Pilot Solar-PV Rural Electrification Scheme for Isalu Community in Ota Nigeria

T. M. John, H. E. Orovwode, S. T. Wara

Department of Electrical and Information Engineering
Covenant University Ota, Nigeria

***Corresponding author: temitope.john@stu.cu.edu.ng**

ABSTRACT

This paper discusses an overview and field experience of a pilot rural electrification project which took place at Isalu Community, Ota, Nigeria. This community is energy insufficient and rely mainly on self-generated power from mini – petrol engine and medium – diesel powered generators. They are not connected to the National grid and this may not happen in two decades from now. The first stage of the pilot project involved accessing the feasibility of the project and performing a load audit. This community wide initiative saw to the phasing out of kerosene lanterns, incandescent light bulbs and other fossil based energy sources. The community was enlightened about the different alternative (renewable) sources available to them. Furthermore, the community was introduced to different solar products that outperformed the currently exploited energy sources economically and environmentally. A well accepted flexible payment plan was developed for the community. Ninety - nine percent solar electrification was achieved.

INTRODUCTION

One of the objectives of the Renewable Energy Research Cluster of Covenant University Nigeria is to create awareness through a series of sensitization activities on Renewable Energy to Rural Communities in Nigeria and Africa. Access to Electricity is still an overwhelming challenge in Africa. According to the World Energy Outlook (2016), about 95 percent of the world's population living without electricity resides in Sub-Saharan Africa(SSA) and developing Asia. Also, there are 632 million people living in SSA without access to Electricity [1]. The Africa's Panel for Progress estimates that if Africa continues to increase electrification on current trends, universal electricity access for all in Africa would not be until the year 2080 [2]. This bleak projection is a long way off the Sustainable Development Goals (SDGs); which has a more optimistic outlook that by 2030 there should be universal access to electricity in the World [3] according to SDG goal number 7. Nigeria at 56 still struggles with issues pertaining to energy insufficiency. With a population of over 182 million people according to [4], Nigeria has a 55.6% access to electricity. Table 1 gives a comparison between Total Population, Annual Population growth, Total Access to Electricity and Percentage Access to Electricity for both Rural and Urban areas in Nigeria in the year 1990, 2000, 2010 and 2012. In Table 1, it can be

observed that Rural communities in Nigeria have very low electrification rates. In 2012, the ratio of rural to urban electrification in Nigeria was 34.4 to 83.6 respectively.

Some of the contributing factors to Nigeria and SSA's poor developed energy systems includes waste of resources, high dependence on centralized energy systems that favors the rich and bypasses the poor, corruption, energy-sector bureaucracy etc. amongst others. Despite of all these challenges, Africa's poorest people pay one of the highest energy tariffs in the world. The Africa's panel for Progress estimates that about 138 million households in Africa comprises of people who spend US $10 billion yearly on energy related products like candles, charcoal, kerosene and fuelwood (firewood) and live on less than US $2.50 per day [2]. Comparing energy cost between African countries and the United States, the average cost of electricity in the US is US $0.12 per kWh and the in UK is US $0.15, whereas in Africa about US $10 per kWh is spent only on lighting [2].

Table 1: Nigeria: Comparison between Population, Population growth and Access to Electricity

Dataset	**1990**	**2000**	**2010**	**2012**
Population, total	95,617,345	122,876,723	159,424,742	168,240,403
Population growth (annual %)	2.58	2.51	2.68	2.69
Access to Electricity (% of population)	41.83	44.9	48.0	55.6
Access to Electricity (% of Rural population)	25.11	27.9	34.9	34.4
Access to Electricity (% of Urban population)	72.5	68.0	61.6	83.6

Author's compilation based on World bank's data

In the light of the above stated challenges, the following research questions were formulated:

1. Is it possible to create a sustainable (solar PV) electricity generating eco-system with little or no dependence on the National Grid;
2. Is it possible to increase the awareness of energy efficiency and management to rural communities in Africa;
3. Is it possible to increase the awareness of carbon foot print and environmental impact of energy use in communities?

These questions would be answered through a Site survey and rural electrification project which took place at Isalu Community in Ado-Odo, Ota local Government in Ogun State, Nigeria. References would be made based on the data gathered through a series of questionnaire deployed at the location. In this paper, we shall focus on the energy requirements of the people of Isalu Community; this might not be representative of the need of every rural community. Since the research work is ongoing, this paper presents the successes achieved thus far.

