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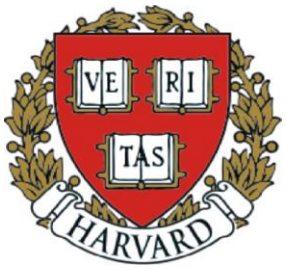

AN ASSESSMENT OF BENEFICIARY PERCEPTIONS ABOUT IMPACTS OF MINI GRIDS BUILT BY RURAL ELECTRIFICATION AGENCY IN SELECTED COMMUNITIES WITHIN NORTH CENTRAL, NIGERIA

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Abstract
The study examines Beneficiary Perceptions on the Impacts of mini-grids built by Rural Electrification Agency in selected communities within North Central Nigeria. A multi-stage sampling technique was adopted to achieve the aim of the study. Questionnaires were

Keywords:
Perceptions, Electricity, Communities, Beneficiaries, Mini-Grids.

INTRODUCTION

Adequate electric power supply is central to the development of all economies and it is viewed as the engine of growth (Joseph, 2014). It is noteworthy that, there exists a linkage between the energy sector and all other sectors of the economy, which gives the energy sector an influential position as a vital element for a range of socio-economic activities and the general wellbeing of an economy (Monzur and Azreen, 2020). This assertion goes ahead to explain why one of the most disturbing economic development issues in Nigeria remains that of poor or zero access to electricity suspected to be caused by widespread institutional inefficiencies (Ogunbiyi and Abiodun, 2015). Achieving improved access to electricity is hampered on many

distributed across the selected sample size based on the number of beneficiaries per community. The results show that 80.9% of respondents within the study area agree that mini-grids improved their productivity and enhanced synergy between the agricultural and non-agricultural sectors since it energized processes such as milling, refrigeration of perishables, powered grinding machines and enhanced packaging activities. Other impacts highlighted include creating an enabling environment for emergence of businesses such as video viewing centers, hair salons, computer centers, grocery stores, cold rooms, welding activities, milling activities and other electricity enhancing businesses. Findings also revealed that electricity improved socio-economic conditions and improved the general quality of life and security within communities. The study further revealed that the performance of mini-grid projects within communities and beneficiary perceptions about the projects differs significantly from community to community even where such projects are executed under the same policy framework or by the same agency. The project perceptions were found to also vary across categories of beneficiaries. The study makes various recommendations including for REA to ensure PPP agreements incorporate accurate load analysis for appropriate plant sizing and proper load distribution, for greater efficiency of the initiative.

fronts, but the most disturbing obstacle remains huge project costs and limited finance that have led governments, financiers and other stakeholders to innovative ideas and approaches at providing funding for electricity projects and improving efficiency in quality and sustainability of services.

In India a study on perceptions towards solar mini-grid systems adopted a multi-stakeholder analysis to identify and assess the perspectives of four key stakeholder groups towards solar mini-grids in rural India, including policy makers, grid developers and operators, development organizations and national grid representatives (Sachiko et al. 2019) and identified their attitudes towards electricity policy, the underlying context for mini-grid development, the role of mini-grids in rural electrification and the inclusion of mini-grid system within the larger framework of electricity sector policies and the result indicates that stakeholders agree that mini-grids as a rural electricity service are currently a viable source of power to complement the national grid due to their high reliability and performance in rural areas.

In a similar study by Nanen and Kama (2022), that accessed beneficiaries of Off-grid electricity and average capacity of energy consumed per month in selected communities within North Central Nigeria establishing that, most beneficiaries use electricity from the mini-grids for low load activities such as lighting, television, radio, charging of telephones and powering of computers with only a small fraction using electricity for cooking and other high load consuming activities.

MATERIALS AND METHODS

Study Area

The study area is the North central part of Nigeria with the scope limited to five out of the seven states, namely Kogi, Niger, FCT, Benue and Plateau. North central Nigeria lies within Guinea Savanna and it is between latitude 14^0 and 16^0 North of the Equator and longitude 12^0 and 13^0 East of the Greenwich Meridian.

