Alapaa	35
		Aba kasumu	35
		OtunAbese	35
4	Ona- Ara	Alapafon	35
		AsigiElebolo	35
5	Lagelu	Aliri/LadunniBalogun	35
		GbanguduOtunOlode	35
6	Akinyele	Omonigbehin	35
Total	6	12	420

4. Empirical Results

This section discusses the findings of the analyses, which include the descriptive statistics of the data as well as, findings from the micro-econometric model based on Logit regression analysis.

4.1 Characteristics of Households in Oyo State Rural Communities

This section describes some fundamental characteristics of rural households in the selected communities, as well as the community characteristics. Information on households’ energy usage is also discussed.

Table 2 shows the distribution of household membership within the sampled community. Twenty-four (24) percent of the respondents have a total of four (4) people in the household, 20 percent has six (6) members in a household, 2 percent has twenty (20) member household, while 1 percent has eleven (11).

Only six (six) percent of the household has a least family member of two (2). Overall, sixty-four (64) percent of the respondents have household membership of more than 4 people. This suggests that family composition is large in rural Nigeria communities, a situation that could lead to indoor congestion with serious health implication if reliance is more on traditional energy type.

Table 2. Distribution of Household Membership in the Selected Rural Communities

Household Members	Frequency	Percentage
2	22	5.6
3	27	6.8
4	93	23.5
5	58	14.7
6	78	19.7
7	16	4.1
8	28	7.1
9	12	3
10	10	2.5
11	5	1.3
12	13	3.3
15	20	5.1
16	7	1.8
20	6	1.5
Total	395	100

The incident of rural poverty is reflected in the proportion of rural communities with household ownership. Of the 395 households surveyed (The rate of questionnaires retrievals was 94 percent, which is considered high for household survey), 57 percent owned the house they occupied, while 43 percent live in a rented apartment (Figure 1). Indicating a low level of well-being, as over 40 percent household’s lacks control over basic amenities such as shelter, a situation that also reflects the high incidence of poverty in rural communities (World Bank estimates of the United Nations World Urbanisation prospects, 2017)

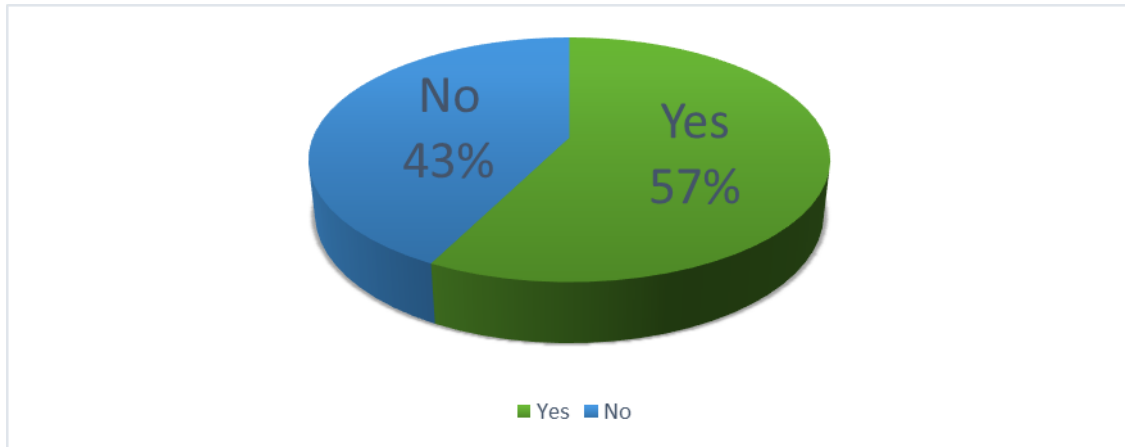


Figure 1. Proportion of Household Ownership
Source: Author’s Depiction from Field Survey, 2017

In the rural communities, most of the household head respondents are youth as 39 percent fell within the age bracket of 20-40, followed by age group of 41-60 years, which also constitute about 34 percent. Of the total, 24 percent of the respondents are within the age of 61 above (Figure 2). Since most of the respondents are in their active age (20-60years), electrification is expected to be essential for increased social and economic activities, therefore, better welfare. About 93 percent are fully engaged in different types of jobs (Figure 3). Of the total, 37 percent are involved in commercial activities either as a business/trader, 37 percent are professionals, and 12

percent are farmers with another 12 percent working as artisans. The remaining 7 percent are unemployed. But the concern here is if those engaged are fully employed based on the International Labour Organisation (ILO) standard that could earn them a decent living.

