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THE CONTRIBUTION OF OFF GRID ELECTRICAL POWER ON SOCIO-ECONOMIC DEVELOPMENT OF HOUSEHOLDS IN RURAL AREAS OF RWANDA, A CASE OF KAYONZA DISTRICT.

Faculty of Environmental Studies, University of Lay Adventists of Kigali (UNILAK). Kigali City, Rwanda

Allan MUDENGE mudengeallan12@gmail.com +250788531075

Jean Adolphe NKEZABERA nkezaberaa@gmail.com +250783260116

Francois Xavier NSHIMIYIMANA nshimiyimanaxavier@gmail.com +250787435757

Philip MUTIJIMA mutijimapp@gmail.com +250788373709

Christophe MUPENZI mupenzic@gmail.com +250788666156

Abstract

Development benefits greatly from reliable and efficient energy facilities for heating, lighting, cooking, transit, telecommunications, and transportation. According to this research on "the contribution of off grid electrical power on socioeconomic development of households in rural areas of Rwanda: a case study of the Kayonza district," the following objectives served as the study's direction: to evaluate the accessibility of off grid energy services in the Mwiri and Ndego sectors of district, to examine the relationship between off grid energy services and socio-economic development of households in both sectors of the district. The study adopts Yamane formula to select good sample size of 268 from 810 households in sectors. Questionnaires were used in the research to collect data. Data were analyzed by descriptive statistics (by mean and standard deviation) and inferential statistics (multiple linear regression). The results showed that off grid electrical power services in Kayonza district have high available but low access to the users from higher cost issues. The results on off grid electrical power services indicated a significant impact on the socioeconomic development on households in district, via job creation, saving and income improvement to households. Therefore, recommendation from the study was to Rwandan government must find answers to the various issues in order to increase access to electricity for more people living in rural areas and also raising the standard of grid electricity services provided to its customers.

Key words: Kayonza district, households; off-grid energy, Mwiri, Ndego, SPSS.

Contribution/originality: The objective of the research was to ascertain the effect that households in Rwanda's rural Kayonza district had on their socioeconomic growth. The research will aid in the creation of future energy policies for planning rural areas and development initiatives, linking rural electrification to socioeconomic development.

1. Introduction

The socio-economic growth of a nation and the socio-economic prosperity of its citizens both depend heavily on electrical energy. The international energy agency estimates that one point three billion people around the world, 85% of whom reside in rural regions, lack access to electricity [7]. The degree of connectivity is 99% in north Africa, 93% in Latin America, 90% are found in east Asia and the pacific, 89% are found in the middle east, and 60% and 29% are found in south Asia and sub-Saharan Africa, respectively. 83% of the world's population, who reside in these two areas, lacks electricity [7].

With nearly 585 million people living there without access to electricity, sub-Saharan Africa (SSA) is the area of the world with the least quantity of electricity. The majority of the un-electrified areas significantly expand into rural areas, which make up 14.3% of the SSA region's total electrification level of 30.5% (59.9% urban; 30.5% rural) [7].

The Rwandan government is cognizant of the crucial role that access to electricity plays in promoting better living conditions and health, which in turn helps to accelerate economic growth. The government's top concern is energy, especially access to electricity. Due to substantial investments made and progress made, over 24% of households now have access to electricity. For the government to meet its goals of 70% by 2017–2018 and 100% by 2020, more work must be done. The most economical way to expand access to electricity is to use off grid

technologies, which range from simple solar lanterns that can power a phone or radio to solar home systems that can light an entire house and run appliances like a television and mini-grids that can supply higher electricity levels to both homes and small and medium-sized businesses [11].

Despite the district's great potential for agricultural and industrial development, socioeconomic development in Kayonza remains behind. Insufficient use of contemporary energy sources has been linked to low development, which has led to ongoing underproduction and a decline in economic output, among many other bio-physical factors. One key factor influencing the socioeconomic development of households has been found as electricity. But in Kayonza district, the low adoption and low accessibility of energy pose a significant obstacle to advancing and empowering rural household development [3].

It is thought that Rwandan socio-economic growth can be accomplished with access to rural electricity. However, most communities do not understand how rural electrification adds to socio-economic development, particularly given that the majority of people there are illiterate. Therefore, the purpose of this research was to evaluate the contribution of off grid powered energy on the economic growth of rural Rwandan households with particular reference to the Mwiri and Ndego sectors in Kayonza district.

