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Impact of Implementing Renewable Energy in Power Distribution and Agriculture on Achievement of Sustainable Development Goals (SDGs) in Africa: Case Study of Northern Nigeria

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Session 4: Water, Agriculture and the SDGs

Chaired by Dr. Abhishek Tiwary, IESD

The potential of implementing renewable energy in power distribution and agriculture on achievement of Sustainable Development Goals (SDGs): A baseline study of Northern Nigeria

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Abstract

Agriculture in Africa has a massive social and economic footprint. More than 80 percent of the population of sub-Saharan Africa is smallholder farmers, and about 23 percent of sub-Saharan Africa's GDP comes from agriculture. Yet, Africa's full agricultural potential remains untapped due to some limitations and inefficiencies.

According to the Sustainable Development Goals Report 2019 published by the United Nations, in sub-Saharan Africa, 422 million people still live in extreme poverty; 237 million people live in hunger. In Nigeria, 82 million people are living below the international poverty line ($1.9 per day), and unemployment peaked at 23.1%. As a result, businesses such as utility companies are suffering with collection of bills. The distribution of poverty is greater in underdeveloped rural areas where infrastructure is limited. For example, electricity access is only 41%. In the case of Kaduna Electricity Distribution Company (KAEDCO), customer payments to the company are also low at 17%. This deficit has a significant impact on the cash balance of KAEDCO. In order to address this a study was performed to investigate ways to improve payments, electricity access and agricultural livelihoods.

The research was conducted in Kano, a city in Northern Nigeria. The study considered the effects of implementing renewable energy with respect to power distribution companies in direct relation to SDG goals number: 1, 2, 7, 8, 11, and 13. As part of the research, a survey of 214 households was undertaken. Data was collected via questionnaires, focus group discussions and stakeholder interviews.

With the data collected having a Cronbach's Alpha score of 0.72, a bivariate analysis was conducted using Spearman's rho correlation analysis to understand the impact of energy via renewable means on the average income of households, level of education, average savings, and carbon emissions. All this was examined from the power distribution point of view. Results showed very strong correlation between energy via renewable means with average income, level of education, average savings and carbon emissions. The rho values were 0.617, 0.514, 0.534 and 0.612 respectively. With such rho values, the study indicated that RE will support agriculture and SDGs.

Keywords: renewable energy, utility companies, agriculture, SDGs,

1. Overview

The Sub-Saharan Africa accounts for more than 1 billion people, approximately 13% of the global population (2020, World Bank Reoprt.). Agriculture is the highest employer of labour, employing more than half of the total labour force [2]. While smallholder farms constitute almost 80% of all farms in the region and directly employs about 175million people, many of which are in the rural areas, it provides livelihood for multitude of small-scale producers. Although agriculture accounts for 23% of the regions GDP [3] in addition to abundance of land, labour force and untapped water, the region is still yet to realize its full agricultural potential. This is due to several reasons.

- **Great unexploited potential for expanding irrigation**: rain-fed irrigation system is the primary means of irrigation in SSA. Of the 183 million hectares of cultivated land, 95% is rain-fed and less than 5% is irrigated using other means. Globally, it is by far the lowest irrigation development rate.
- **Limited use of inputs and slow adoption of improved production technologies**: Despite technological advancements in fertilizer production and application, for over 40 years, SSA has the lowest rate of fertilizer use of any region. Use of other yield-enhancing inputs such as improved crop varieties, pesticides, and mechanization are also limited. Agricultural extension services are also very limited.
- **Low private sector investment**

The lack of full potential exploitation in the agricultural landscape in SSA has contributed in keeping a large percentage of the society poor. According to the World Bank report of 2019 [4], there are over 422 million people living below the poverty line of $1.90 per day as stipulated by the UN. Although the poverty rate has gone down from 54% in 1990 to 41.3% in 2018, there are more people living in poverty. This is due to high population growth during the same period. The population has increased from 278 million in 1990 to 422 million in 2018. 82% of the people living under the poverty line live in rural areas where there is limited infrastructure, and economic activities not as prevalent as in the urban areas. The increase in people lacking financial independence cut straight through into the economic prosperity of their respective countries or regions, albeit negatively. This lack of financial independence is clearly defined in the energy (power) sector as will be seen later in the paper.
Agriculture, Poverty and Energy are 3 out of the 17 cardinal points of action of the United Nations Sustainable Development Goals (SDGs). The complete SDGs range from actions dealing with energy, basic materials, industrials, consumer goods, healthcare, utilities, telecoms, consumer services, financial, and technology.
As a case study, Nigeria, a sub-Saharan country with a population of over 200 million people (highest in Africa) was considered. For the purpose of this study, the power sector was considered. The aim was to investigate why KAEDCO customers do not pay their full electricity bills and investigate the potential of implementing renewable energy in agriculture and power distribution on achievement of sustainable development goals.

2. Research Background

With the largest economy and population in Africa, in Nigeria, agriculture, trade and manufacturing are three of the four largest economic sectors, with the oil sector being the fourth. The three former sectors are predominant in the north while the latter is mainly in the southern part of Nigeria. With a total labour force of 77.5 million people, agriculture employed 37.4 million people (48.2%), trade employed 10.8 million people (14%), and manufacturing 6.2 million people (8%) in 2017. However, poverty is widespread in Nigeria.

The apex statistical body in the country, the National Bureau of Statistics (NBS) listed 41% of the country's population as living below the poverty line [5]. This implies, 82 million people live below $1.9 per day. Unemployment is at an all-time high at 23.1% [6]. This is an increase of 5% from the previous year. While [7] concluded unemployment is accompanied by a rapid deterioration in affective wellbeing, [8] attributed it to loss of income, social problems/alienation, less tax revenue and higher gov't borrowing, inefficient use of resources, and loss of human capital. As a result, the unemployment rate of Nigeria rising to 23.1% will affect both the citizens and the economy of the country negatively. The poverty index is further compounded in the rural areas due to limited infrastructure and low electricity access. Electricity access in rural areas in Nigeria is only 41%. Most of the inhabitants in the rural areas of Nigeria are small scale farmers who cultivate less than a hectare of land and yield just enough to feed themselves and their families. Due to these socio-economic challenges, commerce suffers greatly. An example is the power sector, for example in Northern Nigeria the utility Kaduna Electric has bill collection rates as low as 17%.In the case of Kaduna Electric, a power utility company in Northern Nigeria, collection of bills is as low as 17%.

Kaduna Electric is one out of the 11 power distribution companies created in Nigeria after the sector was privatized in 2014. The companies are at the bottom of the value chain. It is they who interact with the final consumer. As such, cash entry point into the sector is at the distribution level. If liquidity is low at this level, it will affect the entire value chain. The invoice these companies receive on a monthly basis from bulk electricity trader consist of generation and transmission costs. Therefore, they will only be able to pay a certain percentage of what they collect to the bulk trader. At KAEDCO, the aggregate technical, commercial and collection (ATC&C) loss hovers between 71% and 74% from inception to date (2014 – 2020), thus, the company records insurmountable losses. As a result, the company is not able to repay for the energy it buys from generation companies and transmission costs to the transmission company. Upon a closer examination of the company's economic model and survey of the market landscape, it was identified that 90% of its customers are residential customers on the R1 or R2 tariff. R1 and R2 are different categories of customers, categorized based on energy consumption. R1 customers consume 0 – 1kW while R2 consume between 1 – 40 kW daily. Further research identified that 67% of the residential customers are engaged in agriculture for their means of livelihood.