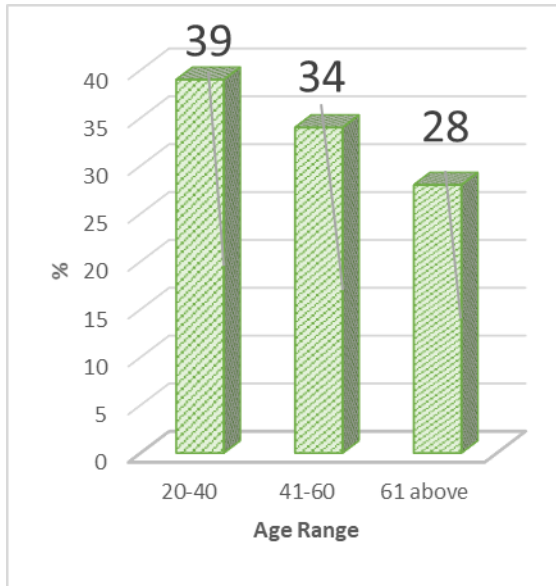


Figure 2. Age of Household Head

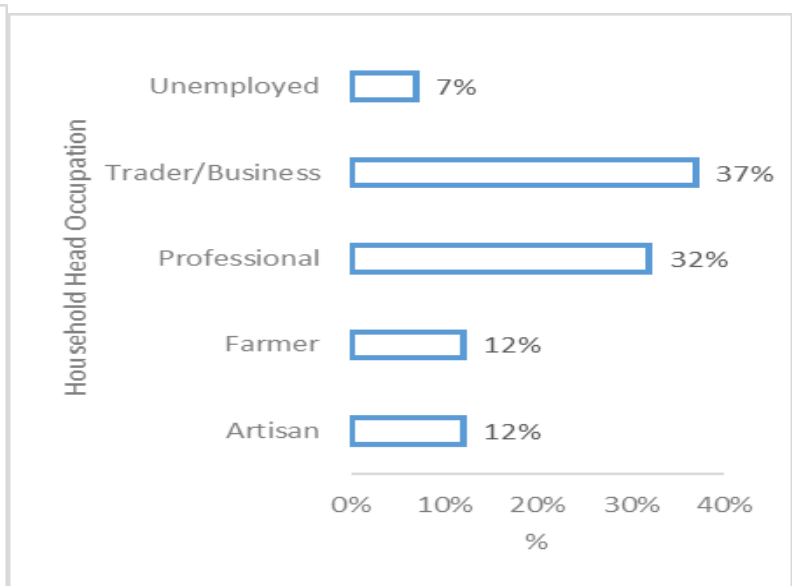


Figure 3. Household Head Occupation

Source: Author's Depiction from Field Survey, 2017

The communities can be characterised as literate since the vast majority of the respondents had some form of formal education (Figure 4). 50 percent and above of the respondents had education beyond basic primary school certificate.

Seven (7) percent had a junior secondary school, 12 percent got a senior secondary school, 12 percent went to a college of education, 20 percent to Polytechnic, 2 percent had bachelors and 2 percent had postgraduate education.

16 percent of the respondents are without any form of education while 15 percent went to vocational and technical schools. This result suggests that physical infrastructure will be widely adopted to increase better living standard.

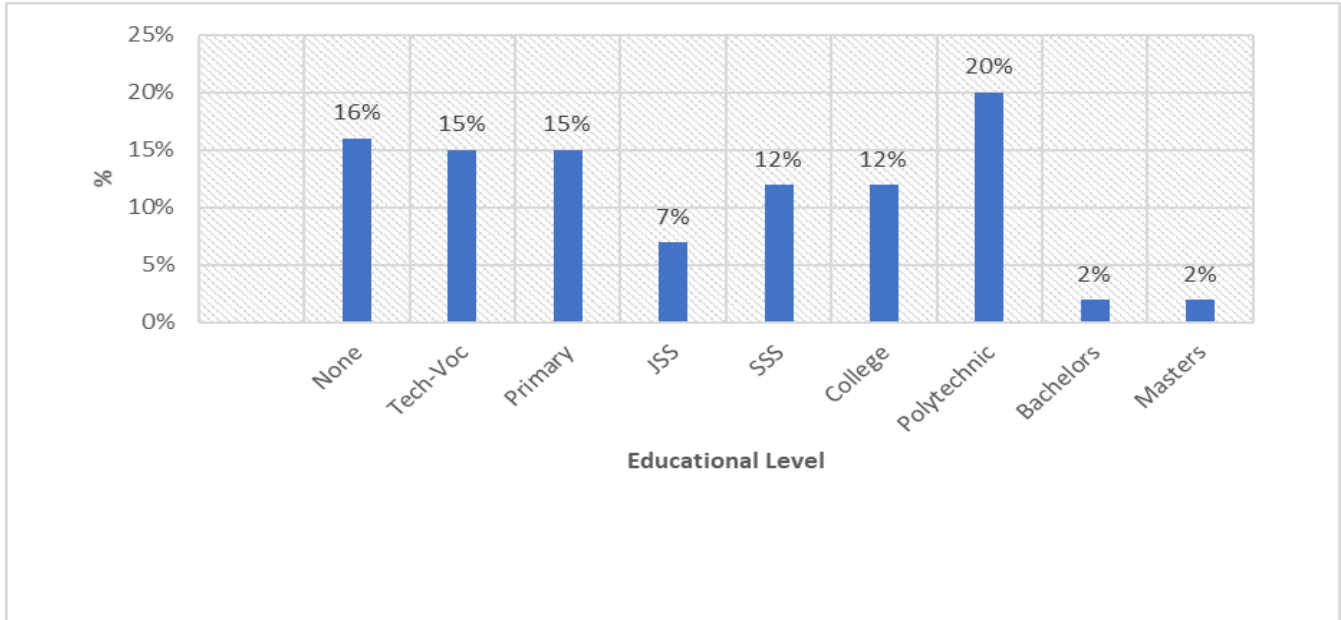


Figure 4. Household Head Educational Level
Source: Author's Depiction from Field Survey, 2017

In all the surveyed rural communities that benefited from RE programme, 76 percent of households are connected to the national grid, while 24 percent remained unconnected (Figure 5). However, availability of power supply has remained a major challenge for the majority as 71 percent of the respondents confirmed lack of frequent supply (Figure 6).