2. Materials and methods

2.1 Description of study area

Kayonza district is one of the seven districts that make up the eastern region of the republic of Rwanda. It is situated in the province's east and shares boundaries with the republic of Tanzania in the east, Gatsibo district in the north, Kayonza in the east, Ngoma in the south-west, and Kirehe in the south. The surface area of district is 1,954 km2. The relief range in height from 1400 to 1600 m. The population is 346,751 people residing in 12 sectors, 50 cells, and 421 villages (Imidugudu), 179 people per km2 population density with an average growth rate of 5.2% [3].

Fig.1. Location of Mwiri and Ndego sectors in Kayonza District map.

2.2 Data collection and analysis

This research adopted both qualitative and quantitative research methodologies since it worked on primary and secondary data. The time frame was limited in five years from 2017 up to 2021. The study's target group consisted of 810 households (432 Mwiri and 378 Ndego sectors) in the Kayonza district that use electricity. In order to get the best group for the study, the researcher used Yamane's formula to calculate sample size from the study's community. The sample size for the study was 268 households composed by 143 in Mwiri and 125 in Ndego sectors using off grid electricity.

By using a questionnaire, the respondents provided the main data on perceptions of statements about the distribution and the challenges and strategies in implementing off grid powered energy services. Responses were evaluated on a scale of strongly disagreed = 1, disagree = 2, neutral = 3, agree = 4, and strongly agree = 5 for their opinions. To ensure that the questionnaires were filled out completely and reliably, the data was first pre-processed, which involved looking over and cleaning them. The responses to following that, the responses to the questions were automatically coded and stored in a computer template with specified variable names for analysis

in SPSS software version 20 descriptive statistics, correlation analysis and multiple linear regressions.

3. The results

3.1 The characteristics of respondents

The respondents in the study illustrated that 126 (47%) they had used electricity for a period of between one and three years, 111 (41.6%) for a period between four and six years, and 31 (11.6%) for a period of less than three years. Based on distances from transformers, 38.1% of respondents who are connected to electricity are found within a radius of between 5 and 10 kilometers, 25.7% within a radius of between 1 and 5 kilometers, 19.5% within a radius of between 300 and 1 kilometers, 13.9% within a radius of more than 10 kilometers, and 2.8% within a radius of less than 300 meters. This demonstrates that the bulk of homes are close to the electrical grid.

3.2 The off grid electrical power services in Kayonza district

By utilizing descriptive statistics through mean, frequency, percentage, and standard deviation, the study aimed to describe off grid electrical power services. A five the Likert type scale was used using a scale of SD: strongly disagree; D: disagree; N: neutral; A: agree; and SA: strongly agree.

3.2.1 Electrical power services reliable in Kayonza district

The mean and standard deviation of the responses on the Likert scales used in the research were determined using descriptive findings. In this study, the data has low mean and high standard deviation in value indicated less reliable on power services.

The most common respondent factors were found to be the mean and standard deviation values, and the respondents' responses revealed that the management of the off-grid electrical supply company is willing to assist customers in resolving issues relating to the best possible use of electricity services. 4.60, 0.84; error-free record management is offered by REG (Rwanda Energy Group). 4.50, 1.00; REG is able to dislike prolonged and frequent outages 4.43, 1.03; REG immediately replaced all malfunctioning electricity equipment at the time 4.32, 1.15; no frequency interruption of current was supplied by an off-grid electrical supply business in the Kayonza area 4.23, 1.31; Supply company must wait more than 24 hours for repairs to be made 4.22, 1.12; management of off grid electrical supply company is willing to assist customers in providing the electricity services promptly 4.22, 1.31; and management of off grid electrical supply company gives regular attention and promptly addresses any complaint or request for electricity services. 4.21, 1.27.

The result indicated that willingness of management of off grid electrical supply company in helping customers, to resolve problems related to the optimum utilization of electricity services were more reliable in Kayonza district than management of off grid electrical supply company gives regular attention and promptly respond to any complaint or request electricity services in all observed factors. This indicates that reg was very highly involved in the area's provision of these services. Therefore, there is empirical evidence to back the idea that electrified public facilities offer better services than non-electrified ones. However, the majority of public

buildings now deliver services much more effectively thanks to REG efforts, and it is generally agreed that the REG was a significant factor in these institutions' quality services.