In Nigeria, people engage in agriculture in two different ways. Either by rainfed agriculture or irrigation agriculture. Although farmers employ both methods, irrigation agriculture is practised for the 7 months of dryness and rainfed for the 5 months of rain. During the 7 months of dryness, farmers employ the use of diesel-powered generators to irrigate their farms. In addition to the process being very expensive, it is also not clean. The pumps are usually very old, emit tones of greenhouse gases and require maintenance most of the time. This consumes almost all the meagre financial resources farmers have and leave them

with no savings and sometimes in debt; but, they are left with no option but to continue irrigating their farms the same way as it is their only means of livelihood. However, renewable energy may solve this problem. The country has a solar radiation average of 19.8 MJ/m2/day and average sunshine hours of 6hr/day, see Figure 2.1 [9]. In addition to the fuel being free, clean and requiring minimal maintenance, solar power can be used to generate energy required to pump water for irrigation and drinking, electricity for schools, homes and productive power. Shaaban et al. [10] investigated the potentials of renewable energy in Nigeria and obtained good results in favour of the technology being feasibility. [11] also confirmed the feasibility of renewable energy in Nigeria when conducting an economic evaluation of hybrid energy systems for rural areas in Nigeria. However, this does not come without some challenges as [12] listed regulatory policies, finance and market size, technological knowhow, institutional problem and socio cultural habits as some of the challenges to overcome. But, all together, the pros outweigh the cons. As the SDGs are also targeted at alleviating poverty, increasing energy access and eradicating hunger, the deployment of RET in Nigeria would further help to achieve the objectives of the SDGs.

The paper presents the methodological basis for the study that was undertaken. The results are presented and analysed to establish the potential for developing renewable energy in the region. Conclusions are drawn to the effectiveness of the objectives of the research.

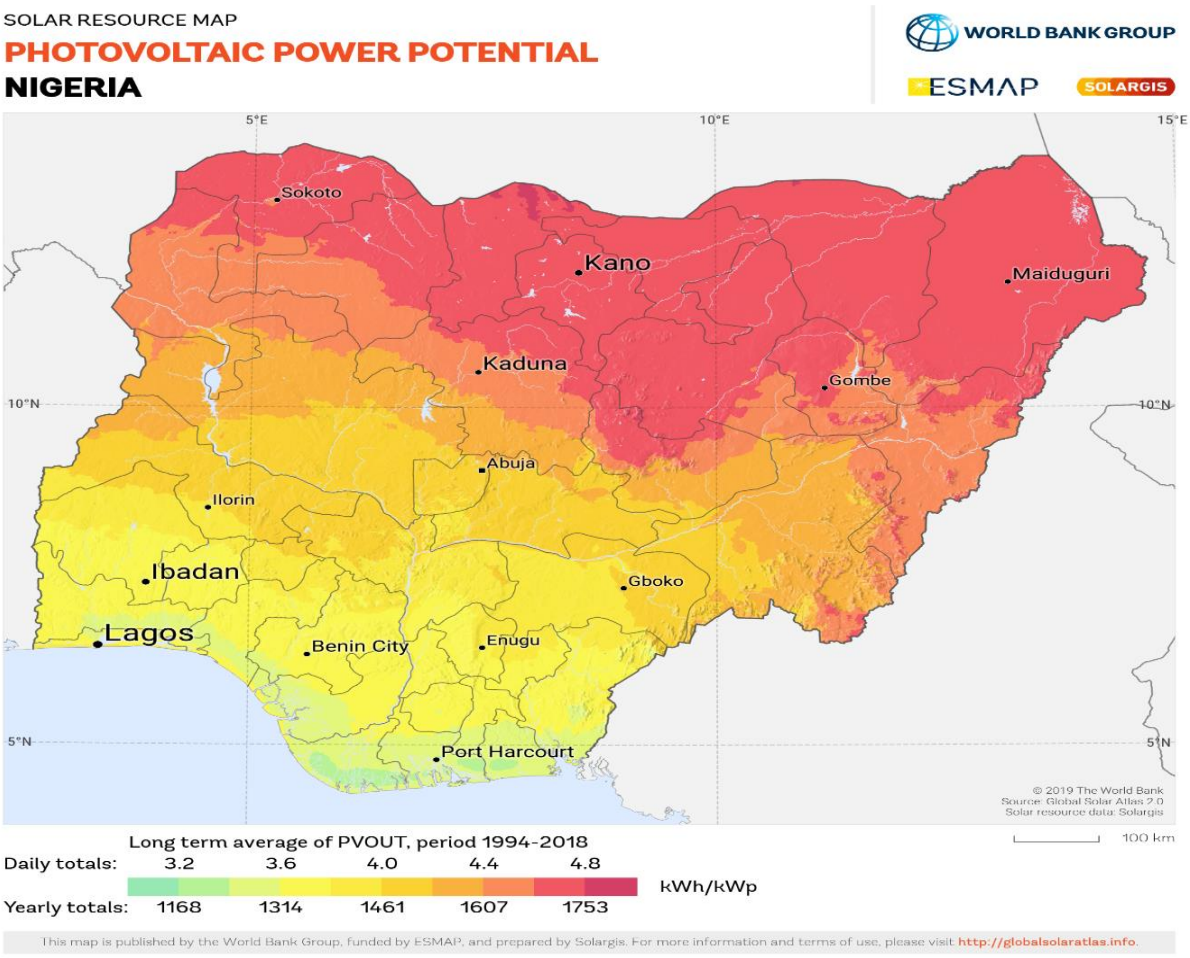

Fig 2. 1 Nigeria Solar Resource Map [9]

3. Aims and Objectives of the Project

When renewable energy is talked about, the main area of interest is in clean energy generation. Not much emphasis is given to the socio-economic aspect renewable energy plays in the area of power distribution and financial independence.
The aim of the study was to investigate why KAEDCO customers do not pay their full electricity bills.

The objectives were to investigate the current demographic and socio-economic situation in the KAEDCO area and evaluate the potential for renewable energy to improve payments to the power utility.

4. Research Methodology and Design

To achieve the aim of the study, the willingness and ability of people to pay for a service or commodity had to be established. This was done by adopting a mixed methods approach. To elicit customers' response, the contingent valuation method (CVM) was combined with the choice experiment (CE) method [13]. This was done to minimize the bias which may arise from adopting the CVM alone. In CVM, the common elicitation approach is the two-alternative (referendum), so certain key information might be missing if adoptedly solely. In CE, a series of questions with more than two alternatives are designed to elicit responses that allow the estimation of preferences. So, combining CVM with CE covered for the gap in the CVM. As a result, a carefully designed survey questionnaire was developed. Both qualitative and quantitative data was gathered while conducting the field study. A descriptive and statistical analysis software, SPSS, was used to conduct a quantitative analysis, whereas, thematic and stakeholder analysis using NVivo was used to analyse the qualitative data.

