# THE IMPACT OF RENEWABLE ENERGY TECHNOLOGIES IN SUSTAINABLE DEVELOPMENT OF RURAL LIVELIHOODS IN UGANDA

CASE STUDY OF ACHOLI SUB REGION

BY

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A DISSERTATION SUBMITTED TO THE SCHOOL OF BUSINESS IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF A MASTERS OF BUSINESS ADMINISTRATION OF OIL AND GAS MANAGEMENT, INSTITUTE OF PETROLEUM STUDIES KAMPALA IN AFFILIATION TO UCU.

SEPTEMBER 2023

DECLARATION

I Cherotich Kaibei hereby declare that this dissertation is my work and has never been submitted before to any other institution of higher learning for fullfillment of any academic award..

Signed……[signature]………………..

Date….11/09/2023…….



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APPROVAL

This is to certify that the thesis entitled "The Impact of Renewable Energy Technologies on Sustainable Development of The Rural Livelihoods in Uganda; A Case Study of Acholi Sub region." has been done under my Supervision and now it is ready for submission.

Signature...[signature]...

Mr. Vincent Kisenyi

Date...11/09/2023...



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## DEDICATION

I dedicate this project to God Almighty my creator, my strong pillar, my source of inspiration, wisdom, knowledge and understanding on his wings only have I soared. I also dedicate this work to my mother

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## LIST OF ACRONYMS

| | |
|---|---|
| AFDB | Africa Development Bank |

| | |
|---|---|
| EAP | Energy Advisory Project |
| GCAA | Global Clean Cook-stoves Alliance |
| GIZ | German Agency for International Cooperation |
| GHG | Green House Gasses |
| HDI | Human Development Index |
| IDA | International Development Agency |
| IEA | International Energy Agency |
| IMF | International Monetary Fund |
| OECD | Organization for Economic Cooperation and Development |
| UNEP | United Nations Environmental Programme |
| UNGA | United Nation's General Assembly |
| USMID | Uganda Support to Municipal Infrastructure Development |
| SDG/SDG'S | Sustainable Development Goal(s) |
| SDI | Shack/Slum Dwellers International |
| SE4ALL | Sustainable Energy for All |
| SPSS23 | Statistical Package for Social Sciences |
| WEF | World Economic Forum |

ABSTRACT

There is an urgency to transform how the societies across the world are producing and using energy, the transfor

Uganda is one of the countries with the low energy access yet already experiencing climate change effects. Therefore, the Ugandan government in its efforts to attain middle income status aims to achieve universal modern energy access by 2030 and 100% Renewable Energy by 2050. The general objective of this study is to assess the impact of renewable energy technologies on sustainable development of the households and other stake holders in the study area. This study employed a quantitative method, and it was cross-sectional in that it was conducted once and thus represents a snapshot of a single point in time. The study holds electricity, solar and efficient cooking stoves as pillars of renewable energy. The data collected was analyzed using Statistical Package for Social Sciences (SPSS23), computer software using descriptive and inferential statistics and the findings were that electricity has a positive but insignificant effect on sustainable development, clean energy cooking stoves has a positive significant effect on sustainable development and solar has a positive insignificant effect on sustainable development. in conclusion renewable energy technologies accounts for 36% of sustainable development in the study area.

# CHAPTER ONE

## THE PROBLEM AND ITS BACKGROUND

This chapter contains the introduction, background to the study, statement of the problem, objectives of the study, research questions, significance of the study, scope of the study and conceptual framework.

This particular chapter describes the background of the study, statement of the problem, research objectives, research questions, conceptual framework, and the justification of the study.

## 1.1 INTRODUCTION

There is an urgency globally to move towards 100% renewable energy this is so because of the effects of fossil fuels on climate change. Many political leaders across the world aim to enact policies and plans for transitioning to 100% renewable energy and to convince others to do the same in their countries. To achieve this these leaders, need to demonstrate quantifiable economic and social benefits of renewable energy.

This research therefore seeks to assess whether renewable energy technologies has any impact on sustainable development of rural livelihoods.

## 1.2 BACKGROUND OF THE STUDY.

There is an urgency to transform how the societies across the world are producing and using energy, the transformation is cutting down on the consumption of fossil fuels and consequently its effects on climate change and environment towards cleaner, renewable forms of energy. The use of renewable energy has gained momentum amongst many people in generating electricity, heating and cooling buildings, cooking and providing mobility. Renewable energy is market-ready and price competitive than conventional sources in many jurisdictions, and met about 19% of the world's final energy demand in 2014.1this percentage has kept increasing and by 2022 January renewable energy accounted for 30% of the world's electricity. ( https://www.aljazeera.com news) the IEA projects that the renewables share of the global power generation mix is set rise to 35% in 2025 up from the current 29%.(WEF) …https://www.weforum.org 2023/3)

Around the world, communities, islands, and cities have found that making the transition to 100% renewable energy is largely a matter of political will and that the required technologies already are at hand.2 Continentally governments are pushing towards 100% use of renewable energy. Local governments, in particular, are pioneers in this movement and have become incubators of regionally appropriate best practices and policies.