3.2.2 Cost of off grid electrical power in Kayonza district

Through descriptive statistical analysis, the respondent's factors observed were respective in value of mean and standard deviation values from highest value on mean but low value on standard deviation to lowest value on mean but highest value on standard deviation, where the citizens indicated that charging the right price allows the electricity company to provide an electricity supply is an effective 4.54, 0.96; interruption to power supply increases the cost of production through expenses of repair of damaged equipment 4.44, 1.12; high electricity tariffs are the cause for cooking using solid and liquid fuels 4.21, 1.10; electricity is used alongside other energy sources to optimize costs 4.20, 1.15; ability to pay on increase in economic activity relying on electrical energy 4.17, 1.20; willingness to pay on change from the use of traditional sources of energy to electricity 4.16, 1.25.

The results indicated that the cost of off grid electrical power in Kayonza district challenged the citizens to pay on change from the use of traditional sources of energy to electricity while the price of electrical power favored the electricity companies to provide an electricity supply effectively but, on entrepreneurs the cost still problem from power interruption lead to increases the cost of production through expenses of repair of damaged equipment.

3.2.3 Accessibility of off grid electrical power in Kayonza district

This part is also based on the means and standard deviation based on the factors which hindered accessibility of off grid electricity (settlement arrangement, public facilities, service delivering of companies, cost and accessibility to the citizens). At condition of the outcomes of variables of mean and standard deviation, where on high value of mean indicated the most popular while, efficiently on lowest value on standard deviation.

According to the results of the survey, an off-grid electrical supply company makes sure that all villages have access to electricity was (4.89, 0.45), that power connectivity processes are very complicated and time-consuming (4.57, 0.90), that all public facilities in rural areas are connected to the power grid (4.56, 0.98), that there is a high connection fee for off-grid power that most people cannot afford (4.48, 1.06), and that the majority of customers are connected to the power grid within 1.5 kilometers of transformer The findings regarding the availability of off-grid electricity in the village of Kayonza district showed that it was readily available but had limited access, making it unaffordable for users. Reg's management of the access to the grid's power connection made it difficult for their processes to connect to it, but district power facilities are easily available in rural areas.

3.3 Socio-economic development of households situated in Mwiri and Ndego sector in Kayonza district.

This part was compared the socioeconomic development of households in the Mwiri and Ndego sectors of the Kayonza district before and after they began using electricity. Based on job creation, income and saving, and access to health care. As a method of data analysis, the research used mean, and standard deviation. The sections below describe the findings.

3.3.1 Employment creation of households located in Kayonza district

The mean and standard deviation values for the general respondent factors were found to range from highest mean with low standard deviation to lowest mean and highest standard deviation. Where the interpretation is based on those conditions, respectively, it was found that the use of electricity-dependent machinery increases labor productivity (4.82, 0.56); electrification promotes business diversification (4.58, 0.93); and access to electricity (4.57, 0.83); started business over the last three years 4.54, 0.82; access to electricity enhances self-employment 4.52, 0.88; electrification allows firms to plan for flexible working hours for her employees 4.36, 0.98; electrification increases demand for labor in newly established electricity-dependent businesses 4.31, 0.54; and the use of electricity allows household members to reallocate labor from household tasks to formal wage labor 4.25, 0.96.

The average mean of respondents' responses to the statements about the improvement of job creation for households in the Kayonza district was at extremely high levels, with an average mean of 4.49, which is regarded as a high mean, and a standard deviation of 0.81, suggesting that there is strong evidence for the fact and heterogeneity response that job creation for households in the Kayonza district has been improved at very high extents.

3.3.2 Income and savings of households located in Kayonza district

The survey participants agreed that access to rural power raised income levels. Whereas the mean and standard deviation of outstanding debts with income from using off-grid electricity were 4.60 and 0.98, respectively; the financial savings in financial institutions increased over the past three years were 4.51, 1.10; the use of equipment that depends on electricity increases income from large-scale production was 4.48 and 0.88; use of electricity enhances income due to reduced business costs 4.31, 1.10; electrification enhances income by attracting/retaining more people in rural areas due to ready market for goods and services 4.24, 1.32; use of electric machines enhances income due to improved quality products and services 3.92, 1.58. The results indicated that in income and saving generation in Kayonza district was improved in both sectors, especially from large-scale production on 0.88 using off grid electricity on 0.98 of standard deviation.

