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THE IMPACT OF RURAL ELECTRIFICATION ON RURAL MICRO-ENTERPRISES IN NIGER DELTA, NIGERIA

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ABSTRACT

This study examines how rural electrification through extension of existing grid has impacted rural micro-enterprises in Niger Delta, Nigeria. The study used purposive sampling and obtained data using structured questionnaires and personal interviews with the owners of the micro-enterprises. From the data, summary information was obtained and the impact of connection to grid-electricity on the micro-enterprises was examined using a log-linear regression model. The result shows that although not statistically significant, on average, enterprises in communities connected to the electricity grid are 16.2% more profitable than enterprises in communities not connected to the grid, and the use of generating sets in providing back-up electricity makes micro-enterprises more profitable. The study also observed that micro-enterprise owners are fully aware of the importance of electricity access to the profitability of their businesses and those who can afford generating sets willingly do so. Incidentally, the total expenditure on generating sets by some enterprises is up to three times (3x) the tariff for grid-electricity in rural areas. The high cost of self-generated electricity increases the total cost of doing business in rural areas thus reducing the profit margin of the micro-enterprises. In conclusion, for rural electrification to be more effective in improving the living standard of rural dwellers, the larger problem of increasing the national generating capacity and the availability of grid-electricity should be tackled, and rural electrification programmes should be carried out alongside other programmes that reduce the barriers to establishing micro-enterprises like the creation of rural agricultural co-operatives to promote the productive use of electricity.

KEYWORDS: Electricity access, impact, micro-enterprises, rural areas, Niger Delta, Nigeria.

PAPER CLASSIFICATION: Research Paper

1.0 INTRODUCTION

In many developing countries, a large percentage of the population are poor[1] and live in rural areas where there are substantial lack of basic amenities like potable water, good roads, electricity, health facilities etc. In most cases, these rural dwellers depend on adjoining streams to meet their water needs, have to trek for long distances in search of traditional biomass to meet their energy needs, and cater for their health needs using crude traditional methods. The lack of these amenities poses a barrier to the reduction in the level of rural morbidity, mortality, and improving the living standard of the poor. Concerned about the low standard of living in many developing countries, in 2000, the United Nations established the Millennium Development

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[1] "Poor" in this study is defined as people living on less than US$1 per day.

Goals (MDGs) and set targets to improve the standard of living of the world's poor (UN, 2000). Although not part of the MDGs, access to clean and affordable energy, especially electricity, is necessary if the MDGs are to be met. For example, to achieve universal primary education, electricity is needed for good lighting for reading in homes and to power some teaching aids; to reduce child mortality and improve maternal health, electricity is needed in health facilities to power refrigerators for preserving drugs and vaccines etc. Studies have shown that there is a high correlation between the level of electricity consumption and human development index (Meisen & Akin, 2008). Given the critical role of access to electricity in meeting the MDGs and in ensuring the development of rural areas, many developing countries strive to provide electricity to their populace.

In Nigeria, successive governments at the different tiers have tried to provide electricity using rural electrification programmes which involves extending the existing distribution lines to rural communities. Such programmes have huge potential benefits because the availability of electricity and other basic amenities can increase the productivity and profitability of existing micro-enterprises[2], and also reduce the barrier to the creation of new micro-enterprises (Kooijman-van Dijk & Clancy, 2010; Nichter & Goldmark, 2009) which in-turn may increase the available disposable income that may be used to improve the standard of living. Cabraal *et al.* (2005) noted that access to electricity has a significant impact in rural development only when it is used efficiently and on income-generating activities. However, these potential benefits may not be derived since rural electrification through extension of the distribution lines does not necessarily translate to availability of electricity, especially given the larger problem of low electricity generation capacity and high transmission and distribution losses faced by the Nigerian electricity sub-sector. Despite the prevalence of this rural electrification approach in Nigeria, very little has been done to ascertain its impact on the socio-economic situation in rural areas. This study intends to examine how connection to grid-electricity has impacted micro-enterprises in rural areas in Niger Delta, Nigeria. The result of the study will bridge the knowledge gap in this area and also provide policy makers useful suggestions on maximizing the potentials of rural electrification in rural development in the region.