4.1 Research Setting

Kaduna Electricity Distribution Company being one of the power distribution companies covers four states in the North Western part of Nigeria, namely Kaduna, Sokoto, Zamfara, and Kebbi states. The study was carried out in two Local Government Areas (LGAs) of Dawakin Kudu and Dala in Kano state. These locations were chosen due to their high energy consumption and low repayment rate, see Figure 4.1

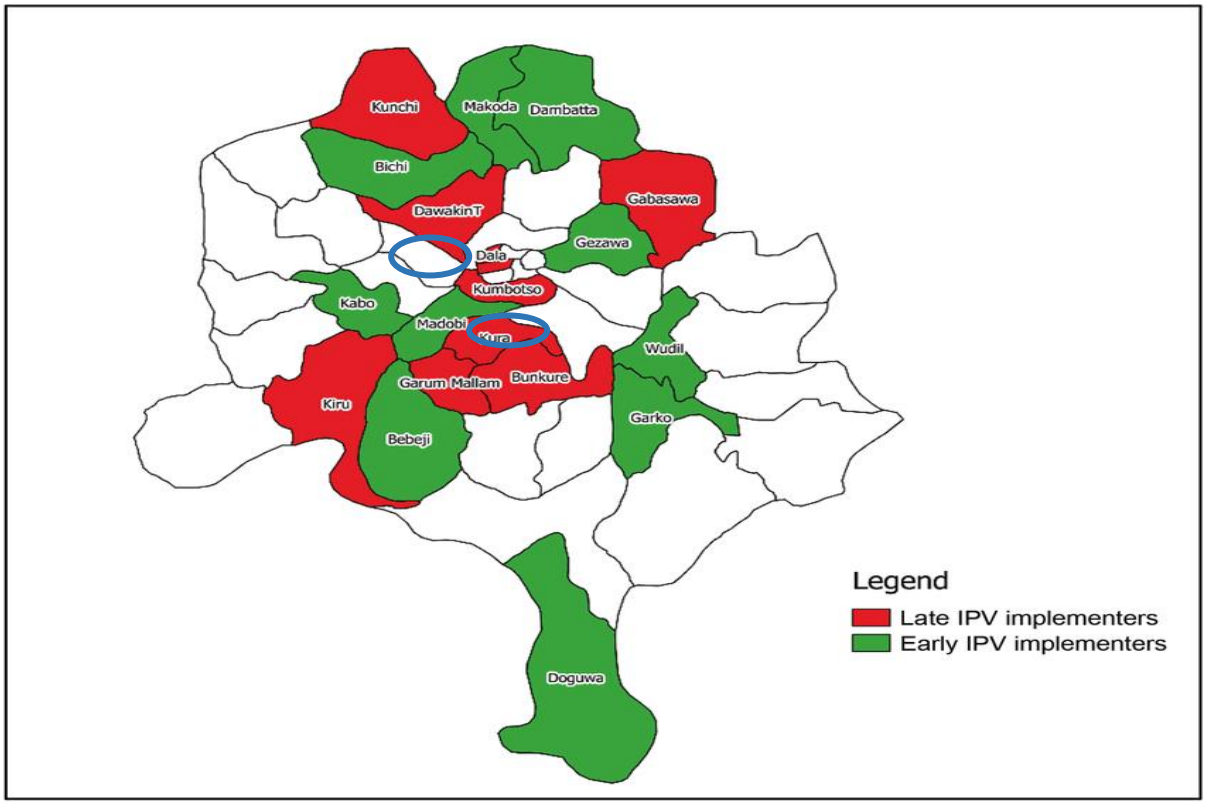

Fig 4.1 Map of Kano showing study locations [11]

4.2 Sampling technique and sample size calculation

Selecting a suitable technique(s) is integral to the overall success of a study. Bias is reduced or increased via the selection of a suitable technique or otherwise. As explained by [14], in studies where the population targeted by researchers cannot be easily listed for sampling purposes, the multi-stage clustering technique is the most ideal. This sampling technique is frequently employed where it is uneconomic to carry out surveys with individuals scattered all over the area. Simple random sampling could be employed to achieve the objective of the survey as well, however, given the nature of the geographical area being very vast (380 km^2) and with limited resources and time available, the multi-stage clustering sample was more ideal and was adopted.

To calculate the sample size, The United Nation's proposed method for sample size calculation [15] was used to determine the optimal sample size of the target population for the study. It was adopted because it considered multiple parameters such as proportion of total population accounted for by the target population, average household size, and rate of non-response.

4.3 Administering Questionnaire to Respondents and Observations

At the development stage of the study, administering questionnaires digitally (via phones or online) was thought about. However, some challenges were identified which made it not feasible. About 57% of the study's subjects do not have any means of secular education. The fact that only 43% of people in North West Nigeria aged between 20 – 60 years of age have ever been to school presents perhaps the largest educational challenge in the world [16]. A unique characteristic is that most of the people are exposed to a non-formal religious education system that has been established for centuries across West Africa. Another angle was that the penetration of mobile phones and internet access was less than 50%. As a result, the face-to-face approach was adopted for the questionnaire administration.

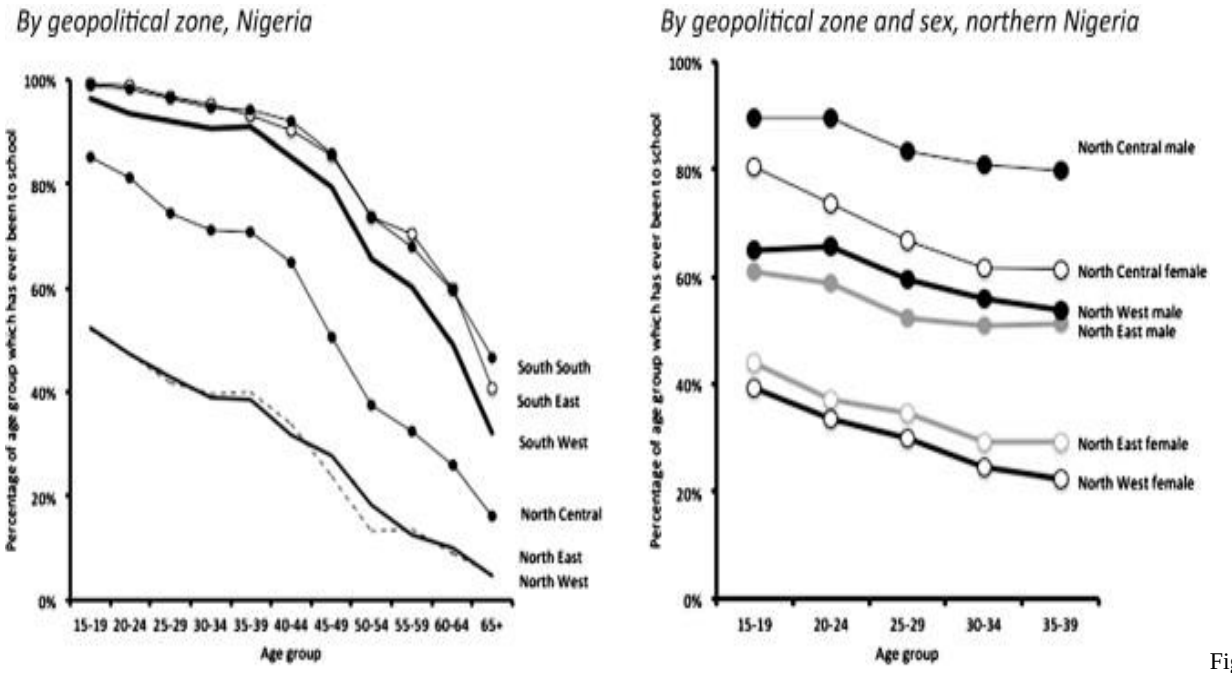

Figure 4.2

Percentage of Nigerian population who have ever attended school. Source: Analysis based on the 2008 Nigeria Demographic and Health Survey [16]

Fig 4.3 Face to face interview in progress

5 Data Analysis and Results

Upon completion of the survey, data was collected from a total of 214 respondents. 150 (70%) of the subjects reported their means of livelihood from agriculture. The data was transferred onto the computer and analysed using analytical tools.