3.4 The relationship between off grid energy services and economic development of households in the Mwiri and Ndego sectors of the district

In order to test the relationship between off grid electrical power services, such as reliable electrical power services, cost of off grid electrical energy and accessibility of off grid electrical power as independent variables, and socioeconomic development of households in the Kayonza district, the researcher also conducted a multiple regression analysis.

Tab.1. The regression coefficients.

Model	Unstandardized coefficients		Standardized coefficients		
	B	Std. Error	Beta	T	Sig.
1(constant)	1.244	0.247		5.034	0.000
X1=reliable electrical power services	0.313	0.043	0.372	7.343	0.000
X2=cost of off grid electrical energy	-0.109	0.037	-0.158	-2.950	0.003
X3=accessibility of off grid electrical energy	0.185	0.026	0.159	7.115	0.001

A. Dependent variable: y = socio-economic development of households in kayonza district

As per the SPSS generated $y = \beta0 + \beta1x1 + \beta2x2 + \beta3x3 + \varepsilon$ becomes:

Y=1.244+ 0.313x1-0.109x2+0.185x3

The results showed that dependable electrical power services have a significant beneficial impact on households' socioeconomic development in the Kayonza district, as shown by β1= 0.313, p-value=0.000 less than 0.05, and t= 7.343. This demonstrates that, if all other independent variables are set to 0, an increase in reliable electrical power services will result in an increase in the socioeconomic growth of households in the Kayonza district of 0.313 units. The results are at odds with an argument made [2], who also believe that reliability appears to have a greater impact on medium and large-scale firms' growth than on small firms and appears to affect the local investments.

The cost of off grid electrical power had a significant adverse impact on the socioeconomic development of households in the Kayonza district, as shown by β2= -0.109, p-value=0.003<0.05, t= -2.950. This demonstrates that, with all other independent variables set to zero, a rise in the price of off grid electrical power will result in a -0.109 unit drop in the socioeconomic development of households in the Kayonza district. This result is consistent with a study [13] that found that the price of electricity has a big impact on how much is used. The finding is consistent with that of a research [16], which found that the users' decision to connect to an electricity supply when it becomes available is significantly influenced by the cost of electricity.

The results showed that access to off grid electrical power had a significant beneficial impact on the socioeconomic development of households in the Kayonza district, as shown by β4= 0.185, p-value=0.001<0.05, t=7.115. This demonstrates that, if all other independent variables are set to zero, an increase of one unit in the availability of off grid electrical power will result in an

increase of 0.185 units in the socioeconomic growth of households in the kayonza district. Similar findings were found in the study conducted [10], which showed that the most people are open to connecting, most do not have the necessary funds to cover the startup and ongoing expenses. Additionally [6], the results concurred with study, which demonstrated that, despite most rural households' willingness to pay for connections, one of the main reasons preventing electrification of rural households is their inability to pay for it.

4. Discussion

The findings on electrical power services reliable in Kayonza district are at variance with [2], who also maintained that power outages have a negative impact on the growth. there is willingness of management of off grid electrical supply company in helping customers resolve challenges that relate to the optimum utilization of electricity services 4.60, 0.84; REG has the ability to detest long duration and high frequency of outages 4.43, 1.03; reg replaced automatically all dysfunction electricity equipment at time 4.32, 1.15; Since only large companies can afford to invest in generators to mitigate the effects of outages, nations with a specific rate of power outages have a dearth of small businesses in electricity-intensive sectors (such as manufacturing) [1]. Therefore, there is no discernible difference in the standard of services provided in electrified and non-electrified public facilities in Kayonza district.

The cost of off grid electrical power in Kayonza district challenged the citizens to pay charging the right price allows the electricity company to provide an electricity supply is an effective 4.54, 0.96, high electricity tariffs are the cause for cooking using solid and liquid fuels 4.21, 1.10. This is in line with findings from [5] that the use of charcoal as the main fuel for cooking was a significant revelation in adding relevant to mains electricity and from [4] that frequent outages in Kenya may be the cause of households' hesitation to actually listen because they may think the cost of service is too high given its erratic accessibility, regardless of their specific budgetary constraints. First, the impression that electricity rates are costly (relative to income), and second, the unstable power generation that forces families to look for alternatives in order to keep up regular mealtimes, may both be significant factors at play here.