[2] A micro-scale enterprise is defined in this study as enterprises with not more than 5 employees and a capital outlay of not more than ₦750,000. For better understanding of the monetary figures used in the study, an exchange rate of US$1=N155 may be used.

The study is organized as follows: after this brief introduction will be a review of related literature. In the third section, we will present the methodology of our study. The fourth section will be the presentation and discussion of results, while the final section will give some concluding remarks and policy recommendations.

2.0 REVIEW OF LITERATURE

Several studies have been carried out on the impact of access to electricity on small and micro-scale enterprises in developing countries (Little, 1987; Tybout, 2000; Neelsen & Peters, 2011) etc. Little (1987) investigated the role of small and micro-enterprises in fostering economic growth and underscore the importance of electricity access as a basic ingredient of firm development. Tybout (2000) found electricity access to be one of the decisive components of business success in developing countries. Using micro-firm level data from World Bank's enterprise surveys, Eifert *et al.* (2008) found that what they define as indirect costs explain low productivity in Africa and that energy constitutes the largest. Neelsen & Peters (2011) assessed the impact of electricity access in micro-enterprises in Uganda using quantitative firm-level data from 200 enterprises complemented by qualitative case studies. The study found out that there was little direct impact of electricity access on firm profits or worker remuneration. However, there was significant indirect effect mainly due to increase in demand for goods and services prompted by migration from non-electrified to electrified communities. The study concluded by stressing the need for productive energy promotion policies to be put in place to assist local entrepreneurs to take informed business decisions.

Arnold *et al.*, (2008) investigated the effect of the reliability of electricity supply and generator usage on firm productivity in 10 African countries. They found that reliability problems of the electricity grid had a statistically significant negative impact on firms' total factor productivity, while generator possession had a statistically significant and positive effect. Bastakoti (2003) examined the role of enterprises for the effective use of electricity in Nepal and noted that rural electrification in isolation, without any complementary service mechanism and policy co-ordination, will not create the necessary development impacts.

Combining quantitative and qualitative survey instruments such as participatory rural appraisals (PRA), Kirubi (2006) discovered a positive contribution of electricity provision to micro-

enterprise growth in rural areas. Cabraal *et al.* (2005) stated that access to modern energy services could facilitate the productivity of small and medium-scale enterprises (SMEs), boost agricultural production, and improve health conditions . Kooijman - van Dijk (2008) examined the decision to take up modern energy and how it might translate into impacts in firms. The results showed positive effects of electrification on working hours that increases the flexibility of entrepreneurs. Furthermore, the study highlights "non-material impacts" such as improved comfort for and increased social status of entrepreneurs.

Peters, *et al.* (2009) highlighted the need for complementary services such as sensitization campaigns or business developing services to promote the productive use of electricity to accelerate the impacts of rural electrification by reporting experiences gained in rural Benin. The study concluded that "responsibility of complementary services should be in principle with the grid operator, while the regulatory bodies have to assure welfare orientation of the services." Peters (2009) presented different approaches to evaluating rural electrification programmes taking into account specific challenges faced by researchers in such interventions. The study suggested that ex-ante evaluations be carried out on yet to be electrified target region and already electrified region. Such evaluations will provide robust evidence on impacts and provide good insights for project design. Fishbein (2003) surveyed the productive use of electricity in several countries and observed that electricity is being used in businesses, irrigation, pumping water, and in other activities that improved the living standard of the people, albeit at different levels.

3.0 METHODOLOGY

3.1 STUDY LOCATION

The study was conducted in Akwa Ibom State, Nigeria. Akwa Ibom State is one of the 36 states in Nigeria located in the Niger Delta region of the country and sharing boundary to its south with the Atlantic Ocean. The state falls within the tropical rain forest agro-ecological zone and has two climatic seasons – the rainy season which lasts from April to October and the dry season which lasts from November to March. The settlement pattern in rural areas in the state is scattered and clustered with average household size of 5.1 (NBS, 2009). Agriculture is the predominant economic activity in the rural areas with majority of people engaged in oil palm and cassava cultivation for domestic and to a lesser extent commercial purposes. Rural communities

in the coastal areas engage mainly in fishing. Other non-agricultural micro and small-scale enterprises are soap making, raffia, tailoring, hair dressing, grocery retailers etc. also thrive in the rural communities. To examine the impact of rural electrification on micro-enterprises, the study employed purposive sampling to select four rural communities – two electrified and two non-electrified. The electrified communities selected for this study are *Ikot Obio Odongo* and *Akpa Utong* villages in Ibesikpo Asutan Local Government Area while the non-electrified villages are *Ikot Ekpang* and *Ibio Ette* Villages in Mkpat Enin Local Government Area, all in Akwa Ibom State.