Without energy, there is no life in a nation as it is an indispensable element in all aspects of life, especially economic and human development. The universal access to modern energy is directly linked to the rest of the Sustainable Development Goals (SDGs) and Agenda 2063; it is a weapon for combating poverty, fostering economic growth and improving health and gender equality (OECD/IEA, 2017). However, most people in Sub-Sahara Africa face severe energy poverty; it is the part of the world with the largest number of people lacking access to modern energy. More than two thirds of

This energy poverty is escalated by the fast growing population in the region leading to high energy demand. This critical challenge implies huge amount of funds for investment to meet the target of universal electricity access by 2025. It is estimated that $60 billion is needed per year to achieve the target (Heffron et al, 2017). Thus, energy deficit is an impediment to economic development, especially in the rural communities of Africa. This challenge must be addressed in a more sustainable way, considering system thinking, to avoid repeating the past mistakes made in the name of economic development that are empirically evident globally as climate change effects and other anthropogenic effects. A steady yet accelerated transition in energy systems is inevitable if we intend to make the world better for generations to come. Climate change is global issue as reflected by the "seven climate records in 2016: melting of the Arctic ice; consecutive hottest months; hottest day in India ever; highest temperature in Alaska; consecutive and biggest annual increase in $CO_2$; hottest Autumn in Australia ever; and highest amount of destruction in Australia's Great Barrier Reef" (Mc Caauley & Heffron 2018). Some of the climate change effects arise from energy emissions that occur during various economic activities. Therefore, a meticulous and holistic energy system development of Africa's abundant energy resources would transform the continent to leapfrog from a subsistence economy to a modern and desirable economy.

Electricity access does not necessarily mean being connected to electricity. The World Bank Group developed a Multi-Tier Framework to define and measure energy access since binary indicators are insufficient in fostering and tracking the SDG7. Consequently, affordable, reliable and modern energy should entail households, productive engagements and community facilities with seven attributes: capacity, duration, reliability, quality, affordability, legality as well as health and safety (SE4ALL, 2016).

Inaccessibility to reliable, affordable and modern energy in Uganda has stagnated the country's development because energy is the dividing line between the rich and the poor and between the developed and the developing countries. For a country to achieve sustainable development, it should put the development of energy at the forefront to serve as an economic confrontation. Therefore, there is need to increase access to energy especially in rural communities of Uganda so as to improve the local economic activities and add value to goods and services which will enable them compete on the global market. This strategy can be achieved through renewable energy integration by using the locally available renewable resources to promote public health and environmental sustainability.

Incorporating off-grid solutions such as the use of solar photo-voltaic systems would be an important source of renewable energy, which has the potential to trigger strategic and sustainable development by transforming lives and economies through improving health and safety, increasing incomes as well as enhancing educational development. However, due to financial constraints, it is not easy to purchase these systems or to make them readily available in Uganda because of the upfront costs involved. Nevertheless, Uganda needs a steep increase in energy supply to leapfrog from a subsistence economy to a middle class modern economy with equitable economic growth and inclusive sustainable development. Moreover, off-grid energy has proven to be better than grid electricity in Uganda in terms of access when considering the Multi-Tier Framework.

Theoretical concepts of Sustainable development provides useful frameworks to assess the interactions between Sustainable development and Renewable Energy Technologies. Sustainable Development addresses the relationships between human society and nature. Traditionally, Sustainable Development has been framed in the three-pillar model—Economy, Ecology, and Society— allowin

Uganda is endowed with abundant energy resources which include hydropower, biomass, solar, geothermal, peat and fossil fuels. The energy resource potential of the country includes an estimated 2,000 MW of hydro power, 450 MW of geothermal, 1,650 MW of biomass cogeneration, 460 million tons of biomass standing stock with a sustainable annual yield of 50 million tons, an average of 5.1 kWh/m2 of solar energy, and about 250 Mtoe of peat (800 MW). In addition, petroleum in an estimated amount of 6.5 billion barrels, of which 1.4 billion barrels are recoverable, was discovered in the western part of the country and production is expected to be underway by 2020 (Energy pedia, 2019).

Uganda, is one of the countries with very low modern energy access. Electricity access at national level stands at 26.70% from 15% by 2013 (10%:2010; 9%: 2006; 5.6%:1991) (World Bank, 2018). However, the question is, are these figures enough to reflect the number of people utilizing the electricity in reality?