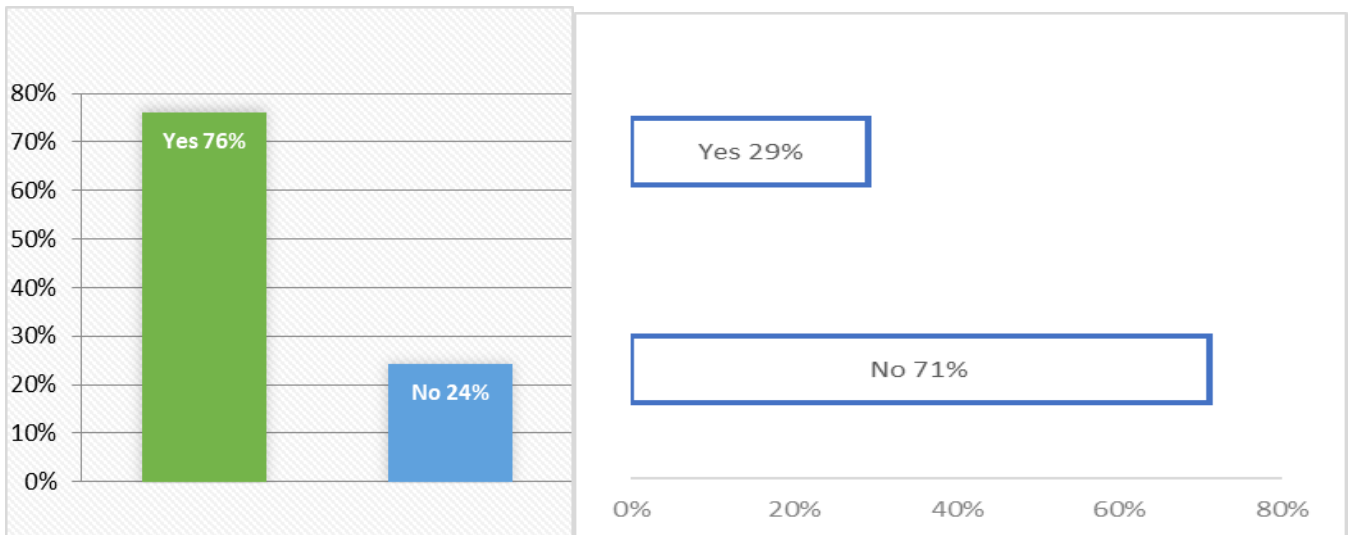


Figure 5. Household Connected to Grid **Figure 6:** Frequent Electric Supply
Source: Author's Depiction from Field Survey, 2017

Having benefited from the rural electrification scheme, 34 percent of the respondents get connected to the national grid less than 5 years ago, while 30 percent were connected between 10-14 years (Figure 6). This indicates a wide acceptance of the programme as more than half (50 percent) of the respondents are connected to electrification more than 10 years into the programme that just turned 21 years in Oyo State. Since electrification could be through on- grid or off-grid solutions as outlined in the Nigerian National Rural electrification scheme, 67% of the respondents are not connected to any off-grid technology, while only 33% of the sampled respondents have access (Figure 7). The available off-grid technology in rural Oyo State is solar energy. With these outcomes, electricity consumption in rural Oyo state is majorly from the national grid.

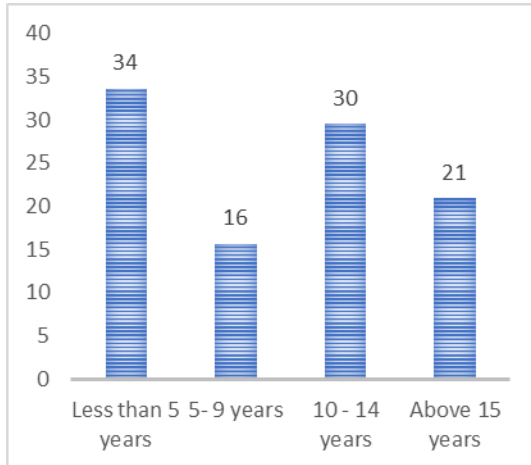


Figure 7. When Connected to National Grid

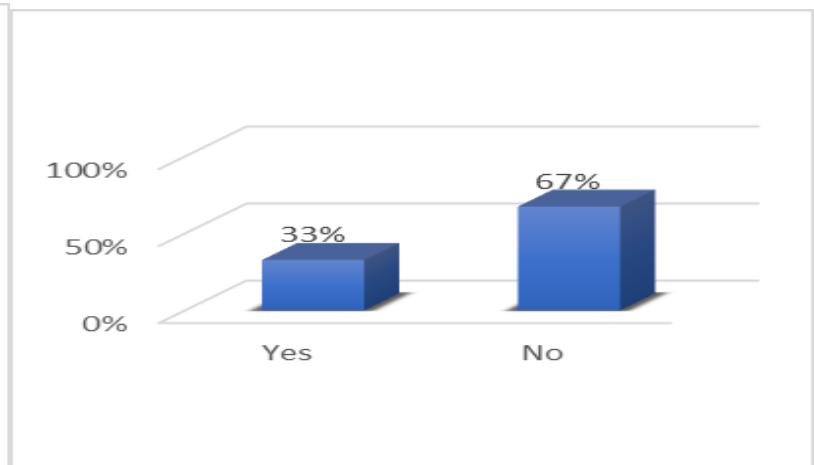


Figure 8. Access to Off Grid

Source: Author’s Depiction from Field Survey, 2017

Considering the household energy options, it is clearly shown that 46 percent has the option of using grid electricity, as also shown by high rate of households connected, while 3 percent supplement grid electricity with Liquid Petroleum Gas (LPG) and 19 percent with Kerosene.

4 percent rely on biomass for energy, 9 percent uses fuelwood, 18 percent uses Premium Motor Spirit (PMS) otherwise known as gasoline. Overall, 2 percent of all the respondents use all the energy type listed (Figure 9).