3.2 DATA COLLECTION AND ANALYSIS

Data used in this study were collected using purposive sampling survey carried out in October, 2012. Primary data were obtained through questionnaires and interviews with the owners of the micro-enterprises in the communities. The survey encountered a high non-response rate of 38% in electrified communities and 56% in non-electrified communities. Many enterprise owners declined completing the questionnaires for fear that the survey is carried out by government agents for the purpose of taxation. In other cases, those met at the enterprise premises said they are not the owners of the business and therefore would not fill the questionnaires, while others refused filling the questionnaires citing that no personal benefits would be derived in doing so. Excluding the enterprises that did not respond, the study covered a total of 62 enterprises in the electrified communities and 44 in the non-electrified communities. The survey questions probed the contribution of grid-electricity to the growth of the enterprises and were divided into four sections.

(a) Personal information (of enterprise owners) which covered information on the background of enterprise owners including age, sex, educational attainment, and marital status.

(b) Business and electricity access information which covered the type of business, the number of years of existence of the business, the time of the day the business is carried out, electricity usage in the business, the source of the electricity, the regularity of grid-electricity supply etc.

(c) Impact of electricity on business which determined the daily cost and revenue to the enterprises[3] and the level of the impact of grid-electricity access on the enterprises

(d) Cost of electricity which covered the expenditure of enterprises on grid-electricity supply or alternative sources (generating sets) and the maximum amount enterprise owners will be willing to pay to have steady grid-electricity

Responses from questions with ordered options were rated on an ordinal scale while the Yes/No responses were rated on a 0-1 nominal scale.

3.2.1 MODEL SPECIFICATION

To assess the impact of rural electrification on the micro-enterprises, the study employed a log-linear regression model. The variables used in the model are described below:

(1) Profitability of business (P): To get the desired information on profitability of business, the study used ranges of values for average daily cost and revenue from businesses. The ranges for cost data were ₦0 – ₦ 500, ₦ 501- ₦ 1000, … ₦2501 and above while the revenue ranges were up to N3501 and above. The use of range was preferred to actual data because of poor record keeping by enterprise owners which makes it difficult to know the actual average daily cost and revenue. Moreover, it is usually difficult on the part of enterprise owners to disclose financial information of one's enterprise. The profitability was calculated by subtracting the midpoint of the cost range from the midpoint of the revenue range selected by each respondent. For example, if a respondent selected the cost range of ₦ 0 to ₦ 500 and the revenue range of ₦ 501 to ₦ 1000, the profitability of the respondent is ₦ 750 – ₦ 250 = ₦ 500. However, this raises some issues because: assuming the actual daily cost is ₦ 100 and the revenue is ₦ 400, the actual profit will be ₦ 300 but since both are in the ₦ 0 to ₦ 500 range, the study calculates it as ₦ 0. Conversely, the daily cost of another respondent may be ₦ 450 and the revenue ₦ 550, the respondent will select the ₦ 0 to ₦ 500 range for cost and ₦ 501 to ₦ 1000 range for revenue. The actual profit will be ₦ 100 but the study calculates the profit as ₦ 750 - ₦ 250 = ₦ 500. In addition, given the procedure stated above, where

[3] The purpose of this was to compare with enterprises in Category B with similar characteristics to estimate the impact of electricity on the category A enterprises in terms of cost and revenue, hence profit.

the profitability calculated is ₦ 0, the study replaced it with ₦ 50 since the natural log of zero does not exist.