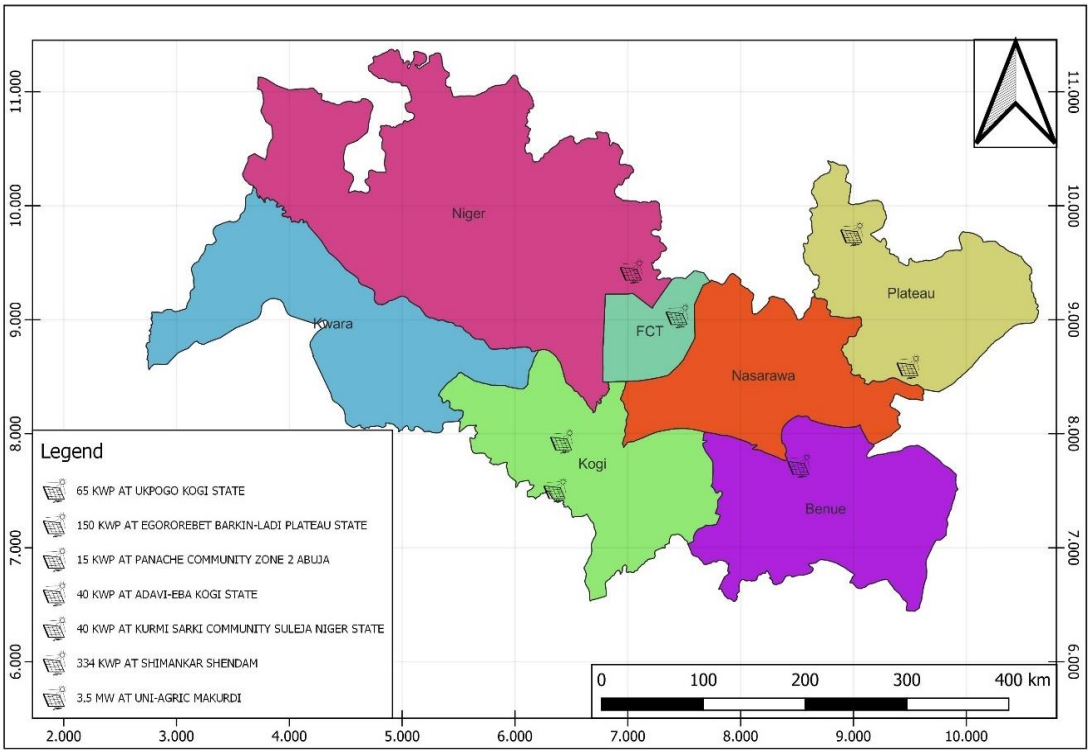

Figure 3.1: Location of Rural Electrification Agency mini-grids in North Central, Nigeria

Source: Authors fieldwork, 2021.

Population and Socio-Economic Activities

The NC geopolitical zone, otherwise referred to as Middle-belt has a population of approximately 20,051,966.00 people (NPC population forecast 2006-2016). This is a total estimate from Benue, Kogi, Nassarawa, Plateau, FCT and Niger State

that make up the zone. This, according to the estimates is broken down as Benue-5,741,815; Kogi-4,473,490; Niger-5,556,247; Nasarawa- 3,564,126 and Kwara-3,192,893 (NBS, 2017). There are a total of 121 Local Government Areas spread across the states in this geopolitical zone. The zone is made up of different tribes, religions and ethnic groups. The predominant tribes include, Tiv, Idoma, Igede in Benue; Igala, Ebira, Okun in Kogi, Yoruba, Okun, Ebira in Kwara; Nupe, Gbagyi, Hausa in Niger; Birom, Angas, Kwalla, Buji in Plateau, amongst others. The mainstay of the economy of North Central Nigeria geopolitical zone is Agriculture with the production of varieties of food and cash crops throughout the year including fishing activities around the rivers Benue and Niger and the many tributaries within the zone.