Although a large chunk of the respondents agreed on having grid electricity option, 39 percent of the households asserted they use PMS for day to day activities (The frequent outage in electricity supply explains the high proportion of PMS and kerosene), 17 percent uses electricity, 24 percent uses Kerosene, 16 percent uses fuelwood, 2 percent uses LPG, with another 2 percent using Biomass (Figure 10).

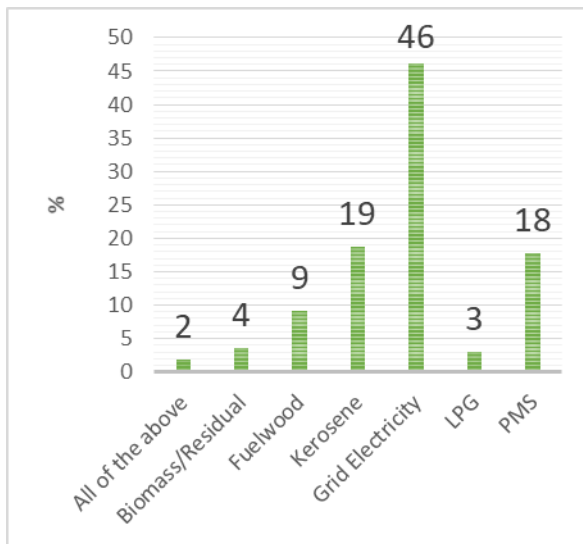


Figure 9. Energy Options

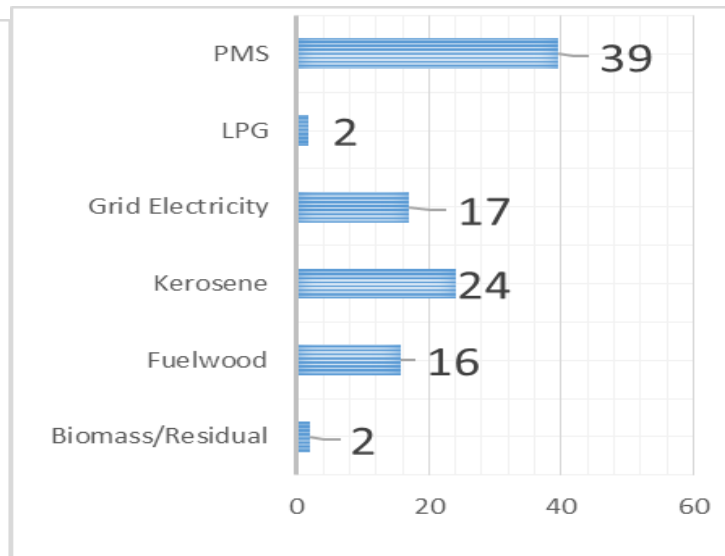


Figure 10. Most Used Energy Type

Source: Author's Depiction from Field Survey, 2017

4.2 Effects of Rural Electrification on Household Social Welfare Indicators

This section presents the logistic regression of the welfare effects of RE. Two welfare outcomes from non-monetary social indicators were estimated. The outcomes are: Increase in children Study Time (*IST*) and Decrease Air Pollution (*DAP*)

In analysing the results, the following were considered: the odd ratio which shows the effect of the independent variable on the dependent variable, Chi-Square which shows if the equation is significantly better, P-Value which also shows the significance of the variables, and the Pseudo R² which shows the overall significance of the equation

4.2.1 Estimation of Education Effect of Rural Electrification

As evident in Table 3, a positive relationship exists between an increase in Children Study Time (*IST*) and the sex of the household head (*HHS*). Also, *IST* increases with the educational level of the household head (*HHED*) and age of the household head (*HHA*). Children study hour increases by 21% with an increase in the educational level of the household head. Access to the road has a negative relationship with children study hour (it decreases by 27%), Children study hour reduces with household access to grid electricity (*HGEC*), it decreases by 8%, contradicting the findings of empirical study like *IEG* (2008) and *Khander* (2009). A better explanation for this relationship could be established by the alteration of electricity benefits due to frequent outages. Expenditure on electricity (*HEOE*) significantly decreases children study hour by 12% probably as a result of a high preference for watching television thereby engendering an inverse relationship between education expenditure and children study time. Thus, expenditure on education decreases children study hour by 65%.

Also, this equation is significantly better with the chi-square value (217.05 > -159.689), the probability value is less than 0.05 which shows that the equation is significant while the R² is 0.4046.

Table 3. Logistic Regression Result of Education Effect of Rural Electrification

Variable	Coef.	S. E	Sig	Exp (β)
HHS	1.198	0.364	0.001	3.314
HHA	1.902	0.240	0.000	6.702
HLED	0.197	0.069	0.005	1.218
CARD	-1.308	0.355	0.000	0.270
HGEC	-2.483	0.534	0.000	0.084
HEOE	-2.519	0.286	0.000	12.422
HEED	-0.439	0.221	0.048	0.645
CONSTANT	-7.367	0.934	0.000	2.021
chi square value (217.05) > -159.689)				
p-value 0.0000				
Pseudo R2 0.4046				

4.2.2 Estimation of Health Effects of Rural Electrification

The odd ratio shows that there is a positive relationship between decrease indoor pollution and the sex of the household head. The relationship is equally positive between household-head age, educational level and decrease air pollution. Implying that age of the household head, Household head educational level has a positive relationship with reduction in indoor pollution. Reduction in indoor pollution decreases, as access to good road increases, which turns out counterintuitive, because increase road access signifies proximity to development that should reduce household health and related hazard. The effect of electrification on a reduction in air pollution equally turns out perverse. A 1 percent increase in electricity access slowed down the rate at which indoor air pollution reduces. Specifically, electrification decreases the rate at which indoor air pollution reduces by 1.1 percent. This could infer from the frequent non-availability of electricity supply in spite the access. While the household electricity expenditure increases with reduction in indoor air pollution, it decreases the rate of air pollution by 1.6 percent. This implies that more spending on modern electricity reduces the rate of indoor air pollution. Better illumination due from access to modern electricity brings about reduction in indoor pollution by 1.2 percent since households do not have to rely solely on traditional sources of energy which are more detrimental to health. Usage of modern and traditional energy brings about complementarity in the adoption of energy choice, thereby reducing the health danger of air pollution.