This paper is organized as follows: Section 1 gives the Introduction and Background of the study. Section 2 describes the methods used in carrying out this research; Section 3 discusses the results; and Section 4 Concludes the case studies including other activities and Recommendations.

BACKGROUND

In September 2016, the Renewable Energy Research Cluster (RERC) of Covenant University, Nigeria carried out a survey to understand the characteristics and living conditions of households in a selected Rural Community. The subject of the Research was a small community called Isalu in Ado-Odo Ota Local government with a total of 54 households. The span of this research will cover 40 households. The questionnaires deployed were designed to extract as much information on the current energy use of the rural community.

The Research team lead from Covenant University first approached the Community leaders in Isalu and ultimately got the support of the leaders to commence activities. The community leaders then informed the members of the community, to stir up interest within the members of the community.

Volunteers from Covenant University as well as other youths living within the community were trained to administer the questionnaires in the local language of the respondents. This encouraged better participation by the members of the community. The Volunteers worked hand-in-hand with the local youths, who introduced the volunteers to the household; explained the purpose of the visit and then moved on to another household while the interview continued.

Section 2: METHODS

The main thrust of the questionnaires deployed in the community was to gather as much information on the energy consumption and demand pattern of the members of the community, to understudy their awareness and knowledge of using Energy Efficient Devices(EEDs). Also, to discover the readiness of the community to engage Renewable Energy(RE) and Renewable Energy Technologies(RETs) for their energy use. A three-sectioned questionnaire was administered for various reasons as detailed below in section 2a - 2c. Also, a solar charging kiosk developed by the RERC was deployed at the pilot location. The aim of this was to encourage user acceptability and to test the workability of the Solar kiosk; this is detailed in section 2d.

Section 2a discussed the basic information of each household in Isalu to include the size of the household; age range; the earning capacity and occupation of the family head and the type of building envelope.

Section 2b focused on the current energy source for cooking and other electrical needs in the community and the major loads that constitute the largest energy demand in the community.

Section 2c the analyses of the extent of the penetration of energy efficient appliances especially in lighting was undertaken; since it constituted the largest need in the community. Also, the community member's readiness to adopt RE for their electrification needs was explored.

In Section 2d insights to user acceptability of the Solar Kiosk are given.

RESULTS

The results focused majorly on the data collected from the respondents at this point, analyzed using IBM SPSS version 12 as organized in the sections above. More details on the Project would be published as the Light-Up Isalu project progresses.

Section 2a: Isalu Household Characteristics

From the responses, it was discovered that 85.3% of the respondents earned below 18,000 naira (US$59) monthly (assuming 305 naira to 1 dollar [5]) as in Figure 1. Also, 55.9% of the respondents are in the agriculture and other agro - allied businesses like Oil Palm Processing, Corn Processing etc. 20.6% of the respondents are involved with other forms of small businesses like hairdressing and tailoring., Other categories include semi-skilled businesses which accounts for 11.8%. Retired individuals account for 5.9% as seen in Figure 2.