5.1 Data Validity and Reliability

In analysing a data set, the reliability and validity of the data are very important. [17] suggest the two to be critical and significant in the scale-evaluation process. SPSS was used to measure the reliability of the data set obtained using the Cronbach's Alpha test. [18], [19] suggested a Cronbach's Alpha score of 0.7

as good, 0.8 as better and 0.9 as best. The Cronbach's Alpha score for the data obtained was 0.72. This qualifies the questionnaire as good.

External validity for the study was conducted by comparing the study's results with similar studies and existing literature available in the public domain. The questionnaire and statistical tool (SPSS) used for analysis also adds to the validity and reliability of the study.

5.2 Results

5.2.1 Main occupation data

Available data on KAEDCO customers' occupation indicated that 70% of the company's customers on the R2 tariff are directly or indirectly involved with agriculture [20]. Data and results obtained from the study further reinforces the claim by KAEDCO. As illustrated in Fig 5.1 agriculture related activities account for 67.28% of the sample size. 52.80% engage in small scale farming, 9.81% subsistence agriculture, while 4.67% engage in commercial agriculture. The main agricultural produce cultivated in the area are rice, maize, millet and groundnut. The source of income for households comes mainly from the agricultural sector. Agriculture contributed 24.4% to the GDP in 2017 [21]. It is the largest non-oil contributor to the GDP. As of 2011, agriculture provided employment for about 65% of labour force in Nigeria [22]. This further coincide with the percentage in this study. With a large percentage of the citizens directly or indirectly relying on agriculture for their source of income, it provides an avenue for power distribution companies to capitalize on that sector to increase citizens' earning.

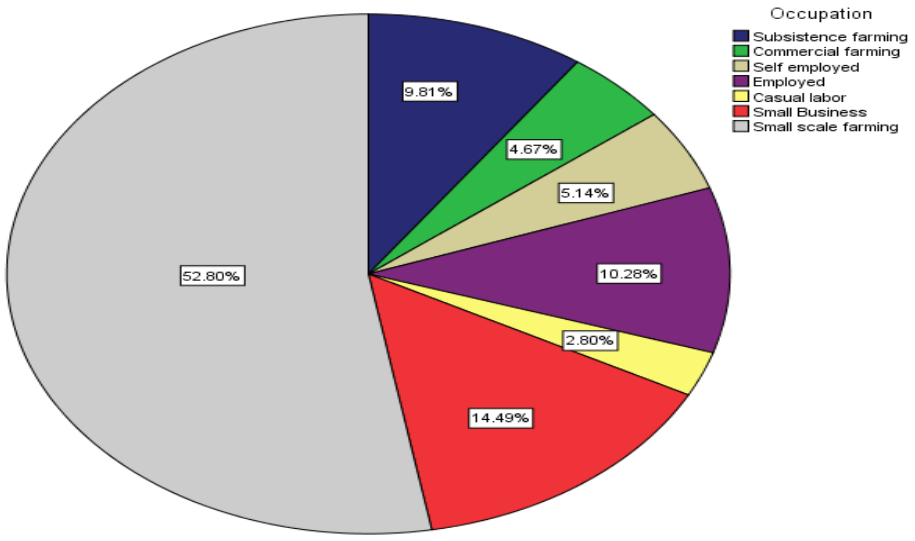

Figure 5.1: Main occupation of household, n=214

5.2.2 Farm operations structure and expenditure

With 144 (67.75%) respondents out of 214 mentioning agriculture as their main source of income, their operations and expenditure were examined in the study. 133 respondents indicated to be using diesel powered generators to irrigate their farms. This practice emits tonnes of CO_2 into the atmosphere. Sagar Adhikari et al [23] studied the characterizing emissions from agricultural diesel pumps in Nepal. They highlighted some characteristics (age, size, maintenance and fuel mixture use) and estimated their impact on emissions. They found the emission factor (EF) for pollutants varied in the range of 2.67–80.33 g/L (PM2.5), 0.24–5.86 g/L (BC); 424–2592 g/L (CO2); 39.1–1418.9 g/L (CO). Work is currently in progress to estimate the EF of the farmers in the study. Implementing a PV system will eliminate the emission of the greenhouse gases and help achieve the SDG target on affordable and clean energy.
Further studies are in progress to identify the frequency at which farmers irrigate their farms on a monthly basis, and the cost element involved due to renting of pumps, maintenance, and fuelling.

5.2.3 Income Profile analysis

Household income of farmers is quite low. To validate how much respondents pay for their energy bill, it was found necessary to collect both the income and expenditure profile of the households surveyed. Fig 5.2 illustrates the monthly saving as a function of average income and monthly spending. 98 (68%) respondents had an average income of $50 and below, and a monthly spending of $50 and below. Consequently, that lead to a monthly saving of ***$50 and below***. The only respondents with some sort of savings were the commercial farmers who had an average income of $300 and above monthly.

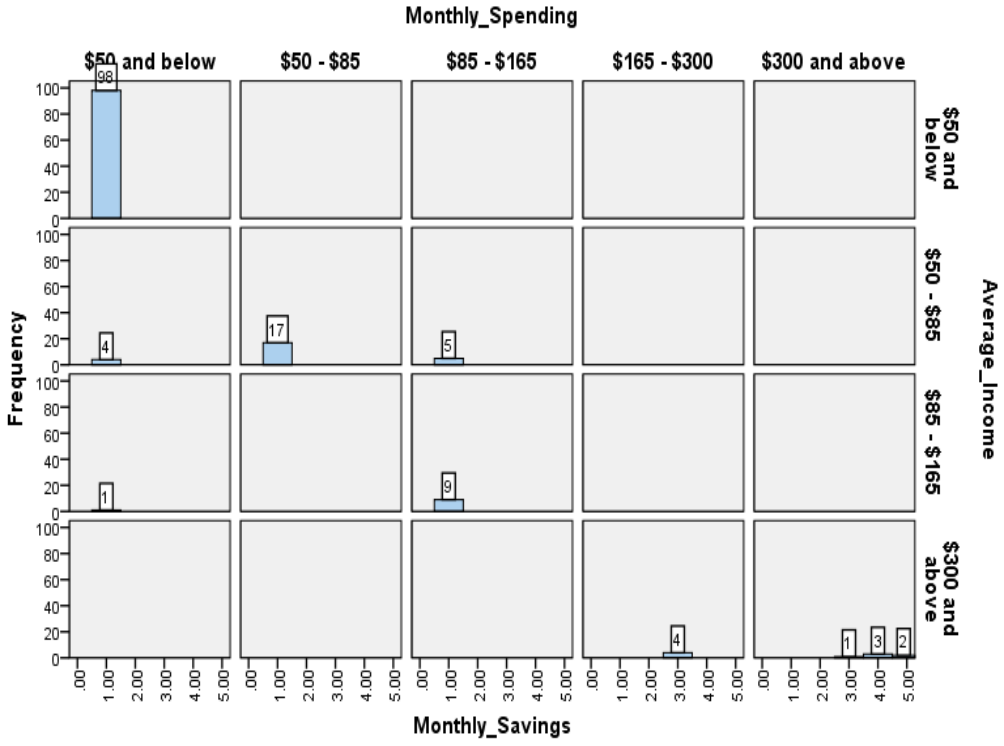

Fig 5.2: Occupation, average income and monthly savings of farmers

Evidently from the Fig 5.2, only 10 respondents out of 144 had some sort of savings. All the 10 responds were engaged in commercial farming as opposed to the other 134 who had no savings whatsoever. The general response amongst the 134 respondents was that all their income has gone back into fuelling, maintaining and renting pumps for irrigation purposes. A review of the electricity bill payment of the 134 respondents confirmed the notion that respondents without savings will not be able to pay their electricity bills.