Farming: Farming is the dominant occupation of the people of the NC, with rich guinea savanna soil, adequate durations of sunlight and rainfall within the year. Agricultural activities are greatly enhanced with the presence of rivers Benue and Niger. The soil in the geopolitical zone varies in texture and color, however have proven to be very fertile and moist. Crop production across the geopolitical zone include Yam, beans, soya beans, maize, rice, wheat, millet, sesame seed, sugar cane, cassava, orange orchards, bananas, groundnuts, and potatoes. Economic trees such as mangoes, cashew and palm kernel are also grown in large numbers in the zone.

Fishing: The zone is blessed with two major Nigerian rivers, Benue and Niger with multiple tributaries of various depth and width extending various kilometers across the zone. This makes fishing a major activity, especially among the people along the river banks.

Trade and Commerce: There is a high volume of trading and commercial activities on a daily basis across the NC, such as retail and wholesale of goods including fish and farm produce. Other businesses across the zone include tailoring, barber shops, hairdressing salons, restaurants, hotels, pubs, clubs, electronic sales, block industries, car wash, laundry services etc. There are street shops along major roads and streets across the zone and also the presence of major markets ranging from large rural farmers markets to central markets.

Study Design

The study adopts a mixed method approach which involves qualitative and quantitative data collection. Quantitative data was extracted through structured questionnaires from which relevant information on socio-economic impact and beneficiary perceptions on the Impacts of the Rural Electrification scheme. While qualitative data was collected through key informant interview of stakeholders, community leaders and representatives.

Methods of Data Collection

Data was obtained through the use of questionnaires and key informant interview, while graphs and charts were used to present results and to assess the number of Beneficiary Perceptions on the Impacts of Rural Electrification Agency

Mini-grids. In respect of key stakeholder interview from which relevant data for the study were extracted, the selected persons comprised a mix of members of the public and private sector participants, including officials of the REA of Nigeria, host community leadership/traditional heads.

Sampling Technique and Data Analysis

A multi-stage sampling technique was adopted for this study, whereby purposive selection of all the projects executed by REA between 2016 and 2021 in North Central Nigeria were picked from the total number of projects executed by the Agency across the 6 geopolitical zones in Nigeria. The study selects all the mini-grids developed and commissioned by the REA in the study area in-order to achieve a reflective and realistic sample size. Questionnaires were distributed across the selected sample size based on the number of beneficiaries per community. Also, business operators/owners and community heads were sampled randomly in each host community. Inferential and descriptive statistics alongside quantitative tools were used to achieve the aim of the study while ANOVA was used for data analysis and presentation of results.

RESULTS AND DISCUSSION

The perception of beneficiaries about solar hybrid mini-grid projects executed by REA in communities within the North Central was analyzed using 7 variables as follows; Beneficiary satisfaction with the electricity service, attribution of improvement in quality of life within the communities, improvement in security, improvement in productivity, stimulation of business growth, enhancement of synergy between Agricultural and Non-Agricultural sectors and tariff affordability. The analysis was carried out using ANOVA to analyze beneficiary responses for each mini-grid in the study area. The results indicate that there is a difference in perception across the facilities energized in the study area which include Educational use, Healthcare facility use, Recreational facility use, Residential and Commercial uses.

The study revealed that electrifying each category highlighted above through mini-grids have varying levels of success, impact on the beneficiaries and the society at large. The results of this analysis agree with findings by a study carried out by Bharat Raj Poudel in 2019 on the 'Criteria for sustainable operation of renewable energy based mini-grid services in Nepal', which found that, mini-grids perform differently from community to community even if implemented under apparently the same policy framework, due to peculiar attributes. It also became evident that, at present the solar mini-grid technology seems to be more effective and sustainable for less load consuming activities such as lighting and home

appliance use, than for activities with high load demands such as commercial and productive uses.

ANOVA results obtained from data extracted from beneficiaries of REA mini-grids within North Central Nigeria reveal as follows:

3.5 MW Solar Hybrid Mini-Grid at Federal University of Agriculture, Makurdi, Benue State.

This mini-grid development is an initiative of the Federal Government of Nigeria, driven by the REA to provide sustainable and clean power to Universities and Teaching Hospitals across Nigeria through isolated generation sources including solar, Gas and Geo-thermal. This study found that, the institution has been taken off the national grid. ANOVA result on beneficiary perception about the mini-grid indicates a generally good level of project acceptance and beneficiary satisfaction as shown on Table 1, where the P-Value supports evidence of beneficiary enthusiasm, satisfaction, and a desire for project sustainability.