(2) Average daily availability of grid-electricity (X_1): As stated in the Introduction, rural electrification through extension of the existing grid does not necessarily translate to availability of grid-electricity for productive use. This variable represents the average daily duration of grid-electricity in the communities as reported by the respondent. The study expected the length of electricity supply to be uniform for all the enterprises within each electrified community, however, respondents selected different though adjoining ranges. For example, some respondents in a particular electrified community may select 0-3hrs while others selected 4-6hrs. The variable was coded using an ordinal scale as follows: enterprises in non-electrified communities = 0; one to three hours = 1; four to six hours = 2; seven to nine hours = 3; and ten hours and above = 4. The study expects that the profitability of micro-enterprise will increase with longer hours of grid-electricity availability. Thus, the coefficient of this variable is expected to be positive.

(3) Cost of running a generating set (X_2): This represents the average daily cost of using a generating set as an alternative source of electricity by the micro-enterprises. This cost is in terms of the average daily expenditure on fuel and oil and not expenditure on repairs and maintenance which is done occasionally. The variable has two purposes: First, it indicates the enterprise owners that use generating sets. Second, for enterprise owners that own generating sets, it indicates the average daily cost of using the generating set in the enterprise. The variable is coded using an ordinal scale as follows: enterprise without a generating set = 0; ₦ 0 - ₦ 200 = 1; ₦ 201 - ₦ 400 = 2; ₦ 401 - ₦ 800 = 3; ₦ 801 and above = 4. Although expenditure on generating sets increases the cost outlay of running a business, in some cases the business will not run without using the generating set. Thus, a positive coefficient is expected.

(4) Number of years in business(X_3): This represents the number of years of continuous existence of the micro-enterprise. The variable is coded using an ordinal scale as follows: < 1year = 1; between 1 and 4 years = 2; between 5 and 10years = 3; above 10yrs = 4. The expectation is that the longer the number in years of the business the more profitable the business, thus the study expects a positive coefficient.

(5) Connection to grid-electricity (GE): This represents the status of an enterprise with respect to being connected to grid-electricity through rural electrification. It is a dummy variable where 1 is used for enterprises in electrified communities, and 0 otherwise. The study expects that, on average, enterprises in electrified communities will be more profitable thus the differential coefficient is expected to be positive.

(6) Type of Business: Each type of business considered in the study is considered as an independent dummy variable where 1 is used if the enterprise owner belongs to the business category, and 0 otherwise. This is done to ascertain if the type of business contributes to the profitability of the business. In particular, we have *Agro-related* micro-enterprises (cassava processing, oil palm processing etc) as BC_1; *Health-related* micro-enterprises (traditional birth attendants, traditional bone attendants, patent medicines retailers etc) as BC_2; *Artisans* (carpenters, tailors, hairdressers, barbers etc) as BC_3; *Grocery retailers* as BC_4; *Relaxation spots*[4] as BC_5; and *Others* (selling of water, renting of chairs, live band group etc) as BC_6.

The model is specified as follows

$$Ln\ P_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \alpha_1 GE_i + \gamma_1 BC_{1i} + \gamma_2 BC_{2i} + \gamma_3 BC_{3i} + \gamma_4 BC_{4i} + \gamma_5 BC_{5i} + \varepsilon_i$$

The log-linear model is used because it compresses the large values of the dependent variable. The *Others* (BC_6) category is used as the benchmark category because of the divergence of the nature of businesses in this category and is excluded to avoid perfect multicollinearity. The study expects the coefficients of BC1, BC3, BC4, and BC5 to be positive given the observable frequency of productive activities by the enterprises in these categories but is unsure of the expected sign of the coefficient of BC2. The actual analysis was done using EVIEWS.

4.0 RESULTS AND DISCUSSIONS

The results of the study are presented in two parts. First, the study presents the summary of the personal information of the respondents which provides an insight into the demographics of rural

[4] Some grocery retailers do sell drinks and have a place to relax. Such enterprises were counted under grocery retailers

enterprise owners, followed by summary of information on the categories of the enterprises and their electricity use. Second, we present the results of our regression analysis.

4.1 Summary of Results

4.1.1 Summary of Personal Information of Respondents: The summary of the personal information of the respondents is presented in table 1.