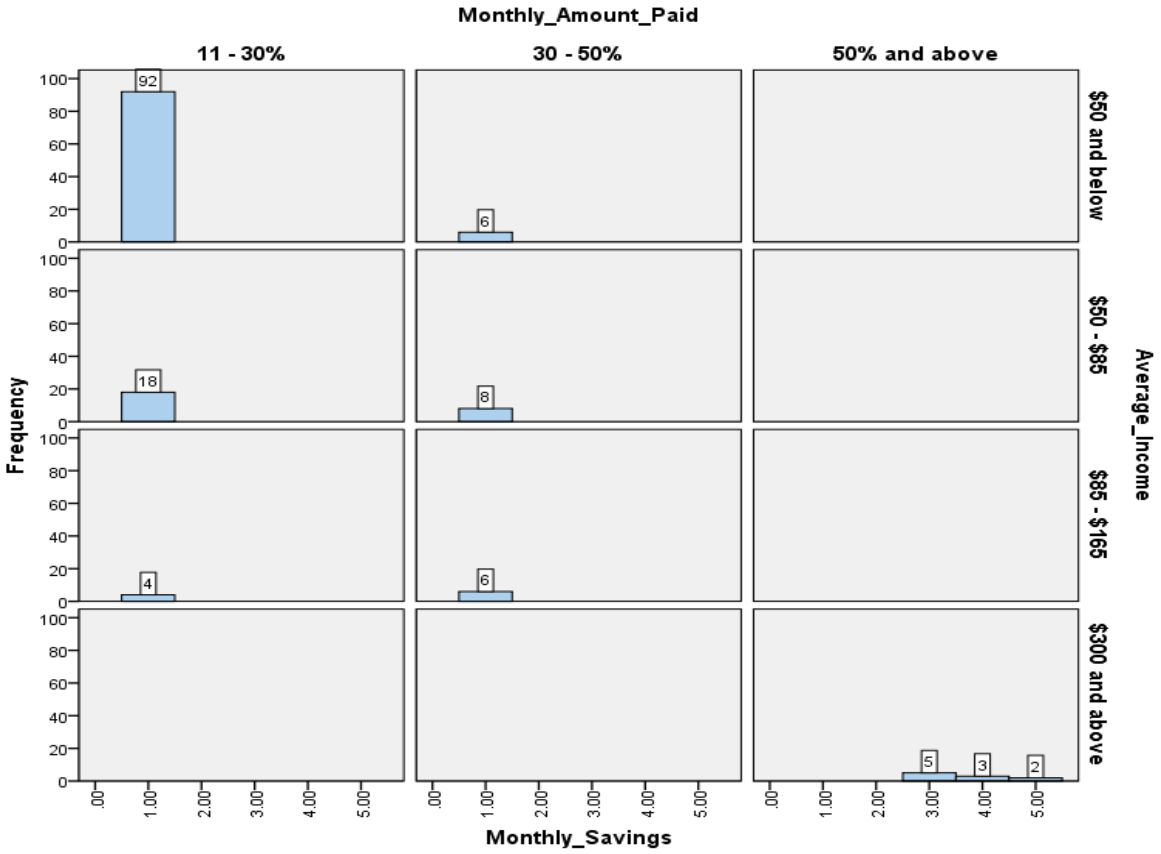

Fig 5.3: Average income, monthly savings, and electricity bill percentage farmers pay

Evidently from Figure 5.3, only the 10 commercial farmers paid 50% and above of their electricity bill. This was not surprising or unexpected judging from the responses of the 134 respondents.

To further understand what influences the payment of bills, a bivariate analysis was conducted using Spearman's rho correlation analysis. The Spearman's rho correlation analysis is a non-parametric analysis method used for measuring association between two variables. The strength of the relationship is measured by the rho value (r). The interpretation of ***r*** is as such: small $r = 0.1$ to 0.29, medium $r = 0.3$ to .49 and large $r = 0.5$ to 1.0 [24].

From the analysis, it was determined that the relationship between monthly amount paid for electricity is strongest with ***monthly savings***, with an ***r value of 0.622***. The next strong relationship is with ***average***

income; that had an ***r value of 0.617***. The last strong correlation between monthly amount paid for electricity was with respondents' ***occupation***. That had ***an r value of 0.493***.
[25] in a study conducted an economic analysis on Solar Desalination System Design for Irrigation/Drinking Water and Electricity Generation in Desert or Arid Areas, and their model established huge savings pumping water using PV compared to utilizing diesel pumps. This confirms a similar system developed for KAEDCO customers engaged in agriculture will decrease the cost they incur to irrigate their farms and increase their savings. This increased savings can then be channelled into electricity bill repayment. This will also help achieve the SDG target on poverty alleviation, zero hunger, and decent work and economic growth.
Work is currently in progress on the economic analysis for KAEDCO and power distribution companies alike to increase collection rate and reduce losses utilizing renewable energy.

6 Conclusion

A study was conducted in Kano, a city in North-West Nigeria to ascertain reasons for low collection efficiency for Kaduna Electricity Distribution Company, and how it can be mitigated to increase liquidity. As a result, the potential of implementing renewable energy in power distribution and agriculture was investigated. The implementation would also help achieve targets 1, 2, 7, 8, 11 and 13 set out by the Sustainable Development Goals. A survey was conducted using a carefully designed questionnaire where both quantitative and qualitative data was collected from KAEDCO's customers. The quantitative data was analysed using SPSS and the qualitative NVivo. This showed 67.2% of KAEDCO's customers are engaged in agriculture. 93% of these customers had no savings. They use most of their financial resources to fuel and maintain diesel-powered pumps for irrigation during 7 months of dry season. As such, they are left with little or nothing to pay for their electricity bills. In addition to the practice being expensive, it is also not eco-friendly. An objective was to establish the potential for people to pay. At this moment it seems only a small number can, so more measures are needed to improve income. This is where RE could come in for water pumping system.

6.1 Further Work

Although work is in progress, it was established that the practices some of KAEDCO's customers employ to irrigate their farms for their means of livelihood pollute the environment. They also expend a lot of money to irrigate the farms, leaving them with little to no savings. And, without savings, they cannot pay their electricity bills. This puts a financial strain on the entire power sector.
However, it was established, with confirmation from multiple studies that employing renewable energy for irrigation can achieve a lot of objectives. It will enable customers save more, reduce environmental pollution, and help achieve multiple objectives of the SDGs. Work is currently in progress to estimate the actual economic cost and savings the system would bring about. Reduction in pollution level is also analysed currently.