Table 1: ANOVA table on project perception for mini-grid at FUAM

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1.46E11	6	2.43E-12	7.22E- 16	1	2.445259
Within Groups	94034.4	28	3358.371			
Total	94034.4	34				
Source: Author's fieldwork,	2022					

40 kWp Solar mini-grid at 250 bed Hospital, Adavi-Eba LGA, Kogi State.

The result of this analysis shows significant level of beneficiary satisfaction with the mini-grid at Adavi-Eba, Okene. According to table 2, the P-Value indicates a generally good perception about the project and its benefits to the staff of the clinic and the beneficiary community, with the hospital presently enjoying almost 24 hours electricity and as a result, improving the work process and services by providing steady power for fridges, laboratory equipment, Security lighting. The result agrees with findings by Joern F. et al in 2021, Evaluation of mini-grids in Tanzania, that isolated mini-grids improved healthcare.

Table 2: ANOVA table on project perception for mini-grid at 250 Bed Hospital, Adavi-Eba, Kogi State.

ANOVA

Source of Variation	***SS***	***Df***	***MS***	***F***	***P-value***	***F crit***
Between Groups	0.171429	6	0.028571	0.000466	1	2.445259
Within Groups	1716.4	28	61.3			
Total	1716.571	34				

Source: Author's fieldwork, 2022

15 kWp Solar mini-grid at Panache Recreational Park, Zone 2, Abuja.

Table 3. The P-Value indicates significance of the result and acceptance of the alternative hypothesis that beneficiaries of a mini-grid provided at a recreational facility in Panache community Zone 2, Abuja have a good perception about the initiative and agree that it is beneficial, improved the social wellbeing of the community, enhanced fitness and recreation and the flood lighting provided at the facility improved the general security of the neighborhood.

Table 3: ANOVA table on project perception for mini-grid at Panache Park

ANOVA

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	-2.3E-13	6	-3.8E-14	-6.5E-16	1	2.445259
Within Groups	1622.4	28	57.94286			
Total	1622.4	34				

Source: Author's fieldwork, 2021

334 kWp Solar Hybrid Mini-grid at Shimankar, Shendam LGA, Plateau State.

The P-Value result on Table 4. Is significant indicating low perception and dissatisfaction amongst beneficiaries within the community, especially commercial and productive users of the mini-grid. Productive users had more reservations and complaints about the electricity supply. This result indicates that there is a significant difference in performance of the plants and also beneficiary perception about the electricity interventions from facility to facility.

Table 4: ANOVA table on project perception for mini-grid at Shimankar, Plateau State

ANOVA

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.171429	6	0.028571	0.000718	1	2.445259
Within Groups	1114	28	39.78571			
Total	1114.171	34				

Source: Author's fieldwork, 2021

40 kWp Solar Hybrid Mini-grid at Kurmi Sarki, Suleja, Niger State.

The mini-grid is strictly for residential use and street lighting and the P-Value on Table 5 indicates that, there is a significant relationship. This implies that the impact of the project and beneficiary perception is good. The stud further suggests that perception and enthusiasm remained good because the plant only augments

electricity supply from the national grid and beneficiaries are only expected to cover costs of connection and participate in plant maintenance through an electricity cooperative user's society.

Table 5: ANOVA table on project perception for mini-grid at Kurmi Sarki, Suleja, Niger State

ANOVA

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0	6	0	0	1	2.445259
Within Groups	1370	28	48.92857			
Total	1370	34				

Source: Author's fieldwork, 2022

150 kWp Solar Mini-grid at Egororebet, Barkinladi, Plateau State

The result of this analysis indicates a significant relationship, implying that the perception about the project and its benefits to the community is poor. The result as presented on Table 6. Indicates that (p-Value=1) is based on the variables analyzed but it does not satisfy the response of beneficiaries about their satisfaction with the mini-grid service. This result aligns with the dissatisfaction expressed by the respondents within the study area. Although the project does not attract bill payment, it evidently has minimal success and impact on the community. This finding agrees with a study by Pranesh K.D and Iain M. in 2013, carried out to address issues related to hybrid mini-grid failures in Fiji, revealing that the common causes of failure of mini-grids include poor system design, lack of proper documentation of systems, lack of comprehensive template for operation and maintenance and failure to incorporate lessons from previous projects.