Table 1: Summary of personal information of respondents (in percentage)

AGE	**Electrified**	**Non-electrified**
18-30	43.55	29.55
31-40	37.10	43.18
41-50	14.52	15.91
51 and above	4.84	11.36
Total	100.00	100.00
SEX	**Electrified**	**Non-electrified**
Male	62.90	63.64
Female	37.10	36.36
Total	100.00	100.00
EDUCATIONAL ATTAINMENT	**Electrified**	**Non-electrified**
No formal Eductaion	0.00	0.00
Primary School	9.68	11.36
secondary School	51.61	52.27
OND/NCE*	35.48	36.36
HND**/B.Sc.	3.23	0.00
PGD***/M.Sc.	0.00	0.00
Total	100	100
MARITAL STATUS	**Electrified**	**Non-electrified**
Single	58.06	63.64
Married	37.10	31.82
Widow/Widower	3.23	4.55
Separated	1.61	0.00
Divorced	0.00	0.00
Total	100.00	100.00

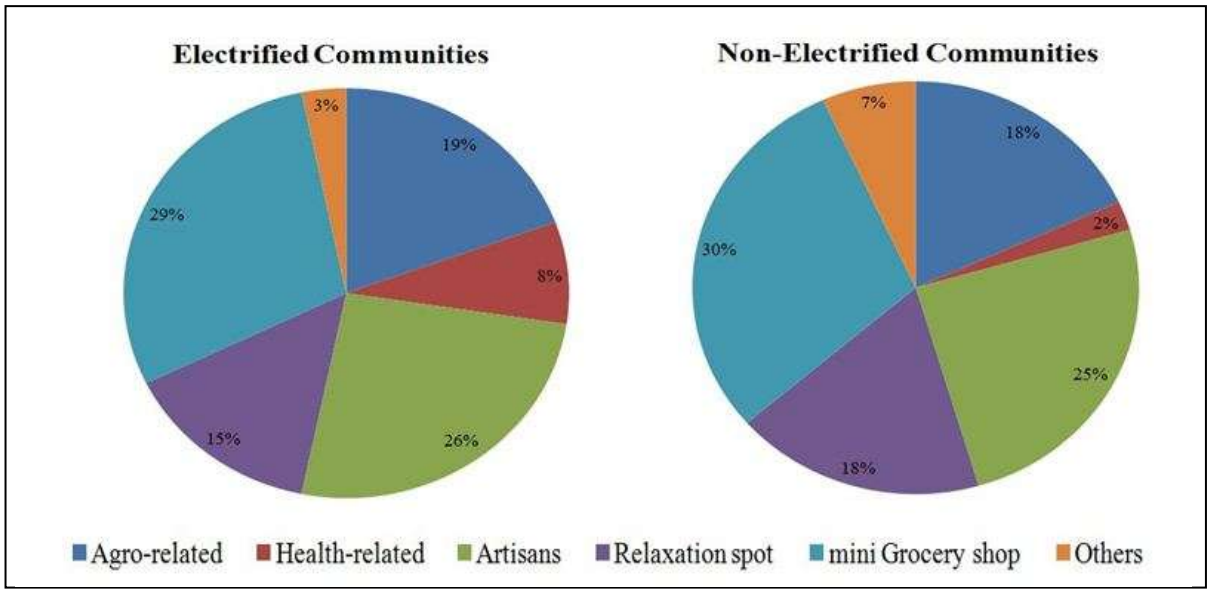
* OND/NCE: Ordinary National Diploma/National Certificate of Education
**HND: Higher National Diploma
***PGD: Postgraduate Diploma

The results from table 1 shows that the modal age of micro-enterprise owners in the study area is 31-40 years for non-electrified and 18 – 30 years for electrified communities suggesting that electrification has reduced the barrier to the establishment of micro-enterprises by younger people in the electrified communities of the study area. In total, a large percentage of business owners in both electrified and non-electrified communities fall within the age range of 18 - 40 which suggests that younger people are more likely to own micro-enterprises in rural communities. The distribution of micro-enterprise owners by sex shows that men own more

enterprises than women in both electrified and non-electrified communities and there is no difference between electrified and non-electrified communities in the male : female ratio of micro-enterprise owners in the study area. On educational attainment, about 90.3% of enterprise owners in the electrified communities have attained secondary education with 3.2% having a bachelor's degree while the percentage of respondents in non-electrified communities with at least a secondary education is 88.6% with no respondent having a bachelor's degree. This suggests that connection to grid-electricity may be an attraction to setting up of micro-enterprises in rural areas by persons with a high level of educational attainment. On marital status, our result shows that in both electrified and non-electrified communities most micro-enterprise owners are single.