Overall, this equation is significantly better with the chi-square value (172.32 > -179.910), the probability value is less than 0.05 which shows that the equation is significant while the R² is 0.3238.

Table 4. Estimation of Health Effect of Rural Electrification

Variable	Coef.	S. E	Sig	Exp (β)
HHS	0.925	0.338	0.006	2.521
HHA	0.469	0.201	0.020	1.599
HLED	0.126	0.063	0.0045	1.134
CARD	-0.763	0.311	0.014	0.466
HGEC	-1.087	0.398	0.006	0.337
HEOE	1.618	0.213	0.000	5.041
ABI	1.247	0.313	0.000	3.478
CONSTANT	-5.194	0.773	0.000	2.021
chi square value (172.32) > -179.911)				
p-value 0.0000				
Pseudo R2 0.3238				

Policy Implications

The Nigerian rural electrification strategy was set up with numerous objectives. From the social point of view, it is meant to promote cheaper, more convenient and more environmental friendly alternatives to the prevalent kerosene, candle, and vegetable oil lamps and fossil fuel-powered generating sets; protect the nation's health and environment by reducing indoor pollution and other energy-related environmental problems, as well as increase individual's living standard. In view of this, access to rural electrification in the twelve (12) rural communities has not brought about the desired impact on education and health. Children study time-educational outcome - increases with the educational level of the household head by 21%. Children study time reduces with household access to grid electricity, it decreases by 8%. A better explanation for this relationship was established by the alteration of electricity benefits due to frequent outages. In addition, the effect of electrification on reduction in air pollution turns out perverse. A 1 percent increase in electricity access reduces the rate at which indoor air pollution decreases. Specifically, increase electrification rate decreases the rate at which indoor air pollution reduces by 1.1 percent. This could infer from the frequent non-availability of electricity supply in spite of the access. Better illumination due from access to modern electricity brings about a reduction in indoor pollution by 1.2 percent since households do not have to rely solely on traditional sources of energy which are more detrimental to health.

Apparent from the findings, the effects of electrification are offset by the frequent non-availability of electricity supply. To worsen the situation is the fact that centralized grid electrification remains the main source of electrification in Nigeria. In this present form, the system is overwhelmed and cannot provide adequate and reliable services when expanded, hence the non-impact of electrification on social outcomes. To surmount this challenge, the mini-grid option is required. There is need to reemphasise this due to a rapid decline in cost arising from technological improvements and growing markets (World Bank, 2017). Long-term sustainability requires government commitment, and if possible, provision of financial assistance (e.g. capital expenditure subsidy for construction assets or, operational-based subsidy such as reimbursement on each new connection etc.). In addition to the mini-grid option the off-grid solution such as renewable option should be pursued vigorously. Although the Nigerian government in 2015 launched the renewable energy policy; like Ghana, Kenya, and South Africa, Nigeria should have a strong supporting legislation to support its position on rural electrification strategy. Promoting renewable energy efforts through direct policy efforts and incentives, private participation should be encouraged through transparent and simple procedures to enables greater reliability. To facilitate the optimal performance of the existing electricity system, implementation of the gas master plan is crucial, paving way for sustainable gas supply. This in a way will also increase supply reliability, coverage, and then higher social benefits.

Conclusion

The Nigerian rural electrification (RE) programme is meant to increase electricity access by extending centralized distribution lines to rural communities as part of strategies to facilitate inclusive growth and development. Hence, the study analysed the effects of rural electrification on household welfare indicators such as education and health in Oyo State, while suggesting strategies for enhancing benefits. Using a logistic regression model, key empirical findings revealed that children study hour reduces with household access to grid electricity, it decreases by 8 percent. Expenditure on electricity significantly decreases children study hour by 12 percent.

A 1 percent increase in electricity access increases the rate of indoor air pollution. Specifically, electrification decreases the rate at which indoor air pollution reduces by 1.1 percent. Household electricity expenditure increases with reduction in indoor air pollution, and it decreases the rate of air pollution by 1.6 percent. Better illumination due to access to modern electricity reduces indoor pollution by 1.2 percent.

Hence, to increase benefits, the adoption of mini-grid option is inevitable, which requires government commitment to sustainable development. Another option is the off-grid solution such as renewable option, which should be promoted by strong supporting legislation that is incentive-based for rural electrification strategy. The efficiency of the existing electricity system entails the implementation of the gas master plan, which is crucial in paving way for sustainable gas supply for the major source of electricity generation in Nigeria. This in a way will also increase supply reliability, coverage, and then higher social benefits.