The respondents' overall opinions on the statements pertaining to the level of accessibility of off grid electrical power in the Kayonza district has low access, based on mean and standard deviation value of 4.89, 0.45, power connectivity processes are very complex at takes a lot of time 4.57, 0.90 respectively. This indicates that the accessibility of off grid electrical power is extremely favorable in the Kayonza district. These findings support a study by [1] that found institutional, financial, and poverty-related drivers and obstacles to grid and off grid electrification in various countries. The majority of policy makers assert that it is well known that the impoverished have trouble affording electricity.

The factors which hindered accessibility of off grid electricity in Kayonza district discussed based on settlement arrangement, public facilities, service delivering of companies and cost to the citizens, indicated that the cost is still higher tend to negative slope coefficient (-0.109). Which has adverse impacts to socio-economic development in district. The switch to off grid electricity can have a beneficial impact on local communities' per-capita demand. According to research done in Latvia by [14], rising electricity costs have a direct effect on industry energy costs, which raises the cost of production and also [12], the transition to off grid lighting improved the prosperity of local businesses by lowering costs and boosting foot traffic and sales

to better lighting and longer hours. Similar to this, [6] stated that the increased hours and perceived security provided by off grid products can draw more customers from neighboring towns, increasing the volume of goods sold.

The results indicated that electrical power in Kayonza district enhanced employment creation to households mostly on the users of machineries enhances labor efficiency 4.82, 0.56. Which making it possible for households to produce products and services that require appliances, it promoted the establishment of new businesses [8]. This backs up the finding by [15] that access to electricity creates opportunities for income generation inside the house and allows for new types of jobs outside the home, potentially increasing the demand for labor and for self-employment.

The average mean of respondents on the statements regarding the income and savings of households located in kayonza district has increased at a very high extent with an average mean of 4.34, 1.16. which is discussed as a mean and standard deviation, provided strong evidence of the existence of fact and heterogeneity response. Electrification may result in rising hours of working of a family overall appreciation on improved lighting and protection. The study's results are consistent with those of [9], who confirmed that having access to electricity increased household work, income, or both, which enhanced well-being.

5. Conclusion

The conclusion based on value of mean, standard deviation and regression factor of interdependent of variables, at which on high value of mean indicated the most popular but efficiently on lowest value on standard deviation. The willingness of companies on management of off grid electrical supply company in helping customers resolve challenges that relate to the optimum utilization of electricity services 4.60, 0.84 while on grid reg replaced automatically all dysfunction electricity equipment at time 4.32, 1.15. Therefore, empirical evidence to back the idea that electrified public facilities offer better services in Kayonza district but efficiently on off grid than on grid managed by reg. The price of electricity in Kayonza district favorized the investors in but still a challenge to the users on paying bills on mean and standard deviation indicators 4.54, 4.16 and 0.96, 1.25 respectively.

The results showed that using electricity services in terms of job creation improved the socioeconomic development of households in the Mwiri and Ndego sector in the Kayonza district, with an average mean of 4.49; with an extremely high mean of 4.34 for income and savings and a high mean of 4.10 for access to educational facilities; healthcare access is very high, with a mean of 4.30, and household wealth is strong, with a mean of 4.39; the majority of respondents (68.7%) firmly agreed that they started their business within the past three years as a result of rural electrification; the very high mean score of 4.31 indicates that 63.4% of respondents firmly concur that using electricity increases income growth because it lowers business costs ; 66.4% of respondents firmly agreed, as evidenced by a very high mean score of 4.48.

According to the findings, off grid electrical power use and accessibility have a substantial beneficial impact on the socioeconomic development of households in kayonza district, where there are reliable electrical power services as indicated by($\beta 1 = 0.313$, p-value=0.000<0.05,); ($\beta 3 = 0.185$, p-value=0.001<0.05) which suggests that a unit increase in reliable electrical power

services, use of off grid electrical energy, and accessibility of off grid electrical power will lead to an increase of 0.313 and 0.185 units in the socio-economic development of households in the kayonza district. However, the cost of off grid electrical power has a significant negative effect on the socio-economic development of households in the kayonza district as indicated by β2= -0.109, p-value=0.00. The Rwandan government must find answers to the various issues preventing the expansion of the services in order to increase access to electricity for more people living in rural areas while also raising the standard of grid electricity services provided to its customers.

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