4.1.2 Summary of Enterprise Categories, Electricity Availability, and Use: Figure 1 gives the summary of the categories of business carried out by the micro-enterprises covered in the study.

Figure 1: Categories of Business carried out by Micro-enterprises



From figure 1 above, the study observes that irrespective of the availability of grid-electricity, most micro-enterprises in rural communities engage in *Agro-related* businesses. The next dominant business category is *Artisans* which includes barbers, hairdressers, tailors etc. The business category with the least number of microenterprises in the electrified communities is *Others* (recharge card sellers, selling of water, renting of chairs/tables etc) while the least in non-electrified communities is *Health-related.*

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In addition, the study observed that the availability of grid-electricity in the electrified communities is low. Of the 62 micro-enterprises sampled in the electrified communities, 38 responded that, on average, electricity is available for between zero to three hours daily while the remaining 24 selected the four to six hours range. This clearly shows that mere connection of communities to the electricity grid is not synonymous to electricity access. The result also shows that about 58% of enterprises in both electrified communities own electricity generating sets to support their businesses while 32% of enterprises in non-electrified communities own same. The enterprises which own generating sets fall mainly in the *Artisans* and *Relaxation spot* categories. In terms of electricity use in each business category, the survey result shows that electricity is used by agro-related businesses in the electrified communities mainly for lighting to improve the luminance of the working environment at night and not to power the cassava or oil palm processing equipments which are powered with diesel engines. For *health-related* micro-enterprises, electricity is used mainly for lighting and for refrigeration. The most productive use of electricity (both grid-electricity and from generating sets) is by micro-enterprise owners in the *Artisans* and *Relaxation spot* categories who use the electricity to power equipments and machines. Barbers in the non-electrified communities use generating sets at night for luminance and to power their clippers whenever they have customers while those in the electrified communities alternate between grid-electricity and generating sets. Tailors use electricity for lighting and for ironing clothes and welders use electricity to power their welding equipments and for lighting. The owners of Relaxation spots use electricity for lighting, refrigeration, and to power television and music players while the owners of mini-grocery shops use electricity mainly for lighting and refrigeration.

The study also considered the number of years of existence of the micro-enterprises as it sometime affects the profitability of business because, over time, enterprises owners will have a learning curve on how to minimize cost and optimize productivity. We present our result in figure 2

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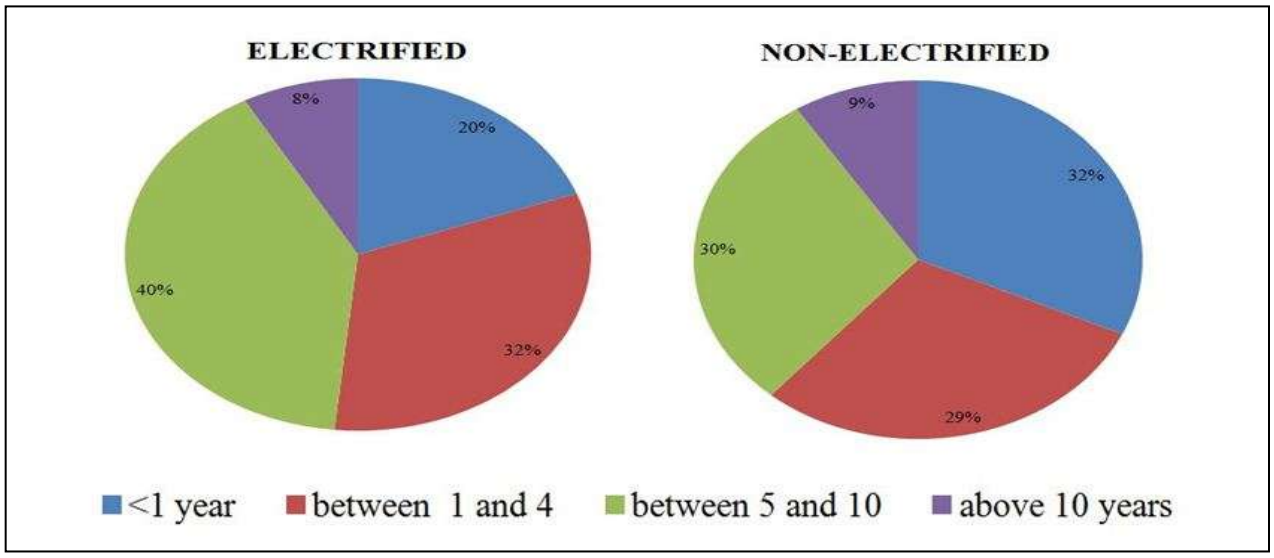
Figure 2: Number of Years in business of enterprises in electrified and non-electrified communities