Table 6: ANOVA table on project perception for mini-grid at Egororebet, Plateau State.

ANOVA

Source of Variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0	6	0	0	1	2.445259
Within Groups	1752	28	62.57143			
Total	1752	34				

Source: Author's fieldwork, 2022

Challenges faced by Rural Electrification Agency in its Mandate to Electrify Rural Communities

The challenges faced by REA were mostly extracted during Focus Group Discussion and Key Informant Interview of select staff and Management of the agency as prescribed in the methodology of the study.

During discussion, the Executive Director-REA and his team stated that, the remote nature of most non-electrified rural areas is a major problem and this problem is a recurrent type featuring all through the project lifecycle because it is vital to carryout periodic site visitation throughout the project lifecycle to ascertain the functionality of plants, interact with end users, track problems and proffer solutions. They also mentioned the problem of funding due to inadequate budget allocation by the National Assembly to accelerate rural electrification across the country and close the electrification gap. Also, high interest rates by lending institutions results to high Levelized Cost of Electricity (LCOE) resulting to high tariffs to beneficiaries as a means of cost recovery. This is a serious issue because most remote areas are characterized by low ability to pay for services with their most common use for electricity been for lighting and other low load activities with minimal productive uses.

Other challenges faced by the agency include, limited research about mini-grids to expose the post commissioning challenges, the problem of ensuring long term commitment of mini-grid developers observed to be less concerned about post development operation and maintenance. Another challenge is the rising spate of insecurity across the nation that increases the risk of site visitation to include kidnapping, armed robbery attacks, terror attacks and banditry. Lack of claimed technical expertise and commitment on the part of developers and the use of substandard equipment or components despite efforts by the REA to ensure adherence to prescribed standards. Another challenge is the issue of component repair or replacement that sometimes requires specific specialty and technicians that are not within the communities or cases where repairs require spare parts that are not manufactured locally. This results to a slow pace of problem redressal and long periods of service downtime.

The challenges can be summarized as follows.

1. The remote nature of most non-electrified rural areas makes them difficult to access during development, periodic maintenance and inspection throughout the project lifecycle.
2. Inadequate funding of the REA by the Federal Government of Nigeria.
3. High interest rates charged by lending institutions resulting to high levelized cost of electricity (LCOE) and consequently to high tariffs.
4. Limited research on impact and sustainability of mini-grids.
5. The problem of ensuring long term commitment of plant developers and consultants.
6. Importation of substandard components and spares by consultants and dealers.
7. Insufficient technicians and experts.
8. Increased spate of insecurity within the country, especially in rural areas.

9. Low ability to pay, low economic activities and insufficient productive use of electricity by most rural inhabitants.

CONCLUSION AND RECOMMENDATION

The general perception about the success of mini-grids within the study area is that it has led to improvement in quality of life, improved sense of belonging within the communities and a feeling of satisfaction with many beneficiaries enjoying constant electric power supply. This is despite the loud dissenting voices of dissatisfaction with the quality of service, the study established that most beneficiaries concede that mini grids improve security, healthcare delivery, extended productive hours of the day into the night. Such productive activities as tailoring and rice milling can also operate at night. The stud recommended that REA should ensure PPP agreements incorporate accurate load analysis for appropriate plant sizing and proper load distribution as the first right step towards achieving greater efficiency of mini-grids. SON and NEMSA should partner with Nigerian Immigration Service to improve security at all entry points into the country to prevent entry of sub-standard solar equipment and spares into the country. Also, REA should ensure incorporation of post-development appraisal in their strategy to be carried out at least once every year.

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