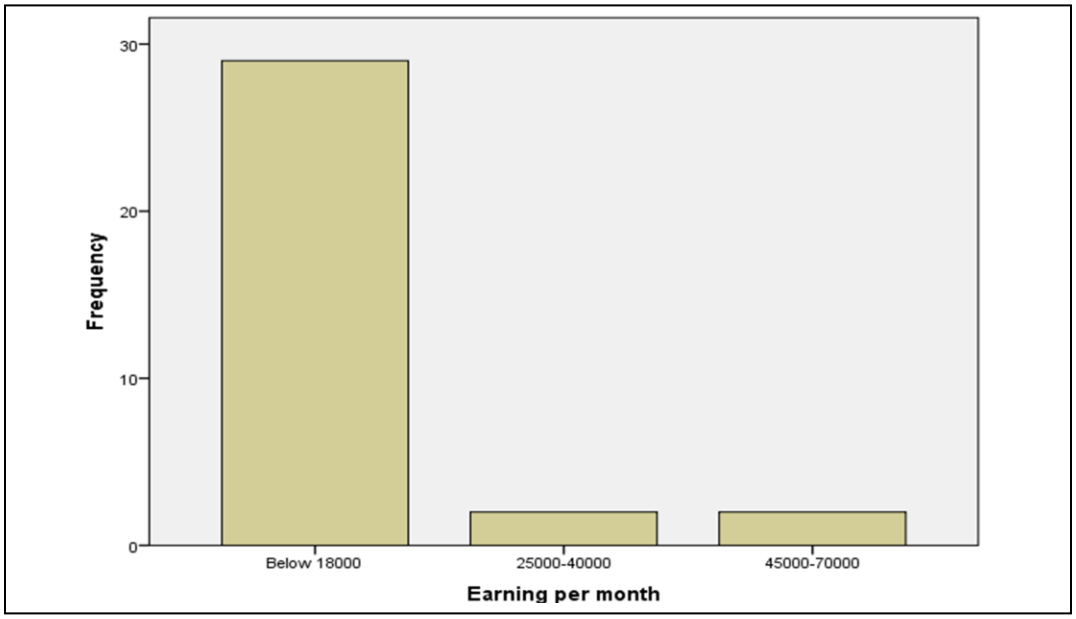

Figure 1: Showing the Earning Capacity of the Household Leader

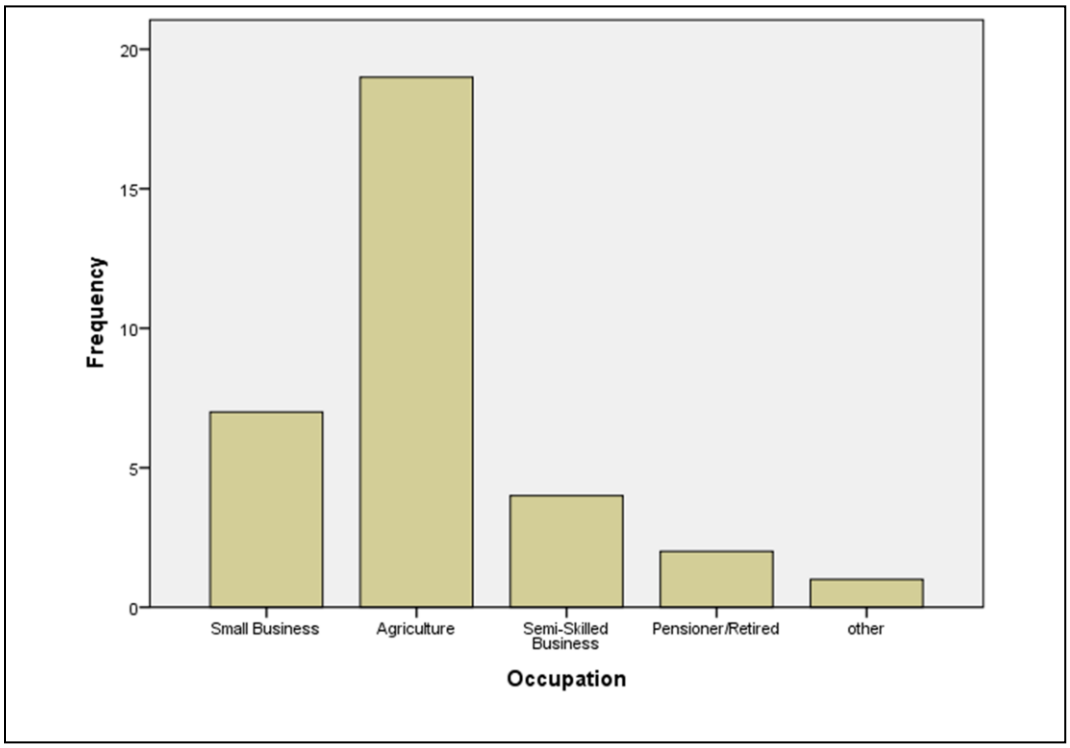

Figure 2: Occupation Favored by the Members of the Isalu Community

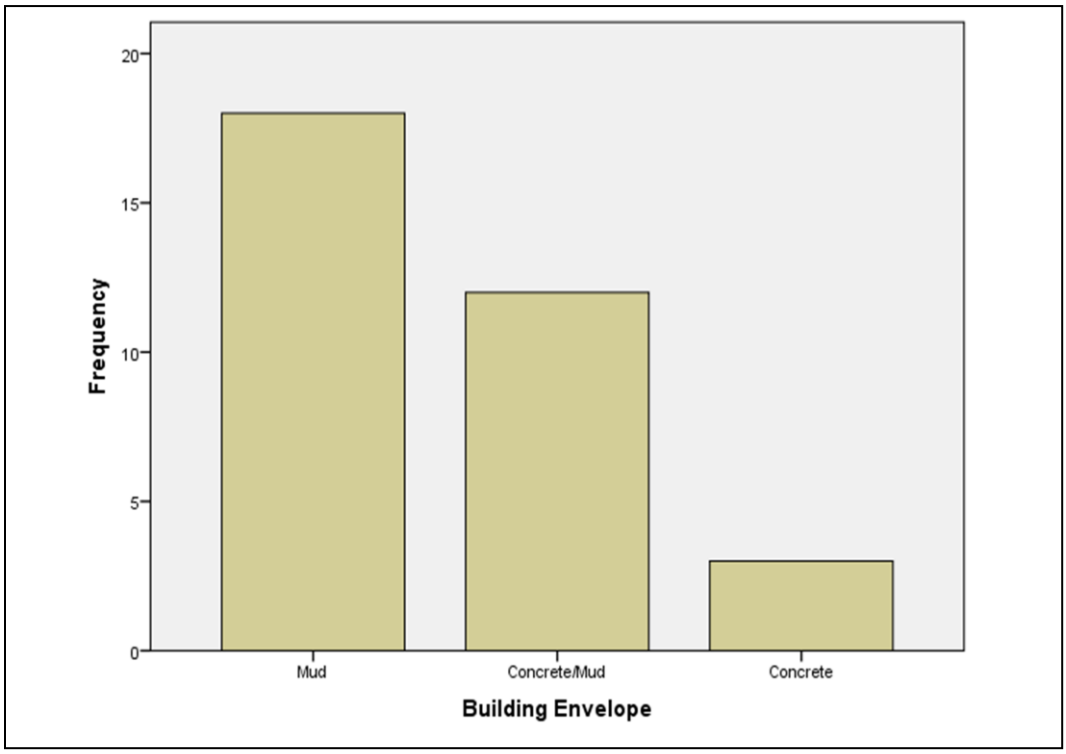

Figure 3: Building Envelope by Members of the Isalu Community

A walk-through audit as well as data retrieved from the questionnaire responses revealed that 55% of the respondents live in mud houses, 37% of the respondents live in mud houses that have been upgraded with concrete plastering, and 8% of the respondents live in concrete houses as shown in Figure 3.

Section 2b: Energy for cooking and Highest load demand in the community

Comparing Table 2 and Table 3, out of 33 households' valid responses; 32 (97.0%) of the household reported to using Firewood for their cooking and 69.7% of the respondents reported to using Kerosene for their cooking. In the other category, 15.2% of the respondents report to using charcoal for their cooking. The bulk of the Firewood used for cooking is fell from the forest in the Isalu locality. This has led to increasing levels of deforestation. Charcoal is prepared by members of the community from the firewood.

Table 2: Case Summary of the Energy Sources for Cooking in Isalu

	Cases					
	Valid		Missing		Total	
	Number	Percent	Number	Percent	Number	Percent
Sources of Energy for Cooking	33	91.7	3	8.3	36	100.0

Table 3: Energy for Cooking Frequencies

		Responses		Percent of Cases