7 Reference

[1] World Bank. 2020, “Population, total - Sub-Saharan Africa | Data.” https://data.worldbank.org/indicator/SP.POP.TOTL?locations=ZG (accessed May 10, 2020).

[2] R. Cherif *et al.*, “Competition, Competitiveness and Growth in Sub-Saharan Africa,” *IMF Work. Pap.*, vol. 20, no. 30, 2020, doi: 10.5089/9781513526379.001.

[3] World Bank, “Unlocking Africa’s Agricultural Potential: An Action Agenda for Transformation,” *Sustain. Dev. Ser.*, 2013, [Online]. Available: https://openknowledge.worldbank.org/bitstream/handle/10986/16624/769900WP0SDS0A00Box374393B00PUBLIC0.pdf?sequence=1.

[4] World Bank Poverty Reduction: "*Accelerating Poverty Reduction in Africa*." no. June 2019.

[5] Full Report, World Bank, P. At, and A. L. Date, “2019 Poverty and Inequality in Nigeria : Executive Summary,” no. May, 2020.

[6] NBS, “Labor force statistics - Volume 2: Unemployment and underemployment by State,” vol. 2, no. April, 2019.

[7] P. Warr, *Work, unemployment, and mental health*. Oxford University Press, 1987.

[8] F. Biagi and C. Lucifora, “Demographic and education effects on unemployment in Europe,” *Labour Econ.*, vol. 15, no. 5, pp. 1076–1101, 2008, doi: 10.1016/j.labeco.2007.09.006.

[9] G. invest mobilising renewable energy Investments, “Nigeria Renewable Energy Potential.” 2014, [Online]. Available: https://www.get-invest.eu/market-information/nigeria/renewable-energy-potential/.

[10] M. Shaaban and J. O. Petinrin, “Renewable energy potentials in Nigeria: Meeting rural energy needs,” *Renew. Sustain. Energy Rev.*, vol. 29, pp. 72–84, 2014, doi: 10.1016/j.rser.2013.08.078.

[11] L. Olatomiwa, S. Mekhilef, A. S. N. Huda, and O. S. Ohunakin, “Economic evaluation of hybrid energy systems for rural electrification in six geo-political zones of Nigeria,” *Renew. Energy*, vol. 83, pp. 435–446, 2015, doi: 10.1016/j.renene.2015.04.057.

[12] K. E. Okedu, R. Uhunmwangho, and W. Promise, “Renewable energy in Nigeria: The challenges and opportunities in mountainous and riverine regions,” *Int. J. Renew. Energy Res.*, vol. 5, no. 1, pp. 222–229, 2015, doi: 10.20508/ijrer.26250.

[13] J. Tinbergen, Contribution to Economic Analysis (Contingent Valuation). North-Holland.

[14] E. Phiri, “Evaluating opportunities for sustainable rural water provision using solar PV in sub-Saharan Africa : a case study of Malawi,” 2017, [Online]. Available: https://hau.idm.oclc.org/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=ddu&AN=C712129B9215FB68&site=ehost-live&scope=site.

[15] United Nations Statistics Division, “Designing Household Survey Samples: Practical Guidelines,” *Stud. Methods*, no. 98, p. 264, 2005, doi: 10.1177/0193841X07311993.

[16] M. Antoninis, “Tackling the largest global education challenge? Secular and religious education in northern Nigeria,” *World Dev.*, vol. 59, pp. 82–92, 2014, doi: 10.1016/j.worlddev.2014.01.017.

[17] N. Malhotra, *Marketing Research: An Applied orientation approach*, 5th Editio. Pearson Prentice Hall, USA., 2007.

[18] A. G. Joseph and R. G. Rosemary, “Calculating, Interpreting, and Reporting Cronbach’s Alpha Reliability Coefficient for Likert-Type Scales,” *Stud. Inorg. Chem.*, vol. 14, no. C, pp. 349–372, 2003, doi: 10.1016/B978-0-444-88933-1.50023-4.
[19] G. B. Douglas and A. W. Thomas, “Cronbach’s alpha reliability: Interval estimation,hypothesis testing, and sample size planning,” *J. Organ. Behav.*, vol. 60, no. 1, pp. 5–22, 2014, doi: 10.1002/job.
[20] Marketing and Sales Department S, “KAEDCO customer enumeration data for July 2017.” .
[21] National Bureau of Statistics Nigeria, “Nigerian Gross Domestic Product Report Q4 2016,” no. February, pp. 1–139, 2017.
[22] I. Oji-Okoro, “Analysis of the contribution of agricultural sector on the Nigerian economic development,” *World Rev. Bus. Res.*, vol. 1, no. 1, pp. 191–200, 2011.
[23] S. Adhikari, P. S. Mahapatra, V. Sapkota, and S. P. Puppala, “Characterizing emissions from agricultural diesel pumps in the Terai region of Nepal,” *Atmosphere (Basel).*, vol. 10, no. 2, 2019, doi: 10.3390/atmos10020056.
[24] K. F. Weaver, V. Morales, S. L. Dunn, and K. Godde, *Introduction to Statistical Analysis in Research: With Applications in the Biological and Life Sciences*. John Wiley & Sons, Inc., 2017.
[25] J. Izquierdo and R. E. Blanchard, “Solar Desalination System Design for Irrigation/Drinking Water and Electricity Generation in Desert or Arid Areas,” *J. Sustain. Res.*, vol. 2, no. 2, pp. 0–22, 2020, doi: 10.20900/jsr20200018.