From figure 2, the study observes that most enterprises were established between five and ten years ago while only a few enterprises had been in existence for over ten years.

The final section of the questionnaire probed the attitude of enterprise owners to payment for electricity used. 87% of the respondents in the electrified communities affirmed to paying electricity bills promptly and regularly. On the willingness to pay for improved daily regular grid-electricity, all the respondents in the electrified community expressed their willingness to pay N3000.00/month to have grid-electricity for at least 12 business-hours per day while 82% of the respondents in the non-electrified communities expressed their willingness to pay a bill of N3,000 to have grid-electricity for the same business period.

4.2 RESULT OF REGRESSION ANALYSIS

Using the model specified in section 3, the study carried out the necessary diagnostics on the model. The null hypothesis of no heteroskedasticity in the model was tested using Bruesch-Pagan-Godfrey heteroskedasticity test and rejected since the scaled explained sum of squares of 57.76 was greater than the critical chi-square value (χ^2_9) at both 5% and 1% level of significance (p-value = 0.0000). There was no issue with autocorrelation and the Jarque-Bera statistics indicated that the errors are normally distributed. The regression equation was re-

estimated using White's heteroskedasticity-consistent (HC) standard errors. The result of our re-estimated equation is presented in table 2 below.

Table 2: Result of regression analysis after correcting for Heteroskedasticity using White Heteroskedasticity-Consistent Standard Errors & Covariance

Dependent Variable: LOG(P)					
Variable	Coefficient	Std. Error	t-Statistic	Prob.	Significance at $\alpha = 5\%$
C	4.6700	0.5534	8.4384	0.0000	Significant
X1	0.0794	0.1316	0.6035	0.5476	Not significant
X2	0.1310	0.0440	2.9778	0.0282	Significant
X3	0.2688	0.0852	3.1564	0.0021	Significant
GE	0.1497	0.2626	0.5703	0.5699	Not significant
BC1	0.8057	0.3786	2.1279	0.0472	Significant
BC2	0.6897	0.5652	1.2202	0.2254	Not significant
BC3	0.9472	0.2729	3.4709	0.0216	Significant
BC4	0.6071	0.5917	1.0260	0.3075	Not significant
BC5	0.6685	0.5732	1.1664	0.2464	Not significant
R-squared	0.5882				
Adjusted R-squared	0.5296				
F-statistic	6.6264				
Prob(F-statistic)	0.0000				

From the results in table 2, the coefficients of the independent regressors and the dummy variables BC_1, BC_3, BC_4 and BC_5 have the anticipated signs and the coefficient of BC_2 is positive. The study also observes that of the three regressors used in the model only two – average daily cost of running a generating set (X_2) and number of years in business (X_3) are significant while the other - average daily availability of grid electricity (X_1) - is not significant. The dummy variable representing connection to grid-electricity (GE) is not significant which implies that connection to the electricity grid does not have a significant impact on the profitability of micro-enterprises. In addition, only two dummy variables representing business categories – *Agro-related* business (BC_1) and *Artisans* (BC_3) – are statistically significant which implies enterprises in these business categories are significantly more profitable than enterprises in the *Others* category while enterprises in the remaining three categories – *Health-related* (BC_2), *Relaxation spots* (BC_4), and *Mini-grocery retailers* (BC_5) – are not. From the p-value of the f-statistic we reject the null hypothesis that a regression does not exist in the model and conclude that the explanatory variables used in estimating the model provide a good fit for the dependent variable. The adjusted R-square shows that 53% of variations in the enterprise profitability can be explained due to variations in the independent variables after the model has been adjusted for the number of independent variables included. The coefficients of the X_2