		Number	Percent	
Source of Energy for Cooking	**Firewood**	32	53.3	97.0
	Kerosene	23	38.3	69.7
	Other	5	8.3	15.2
Total		60	100.0	181.8

Table 4 and Table 5 show that out of the 32 valid responses obtained from respondents, Lighting, Phone charging and Television ranked in the top 3 position of the load (appliances) demand in Isalu community with 100%, 81.2% and 56.2 % respectively. This validates previous research that homes in rural communities require electricity for basic needs such as lighting and phone charging [6].

Table 4: Case Summary for Electrical appliances used in Isalu

	Cases					
	Valid		Missing		Total	
	Number	Percent	Number	Percent	Number	Percent
Appliance in the household	32	88.9	4	11.1	36	100.0

Table 5: Home Load Frequencies

		Responses		Percent of Cases
		Number	Percent	
Appliance in the household	**Lighting**	32	30.5	100.0
	Television	18	17.1	56.2
	Phone Charging	26	24.8	81.2
	DVD	13	12.4	40.6
	Radio	13	12.4	40.6
	Clipper	1	1.0	3.1
	Other appliances	2	1.9	6.2
Total		112	100.0	350.0

Section 2c: Analysis of Luminaires Types in the Community

At the beginning of the Pilot project, it was discovered that although the members of the community were located far away from the main city, they had tried to embrace some energy saving culture. In Table 7, 51.9% of the 27 valid responses reported to having Incandescent bulbs in their home while 48.1% of the 27 valid responses reported to having Compact Fluorescent Lamps (CFLs) in their homes.