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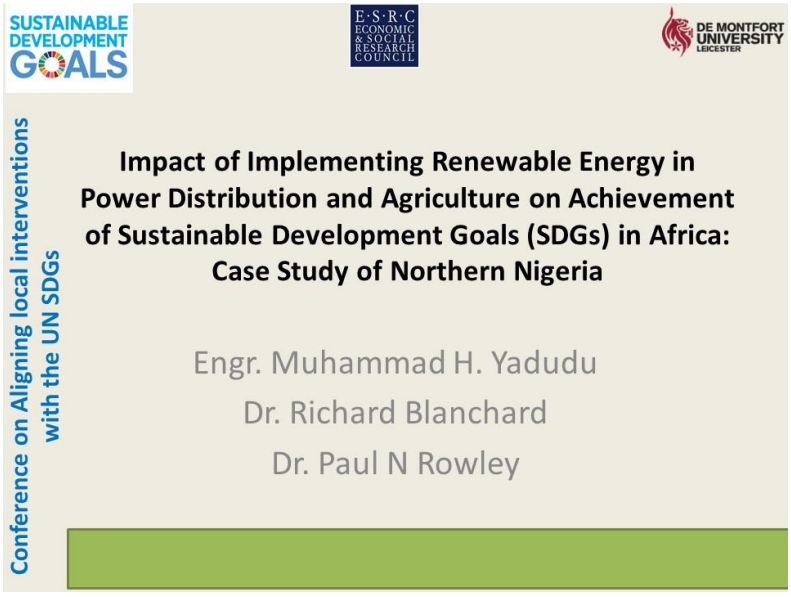
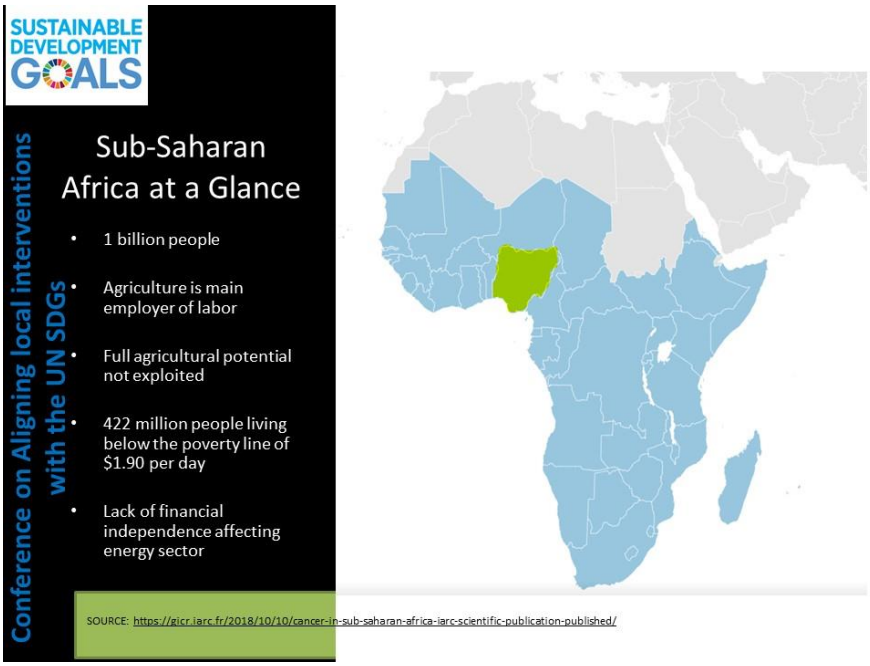
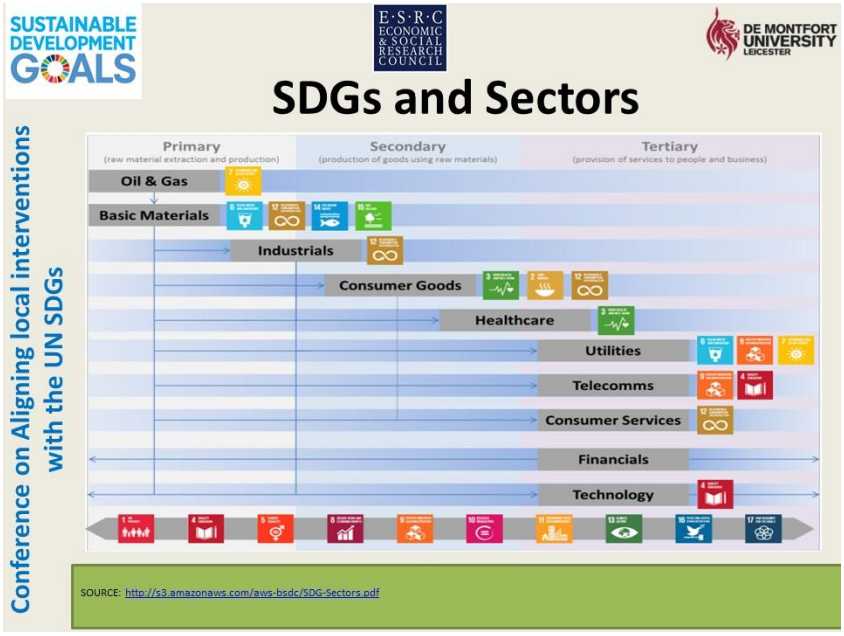



SUSTAINABLE DEVELOPMENT GOALS
Conference on Aligning local interventions with the UN SDGs
Sub-Saharan Africa at a Glance
1 billion people
Agriculture is main employer of labor
Full agricultural potential not exploited
422 million people living below the poverty line of $1.90 per day
Lack of financial independence affecting energy sector
SOURCE: https://gicr.iarc.fr/2018/10/10/cancer-in-sub-saharan-africa-iarc-scientific-publication-published/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SDGs and Sectors
Primary
(raw material extraction and production)
Secondary
(production of goods using raw materials)
Tertiary
(provision of services to people and business)
Oil & Gas
Basic Materials
Industrials
Consumer Goods
Healthcare
Utilities
Telecomms
Consumer Services
Financials
Technology
SOURCE: http://s3.amazonaws.com/aws-bsdc/SDG-Sectors.pdf

Nigeria Energy Sector (Power Distribution)

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- Divided into 11 after privatization
- Aggregate Technical Collection and Commercial loss (ATC&C) percent of 72% average
- Over $2Billion USD owed to Nigeria Bulk Electricity Trader (NBET)

SOURCE: https://www.nigeriaelectricityhub.com/2019/11/26/know-your-disco-who-is-responsible-for-your-electricity-supply/

Agriculture in Nigeria

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- Largest sector employing 48.2% of total workforce
- Means of livelihood for farmers
- Irrigation via rainfed or diesel pumps
- Diesel pump method is very expensive, not eco friendly and requires maintenance most times

Study Background

- Largest economy and population in Africa
- 41% of population living below poverty line and unemployment is at 23.1%
- 41% electricity access
- Commerce affected due to socio-economic challenges
- Energy sector affected negatively due to lack of liquidity

SOURCE: https://www.oasdom.com/map-nigeria-with-states/

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Nigeria Energy Sector (Power Distribution) cont'd…

- Kaduna Electric (KAEDCO) has collection efficiency of 17%
- ATC&C loss percent of 74%
- Average 15% monthly payment to NBET
- 90% of customers on R2 (1 – 40 kW) tariff class
- 67% of R2 customers are farmers
- R2 collection efficiency less than 16%

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Methodology

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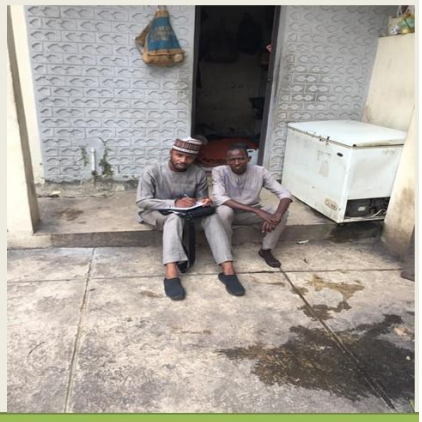
Mixed Methods Approach

- Contingent Valuation Method (CVM)
- Choice Experiment (CE)
- Questionnaire (face to face)



Study Aims and Objective

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AIM:

Establish why customers do not pay their full electricity bills

OBJECTIVE:

Investigate current demographic and socio-economic situation in the KAEDCO area and evaluate the potential of RET to improve payments to power utility companies

Potential of Energy Generation via Renewable Energy

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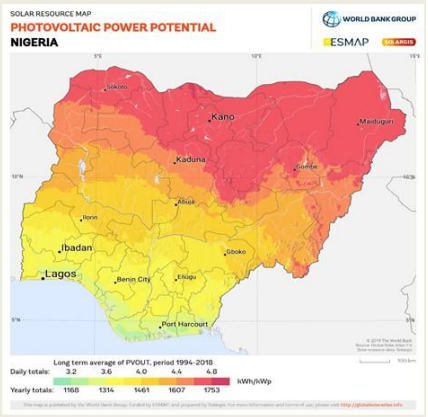
- Potential established by multiple studies
- Free and clean source of energy
- Solar radiation average of 19.8 Mj/m2/day
- Average sunshine hours of 6hrs/day
- Water production potential via RET