(0.1310) shows that for every 1unit increase in the expenditure on running a generating set, on average, the profitability of the micro-enterprises increases by 13.1%. In monetary unit, this 1 unit increase in the variable corresponds to an increase of ₦ 500. It is necessary to note that the increase in the cost of operating a generating set in the context of this study implies an increase in the availability of electricity from a generating set for productive use. It should also be noted that some enterprises in the *Artisans* category (like barbers) cannot carry out their businesses without electricity and make do with the use of generating sets due to non-connection to or low availability of grid-electricity. It also shows that enterprise owners are aware of the importance of electricity to the profitability of their enterprises and willingly spend on the generating sets to provide the needed electricity. Incidentally, on computing the monthly total expenditure on generating sets by some enterprises, and comparing with the grid-electricity tariff for rural areas, the study observes that some enterprises spend up to three times (3x) what would have been spent paying grid-electricity bills. Similarly, the coefficient of X_3 (0.2688) shows for every 1unit increase in the length of stay in business (X_3), on average, the profitability of microenterprises in the rural communities covered in the study will increase by 26.9%.

As noted by Halvorsen & Palmquist (1980) and Giles (2011), the interpretation of the coefficients of dummy variables in a log-linear regression model differs from the interpretation of the coefficients of the continuous regressors which are usually interpreted as "100 $\hat{\beta}_i$ is the estimated percentage change in *Y* for a small change in *Xi"*. In a log-linear regression model, if α is the coefficient of a zero-one dummy variable, D, the proper representation of the proportional impact, p, on the dependent variable, Y, is p = [exp (α) - 1]. Thus, the study computes the proportional impact, p, for all the dummy variables in the model and presents them in table 3

Table 3: Proportional Impacts of the dummy variables in the model

Dummy Variable	Coefficient	Proportional Impact
GE	0.1497	0.1615
BC1	0.8057	1.2383
BC2	0.6897	0.9931
BC3	0.9472	1.5784
BC4	0.6071	0.8351
BC5	0.6685	0.9514

Table 3 shows that, on average, enterprises in communities connected to grid-electricity are 16.2% more profitable than enterprises in communities not connected to the grid. Similarly, enterprises in the *Agro-related, Health-related, Artisans, Relaxation spots,* and *Mini-grocery retailers* categories are more profitable than enterprises in the *Others* category by 123.8%, 99.3%, 157.8%, 83.5% and 95.1% respectively

5.0 SUMMARY, CONCLUSION AND POLICY RECOMMENDATIONS

This study examined how rural electrification through extension of existing grid has impacted rural micro-enterprises in Niger Delta, Nigeria. The study used purposive sampling and selected two electrified and non-electrified communities in Akwa Ibom State. A total of sixty-two enterprises in the electrified communities and forty-four in the non-electrified communities were sampled. Primary data on personal information of enterprise owners, business and electricity access information, impact of electricity on enterprise, and cost of electricity were obtained using structured questionnaires and personal interviews with the owners of the micro-enterprises. From the data, summary information was obtained and the impact of connection to grid-electricity on the micro-enterprises was examined using a log-linear regression model. The result shows that although not statistically significant, on average, enterprises in communities connected to the electricity grid are 16.2% more profitable than enterprises in communities not connected to the grid; the use of generating sets in providing back-up electricity makes micro-enterprises more profitable; and micro-enterprises in the *Agro-related,* and *Artisans* business category are more profitable. The study also observed that micro-enterprise owners are fully aware of the importance of electricity access to the profitability of their businesses and those who can afford it willingly spend on generating sets to provide electricity for their businesses. Incidentally, the total expenditure on generating sets by some enterprises is up to three times (3x) the tariff for grid-electricity in rural areas.

The high cost of self-generated electricity increases the total cost of doing business in rural areas thus reducing the profit margin of the micro-enterprises. For rural electrification to be more effective in improving the living standard of rural dwellers, the larger problem of increasing the national generating capacity and the availability of electricity should be tackled. Finally, the study recommends that rural electrification programmes be carried out alongside other

programmes that reduce the barriers to establishing micro-enterprises like the creation of rural agricultural co-operatives to promote the productive use of electricity, and a more comprehensive strategy should be developed to improve the post-programme monitoring and evaluation of rural electrification schemes.

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