References

- ADB (2009). Building a Sustainable Energy Future: The Greater Mekong Sub region, Manila. Asian Development Bank. <https://www.adb.org/sites/default/files/publication/29307/building-sustainable-energy-future.pdf>
- Ahmad S, Mathai, M. V. & Parayil, G. (2014). Household electricity access, availability and human well-being: Evidence from India. *Energy Policy*, 69, issue C, 308-315 <https://doi.org/10.1016/j.enpol.2014.02.004>
- Ahmad S. (2012). Housing Inequality in Socially Disadvantaged Communities: Evidence from Urban India, 2009. *Environment and Urbanization Asia*. 3(1): 237-249 <https://doi.org/10.1177%2F097542531200300113>
- Asaley, A. J., Isoha, L. A., Asamu, F., Inegbedion, H., Arisukwu, O. & Popoola, O. (2018). Financial development, manufacturing sector and sustainability: Evidence from Nigeria. *Journal of Social Sciences Research*, 4(12), 539-546 <https://doi.org/10.32861/jssr.412.539.546>
- Asaley, A. J., Popoola, O., Lawal, A. I., Ogundipe, A. & Ezenwoke, O. (2018). The credit channels of monetary policy transmission: implications on output and employment in Nigeria. *Banks and Bank Systems*, 13(4), 103-118 [http://dx.doi.org/10.21511/bbs.13\(4\).2018.10](http://dx.doi.org/10.21511/bbs.13(4).2018.10)
- Ayopo, B. A., Isola, L. A. & Olukayode, S. R. (2015). Monetary policy dynamics and the stock market movements: empirical evidence from Nigeria. *Journal of Applied Economic Sciences*, X38(8), 1179-1188 <http://cesmaa.org/Extras/JAES>
- Ayopo, B. A., Isola, L. A. & Olukayode, S. R. (2016a). Stock market response to economic growth and interest rate volatility: Evidence from Nigeria. *International Journal of Economics and Financial Issues* 6(1), 354-360. <https://dergipark.org.tr/en/pub/ijefi/issue/32008/353699>
- Ayopo, B. A., Isola, L. A. & Olukayode, S. R. (2016b). Stock market volatility: Does our fundamentals matter? *Ikonicheski Izsledvania* 25(3), 33-42 <https://pdfs.semanticscholar.org/1cbd/3193ba840af7dfddeb547df5153622d8390.pdf>
- Bairoliya, N., Canning, D., Miller, R. & Saxena, A. (2018). The macroeconomic and welfare implications of rural health insurance and pension reforms in China. *The Journal of Economics of Ageing*, 11, 71-92 <https://doi.org/10.1016/j.jeoa.2017.01.004>
- Benedicts, A. O. (2010). Poverty, access to health care services and human capital development in Nigeria. *African Research Review* 4(3), 41-55 <https://www.ajol.info/index.php/afrrrev/article/viewFile/60149/48400>
- Cheney, A. M., Newkirk, C., Rodriguez, K., & Montez, A. (2018). Inequality and health among foreign-born Latinos in rural borderland communities. *Social Science and Medicine*, 215, 115-122 <https://www.ncbi.nlm.nih.gov/pubmed/30223174>
- Dahunsi, S. O., Adesulu-Dahunsi, A. T., Osueke, C. O., Lawal, A. I., Olayanju, T. M. A., Ojediran, O. J. & Izebere J. O. (2019). Biogas generation from Sorghum bicolor stalk: Effect of pretreatment methods and economic feasibility. *Energy Reports* 5, 584-593 <https://doi.org/10.1016/j.egyvr.2019.04.002>
- Dahunsi, S. O., Osueke, C. O., Olayanju, T. M. A. & Lawal, A. I. (2019). Co-digestion of Thebroma cacao (Cocoa) pod husk and poultry manure for energy generation: Effects of pretreatment methods. *Bioresource Technology*, 283, 229-241 <https://dx.doi.org/10.1016/j.biortech.2019.03.093>
- Dang, D. A. & Lan, H. A. (2019). Does electricity reliability matter? Evidence from rural Viet Nam. *Economic Policy* 131, 399-40 <https://doi.org/10.1016/j.enpol.2019.04.036>