SOURCE: World Bank https://solargis.com/maps-and-gis-data/download/nigeria

Results (Main Occupation)

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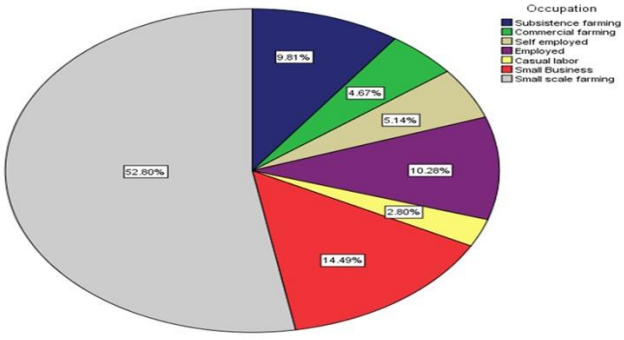

Figure 5.1: Main occupation of household, n=214

Spearman's rho Analysis

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			Average Income	Monthly Amount Paid	Occupation	Monthly Savings	Education	Home Type	Occupants
Spearman's rho	Average Income	Correlation Coefficient	1.000	.617**	.503**	.534**	.031	.093	.043
		Sig. (2-tailed)	.	.000	.000	.000	.118	.074	.611
		N	144	144	144	144	144	144	144
	Monthly Amount Paid	Correlation Coefficient	.617**	1.000	.493**	.622**	.063	.082*	.085
		Sig. (2-tailed)	.000	.	.000	.000	.453	.029	.312
		N	144	144	144	144	144	144	144
	Occupation	Correlation Coefficient	.503**	.493**	1.000	.607**	.053	.054	.129
		Sig. (2-tailed)	.000	.000	.	.000	.524	.519	.123
		N	144	144	144	144	144	144	144
	Monthly Savings	Correlation Coefficient	.534**	.622**	.607**	1.000	.037	.092	.045
		Sig. (2-tailed)	.000	.000	.000	.	.659	.272	.590
		N	144	144	144	144	144	144	144
	Education	Correlation Coefficient	.521	.443	.533	.427	1.000	.438	.485
		Sig. (2-tailed)	.118	.453	.524	.659	.	.352	.064
		N	144	144	144	144	144	144	144
	Home Type	Correlation Coefficient	.093	.182*	.054	.092	.078	1.000	.018
		Sig. (2-tailed)	.074	.029	.519	.272	.352	.	.831
		N	144	144	144	144	144	144	144
	Occupants	Correlation Coefficient	.043	.085	.129	.045	.015	.018	1.000
		Sig. (2-tailed)	.611	.312	.123	.590	.064	.831	.
		N	144	144	144	144	144	144	144

Results (Average Monthly Electricity Payment)

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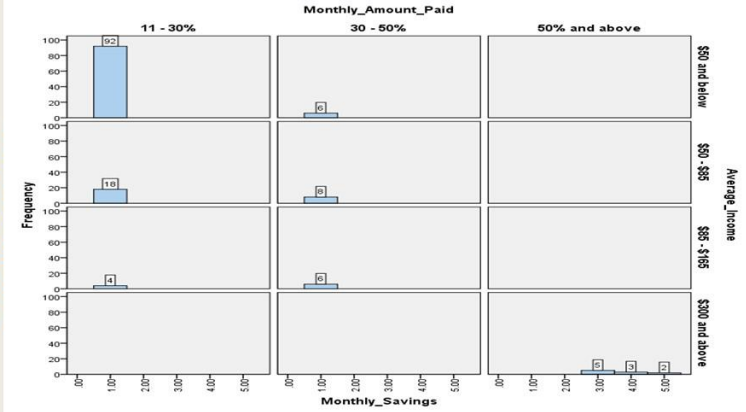

Results (Income Analysis)

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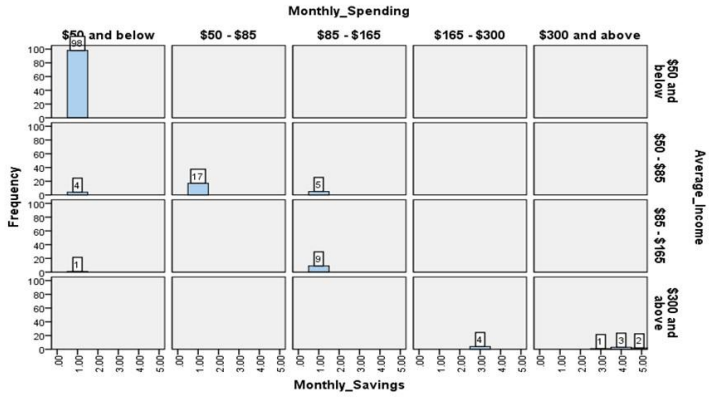

Conclusion

- Poor revenue for power utility companies caused by lack of financial independence
- RET has a potential to increase income generation
- Process aligned with SDGs and would help achieve targets 1, 2, 7, 8, 11 and 13

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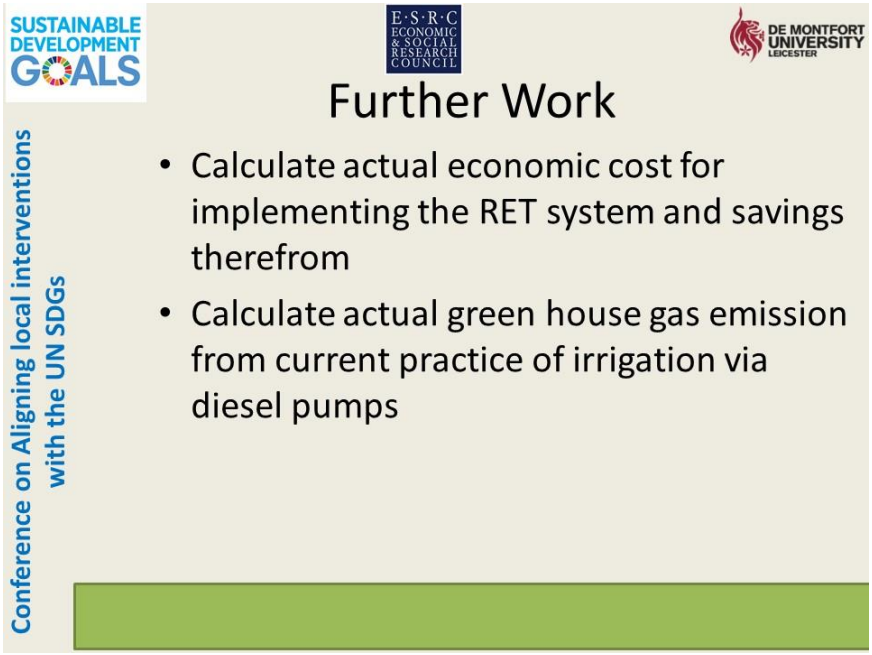
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Further Work
• Calculate actual economic cost for implementing the RET system and savings therefrom
• Calculate actual green house gas emission from current practice of irrigation via diesel pumps
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THANK YOU
Any Questions?
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