Table 6: Case Summary of Different Types of Luminaires used in Isalu

	Cases					
	Valid		Missing		Total	
	Number	Percent	Number	Percent	Number	Percent
Types of Luminaires	27	75.0	9	25.0	36	100.0

Table 7: Types of Luminaires Frequencies

		Responses		Percent of Cases
		Number	Percent	
Type of Luminaires	**Incandescent Bulb**	14	35.9	51.9
	Florescent Bulb	1	2.6	3.7
	CFLs	13	33.3	48.1
	Kerosene Lamp	7	17.9	25.9
	LED Lamp	2	5.1	7.4
	Other lamp	2	5.1	7.4
Total		39	100.0	144.4

Section 2d: Solar Kiosk acceptability details

The Solar Charging kiosk (SCK) developed by the RERC was deployed on the 23rd September, 2016. The SCK consists of a metallic frame housing the solar panel on top, batteries, charge controller, and 2- three ports mobile phone charging points. The leaders of the community were engaged in a dialogue to get their buy-in. One field assistant who is a member of the community was engaged to manage the kiosk and its operations.

The field assistant recorded daily logs of the usage of the SCK. The record showed that the usage increase of 800%. The average charging time of a mobile phone using the mobile phone was calculated to be 2 hours and 38 minutes using the SCK. During the first week of the deployment the field assistant reported that the SCK stopped charging mobile phones at about 4PM. Our team of engineers went to the pilot location and fixed the fault. Afterwards we saw increase in usage based on the charging log data.

So far, the SCK has helped to relieve the members of the community on mobile phone charging cost. Before the arrival of the SCK, members of the community usually pay a sum of 70 naira (23 cents USD based on 24th January, 2017 exchange rate [5]). Three members of the community have shown interest in having a SCK for their private business when the trial and testing period is over.

The success of this pilot led to introducing the members of the community to Solar lamps. The Solar lamps have a dual usage as it can be used as both a lamp and a mobile phone charger. Partnering with Quintessential Solar, Nigeria, we were able to begin the process of distributing the Solar lamps on a flexible payment scheme. Interested members of the community, are placed on a payment plan commensurate to their spending capacities. A down payment of 20% is made initially and the remaining 80% is spread over a period of 4-6 months. Field assistants at the location are charged to collect weekly remittances for the product.

More importantly, a Nigerian Bank has shown interest in partnering with the RERC on this community development initiative. It is expected that a local collection center is set up and run by the bank.

Figure 4: Installation of Solar Charging Kiosk

Figure 5: Phone charging process

Figure 6: Showing the solar lamp to a member of the community

Figure 7: Interactions with members of the community

PROJECT CONTINUATION AND SUSTAINABILITY

The RERC plans to:

1. continue work with the Isalu community and spread to adjoining villages within the area;
2. increase capacity by designing and installing Solar home systems for rural communities;
3. begin mass production of Solar products and allied technologies in order to make these technologies readily available to many more communities across Sub-Saharan Africa; and
4. increase capacity by developing training modules for installation of Solar home systems for youths in SSA.

CONCLUSION

In this pilot, we have been able to analyze current energy usage in Isalu community, Ado Odo, Ota, Local Government Area. It was discovered that 91.6% of the members of the community use either firewood, kerosene stoves or both for cooking; 100% of the members of the community required electricity for lighting while 81.2% required electricity for phone charging. These two constituted the most frequently used load in the community.

We saw the widespread acceptance of the SCK deployed in the community, by exposing the members of the community to Solar Power via the SCK and the solar lamps, we saw that the members of the community craved for larger systems that could help power other appliances in their home like the television set, DVD etc.

The Renewable Energy Cluster of Covenant University plan to spread to other communities in the state and eventually replicate the successes accrue from the pilot schemes all over Nigeria. We are looking forward to disrupting the distributed technologies landscape in Africa. By providing the solution at an affordable rate to rural communities in Nigeria.

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