- Diao, X., Magalhaes, E. & Silver, J. (2019). Cities and rural transformation: A spatial analysis of rural livelihoods in Ghana. *World Development* 121, 141-157 <https://doi.org/10.1016/j.worlddev.2019.05.001>
- Enslev, L., Mirsal, L. & Winthereik, B. R. (2018). Anticipatory infrastructural practices: The coming of electricity in rural Kenya. *Energy Research and Social Science* 44, 130-137 <https://doi.org/10.1016/j.eress.2018.05.001>
- Fashina, O. A., Asaleye, A. J. Ogunjobi, J. O. & Lawal, A. I. (2018) Foreign aid, human capital and economic growth nexus: Evidence from Nigeria. *Journal of International Studies*, 11(2), 104-117 https://www.joiss.eu/?425.en_foreign-aid-human-capital-and-economic-growth-nexus-evidence-from-nigeria
- He, X. (2019). China's electrification and rural labor: Analysis with fuzzy regression discontinuity. *Energy Economics*, 81, 650-660 <https://doi.org/10.1016/j.eneco.2019.05.007>
- Independent Evaluation Group. (2008). The welfare impact of rural electrification: A reassessment of the costs and benefits. Washington, DC: World Bank https://siteresources.worldbank.org/EXTRURELECT/Resources/full_doc.pdf
- Isola, L. A., Frank, A. & Leke, B. K. (2015). Can Nigeria achieve Millennium Development Goals? *Journal of Social Sciences Research* 1(6), 72-78 [https://www.arpgweb.com/pdf-files/jssr1\(6\)72-78.pdf](https://www.arpgweb.com/pdf-files/jssr1(6)72-78.pdf)
- Kennedy, R., Mahajan, A. & Urpelainen, J. (2019). Quality of service predicts willingness to pay for household electricity connections in rural India. *Energy Policy*, 129, 319-326 <https://doi.org/10.1016/j.enpol.2019.01.034>
- Khandker, S. R., Samad, H. A., Ali, R. & Barnes D. F. (2014). Who Benefits Most from Rural Electrification? Evidence in India: Policy Research Working Papers. *The Energy Journal* 35: 75-96 <https://www.iaee.org/en/publications/ejarticle.aspx?id=2559&id=2559>
- Khandker, S., Barnes, D. F., & Samad, H. A. (2013). Welfare impacts of rural electrification: A panel data analysis from Vietnam. *Economic Development and Cultural Change*, 61(3), 659-668 <https://econpapers.repec.org/scripts/redir.pf?u=http%3A%2F%2Fdx.doi.org%2F10.1086%2F669262:h=repec:ucp:ecdecc:doi:10.1086/669262>
- Khandker, S., Samad, H. A., Ali, R., & Barnes, D. F. (2012). Who benefits most from rural electrification? Evidence in India (Policy Research Working Paper No. 6095). Washington, DC: World Bank <http://documents.worldbank.org/curated/en/374171468331748897/Who-benefits-most-from-rural-electrification-evidence-in-India>
- Kuhmonen, T. & Kuhmonen, I. (2015). Rural futures in developed economies: The case of Finland. *Technological Forecasting and Social Change* 101, 366-374 <https://doi.org/10.1016/j.techfore.2015.07.028>
- Lawal, A. I., Olayanju, A., Ayeni, J. & Olaniru, O. S. (2019). Impact of bank credit on agricultural productivity: empirical evidence from Nigeria (1981-2015). *International Journal of Civil Engineering and Technology*, 10(2), 2019, pp. 113-123 https://www.researchgate.net/publication/332251363_Impact_of_bank_credit_on_agricultural_productivity_Empirical_evidence_from_Nigeria_1981-2015
- Lawal, A. I., Asaleye, A.J., IseOlorunkanmi, J. & Popoola, O. R. (2018). Economic growth, agricultural output and tourism development in Nigeria: An application of the ARDL bound testing approach. *Journal of Environmental Management and Tourism*, 9(4), 786-794. [https://doi.org/10.14505/jemt.v9.4\(28\).12](https://doi.org/10.14505/jemt.v9.4(28).12)
- Lawal, A. I., Babajide, A. A., Nwanji, T. I., & Eluyela, D. (2018). Are Oil Prices Mean Reverting ? Evidence from Unit Root Tests with Sharp and Smooth Breaks, *International Journal of Energy Economics and Policy* 8(6), 292-298 <https://doi.org/10.32479/ijeep.6980>
- Lawal, A. I., Nwanji, T. I., Adama, IJ & Otekunrin, A. O. (2017). Examining the Nigerian stock market efficiency: Empirical evidence from wavelet unit root test approach. *Journal of Applied Economic Sciences*, 12(6), 1680-1689 http://eprints.lmu.edu.ng/2493/1/12_1680_1689_AdedoyinIsolaLAWALTonyIkechukwuNWANJIIbrahimJosephADAMA.pdf
- Lawal, A. I., Nwanji, T. I., Asaleye, A., & Ahmed, V. (2016). Economic growth, financial development and trade openness in Nigeria: An application of the ARDL bound testing approach. *Cogent Economics & Finance*, 4(1), 1-15. <https://doi.org/10.1080/23322039.2016.1258810>
- Lawal, A. I., Olayanju, A., Salisu, A. A., Asaleye, A. J., Dahunsi, O., Dada, O., Omoju, O. E., & Popoola, O. R. (2019). Examining Rational Bubbles in Oil Prices: Evidence from Frequency Domain Estimates. *International Journal of Energy Economics and Policy*, 2019, 9(2), 166-173 <https://doi.org/10.32479/ijeep.7463>

- Lawal, A. I., Oye, O. O., Toro J. & Fashina, O. A. (2018). Taxation and sustainable economic growth: empirical evidence from Nigeria. In P. P. Sengupta (Ed.), *Contemporary Issues on Globalization and Sustainable Development* (Volume 1, pp. 121-144). New Delhi: Serials http://serialspublications.com/books/index.php?route=product/product&product_id=3775
- Lawal, A. I., Somoye, R. O. & Babajide, A. A. (2017). Are African stock market efficient? Evidence from wavelet unit root test for random walk. *Economics Bulletin*, 37(4), 2665-2679 <http://www.accessecon.com/Pubs/EB/2017/Volume37/EB-17-V37-I4-P239.pdf>
- Mazur, C., Hoegerie, Y., Brucoli, M., Dam, K-V., Guo, M., Markides, C. N. & Shah, N. (2019). A holistic resilience framework development for rural power systems in emerging economies. *Applied Energy* 235, 219-232 <https://doi.org/10.1016/j.apenergy.2018.10.129>
- Meng, L., Huang, J. & Dong, J. (2018). Assessment of rural ecosystem health and type classification in Jiangsu province, China. *Science of the Total Environment* 615, 1218-1228 <https://doi.org/10.1016/j.scitotenv.2017.09.312>
- Neely, A. H. & Ponshunmugam, A. (2019). A qualitative approach to examining health care access in rural South Africa. *Social Science and Medicine* 230, 214-221 <https://doi.org/10.1016/j.socscimed.2019.04.025>
- Nepal, R. & Paija, N. (2019). Energy security, electricity, population and economic growth: the case of a developing South Asian resource-rich economy. *Energy Policy* 132, 771-781 <https://doi.org/10.1016/j.enpol.2019.05.054>
- Ohiare, S. (2015). Expanding electricity access to all in Nigeria: A spatial planning and cost analysis. *Energy, Sustainability and Society* 5(8), 1-18 <https://link.springer.com/article/10.1186/s13705-015-0037-9>
- Oyedepo, S. O. (2012). Energy and sustainable development in Nigeria: the way forward. *Energy, Sustainability and Society* 2(15), 1-17 <https://link.springer.com/article/10.1186/2192-0567-2-15>
- Palit, D. & Bandgopadhyay, K. R. (2017). Rural electrification access in India in retrospect: A critical rumination. *Energy Policy*, 109, 109-120 <https://doi.org/10.1016/j.enpol.2017.06.025>
- Phadke, A., Park, W. Y. & Abhyankar, N. (2019). Providing reliable and financially sustainable electricity access in India using super-efficient appliances. *Energy Policy*, 132, 1163-1175 <https://doi.org/10.1016/j.enpol.2019.06.015>
- Riva, F., Ahlborg, H., Hartvigsson, E., Pachauri, S. & Colombo, E. (2018). Electricity access and rural development: Review of complex socio-economic dynamics and causal diagrams for more appropriate energy modelling. *Energy for Sustainable Development* 43, 203-223 <https://doi.org/10.1016/j.esd.2018.02.003>
- Riva, F., Gardumi, F. & Tognollo, A. & Colombo, E. (2019). Soft-linking energy demand and optimisation models for local long-term electricity planning: An application to rural India. *Energy*, 166(C), 32-46 <https://doi.org/10.1016/j.energy.2018.10.067>
- Rural Electrification Strategy and Implementation Plan (RESIP) 2016 <http://rea.gov.ng/wp-content/uploads/2017/09/RESIP.pdf>
- Silva, S., Soares, I. & Pinho, C. (2018). Electricity residential demand elasticities: Urban versus rural areas in Portugal. *Energy*, 144, 627-632 <https://doi.org/10.1016/j.energy.2017.12.070>
- Titus, O. B., Adebisola, O. A. & Adeniji, A. O. (2015). Health-care access and utilization among rural households in Nigeria. *Journal of Development and Agricultural Economics* 7(5), 195-203 <https://academicjournals.org/journal/JDAE/article-references/FA8257C52514>
- WDI (2017) International Bank for Reconstruction and Development/The World Bank 1818 H Street NW, Washington DC 20433 <http://documents.worldbank.org/curated/en/816281518818814423/pdf/2019-WDR-Report.pdf>
- WHO (2017). World health statistics 2017: monitoring health for the SDGs, Sustainable Development Goals https://www.who.int/gho/publications/world_health_statistics/2017/EN_WHS2017_TOC.pdf?ua=1
- World Bank. (2002). Rural electrification and development in the Philippines: Measuring the social and economic benefits (ESMAP Report No. 255). Washington, DC: Author http://siteresources.worldbank.org/INTPSIA/Resources/490023-1120845825946/philippines_rural_electrification.pdf
- World Bank. (2017). PPP Conversion factor, GDP [Data file]. Retrieved from <http://data.worldbank.org/indicator/PA.NUS.PPP>

Zhang, T., Shi, X., Zhang, D. & Xiao, J. (2019). Socio-economic development and electricity access in developing economies: A long run model averaging approach. *Energy Policy* 132, 1163-1175 <https://doi.org/10.1016/j.enpol.2019.06.015>

Zou, B. & Luo, B. (2019). Rural household energy consumption characteristics and determinants in China. *Energy*, 182, 814-823 <https://doi.org/10.1016/j.energy.2019.06.048>

Acknowledgement

We appreciate Landmark University, Nigeria for paying the Article Processing Fee to support the Open Access for this article.

Iyabo A. OLANRELE has a PhD in Energy Economics from the Centre for Petroleum Energy Economics and Law (CPEEL), University of Ibadan, Nigeria. She works with the Nigerian Institute of Social and Economic Research in Economics and Business Policy Department. Iyabo equally lectures at CPEEL. She has published in reputable national and international journal outlets. Iyabo has been engaged in several funded projects by the Federal Government of Nigeria. She has attended both local and international conferences. Her main research interests lie in Macroeconomics, Econometrics, Energy Economics, and Macroeconometric Modelling.

ORCID ID: <https://orcid.org/0000-0001-7498-8961>

Adedoyin Isola LAWAL (PhD) is a Senior Faculty with the Department of Accounting and Finance, Landmark University, Omu Aran. He has published extensively in several peer review outlets. He is a referee to a few reputable journals like *African Development Review*, *The Quarterly Journal of Economics and Finance*, *Cogent Economics and Finance* etc. His research focuses on agricultural financing and sustainable energy

ORCID ID: <http://orcid.org/0000-0001-8295-1560>

Olatunde Samuel DAHUNSI (Ph.D.) is an International Research Expert with the Sustainable Management of Natural Resources and Environment Research Group, Faculty of Environment and Labour Safety, Ton Duc Thang University, Ho Chi Minh City, Vietnam. He is equally a Guest Scientist, Group of Microbiology of Anaerobic Systems, Department of Environmental Microbiology, Helmholtz Centre for Environmental Research – UFZ Permoserstraße 15 | 04318 Leipzig, Germany. His research focuses on sustainable energy

ORCID ID: <http://orcid.org/0000-0003-3088-1577>

Abiola Ayopo BABAJIDE (PhD) is an Associate Professor of Finance at the Dept. of Banking and Finance, Covenant University, Ota, Nigeria. She was the Chief Executive Officer of Covenant University Microfinance Bank. She has published extensively in reputable journals. She serves as an Editor to Sage Open and other reputable academic and industry outlets. **ORCID ID:**

<https://orcid.org/0000-0001-7653-8833>

Joseph Ojo ISEOLORUNKANMI (PhD in View) is of the Dept. of Political Science & International Relations, Landmark University, Nigeria, and a Post Doctorial Student (Viva state) of the Dept of Political Science, University of Kwazulu-Nata, South Africa.

He has published extensively in both local and international peer review outlets. His research work has been in sustainable development.

ORCID ID: <https://orcid.org/0000-0003-2662-2900>