Disseminating clean-burning, fuel-efficient cook-stoves, whether through aid or low-cost distribution programs, has recently risen up the global public agenda since the establishment of the Global Clean Cook-stoves Alliance (GCCA) in September 2010. The GCCA is a private-public partnership including the United Nations Foundation, the United States‟ Environmental Protection Agency and the Shell Foundation, among others (United Nations Foundation 2011; Smith 2010). UNEP is an official implementer of the Alliance and is actively working with over 250 other organizations towards a 100 by 20‟ target in which 100 million homes adopt clean and efficient stoves and fuels by 2020. The potential benefits of shifting from current cooking technologies to clean-burning, fuel-efficient cooking stoves include reduced exposure to harmful indoor air pollution, decreased pressure on wood resources for firewood and charcoal, reduced workloads for women and children (the traditional collectors of firewood in many cultures), lower monthly expe

However, in order to meet the 100 by 20 goal, we must examine the past. Interest in stove interventions dates back in the 1970s when concerns were centered mainly on forest conservations. The justification for interventions in household energy broadened over the years to incorporate concerns about public health and climate change, with forest conservation taking a lesser role. Through these shifts, it became apparent that, despite potentially large social and environmental benefits, successful stove dissemination was not easy to achieve. This study therefore, reviews adoption of clean-burning cook-stoves, examined the links between local cooking habits and global climate change, and then examined ways in which the international community can support the widespread dissemination of efficient cook-stoves in line with developmental and environmental goals. The entire study analyzed critically key experiences from the past, current financing opportunities for the development practitioner, and issues related to stove adoption and gender dynamics that are also the key to a cook stove project's success on the ground. The purpose of this study was to unveil the current knowledge on cooking-stove promotion and diffusion, and to finally propose the best practices for, electricity, fuel-efficient cook stove program design, and solar technologies.

Despite the endowment of abundant resources in the country, they are unfortunately not fully exploited. Moreover, some vulnerability to climate change are already being experienced, including extreme weather conditions such as heavy rains that lead to floods, prolonged dry spells, landslides and rise in the temperatures among others (Environment Alert, 2010). These aspects are likely to have significant implications for agriculture, food security, soil and water resources; therefore, they call for a course of actions to be taken to build resilience

## 1.3 STATEMENT OF THE PROBLEM

Uganda is one of the countries with the low energy access yet already experiencing climate change effects for example long spells of drought, floods and landslides. A research conducted by UBOS in 2022 indicates that the national electricity access rate is at 57%, with 60% of the urban population connected to electricity and only 18% of the rural population. ( https://www.afdb.org) Therefore, the Ugandan government in its efforts to attain middle income status aims to achieve universal modern energy access by 2030 and 100% Renewable Energy by 2050.

Northern Uganda especially the study area was plagued by war for nearly two decades ( www.haguejusticeportal.net) which led to severe poverty (poverty status report 2021), with peace prevailing in the region there is rapid increase in population and urbanization. Due to the afore cited limited access to affordable, reliable and modern energy the population largely relies on biomass for fuel i.e. firewood and charcoal which has resulted to deforestation. The government in order to achieve goal No. 7 of the Sustainable Development Goals faces a lot of pressure to meet the energy needs of her population in an environmentally friendly for example the presidential ban on commercial charcoal burning in the North of the country. ( presidential directive No. 3 of 2023)

In spite of the significant investment required and the high number of different development programs related to electricity access and renewable energy deployment, analytical work and empirical evidence on the sustainable development impacts of such efforts remains relatively limited. Only a few studies have evaluated the relationship between inclusive solar power technologies access: photovoltaic systems for street lighting, institutional and home applications and human development indicators, and the vast majority of these have focused on Asian and Latin American countries (Lenz et al., 2015). With this study, the intention is to shed light on both the developmental effect of obtaining access to modern energy and the local value creation generated throu

## 1.4 GENERAL OBJECTIVE

The general objective of this study is to assess the impact of renewable energy technologies on sustainable development of the households and other stake holders in the study area. The study holds electricity, solar and efficient cooking stoves as pillars of renewable energy.

## 1.5 SPECIFIC OBJECTIVES

The study is guided by the following specific objectives;

i. To examine the effect of electricity technology on the sustainable development in the study area

ii. To examine the factors influencing adoption of clean burning, fuel-efficient cooking stoves and its effect sustainable development in the study area

iii. To assess the benefits of solar power technologies on the sustainable development of rural livelihoods in the study area.

## 1.6 RESEARCH QUESTIONS

The study is guided by the following research questions;

i. What is the effect of electricity technology and the sustainable development in the study area?

ii. What is the effect of adoption of clean burning, fuel-efficient cook stoves technologies on sustainable development in the study area?

iii. What are the benefits of solar power technologies in the sustainable development of rural livelihoods

## 1.7 SIGNIFICANCE OF THE STUDY

As indicated, renewable energy investments are projected to increase access to electricity for productive purposes, lighting and clean, fuel efficient cooking means, with potentially high impacts on economic and human development. With both the public and private sectors committing to invest billions of dollars into solar power technologies such as solar photovoltaic systems and clean-burning, fuel-efficient cook-stoves as renewable energy deployment in developing countries like Uganda, an evaluation of such massive investments and their sustainable development impacts is vital for making informed policies and investment decisions on renewable energy developments for the welfare of both humanity and ecosystem.

## 1.8 SCOPE OF THE STUDY

The research looked at the following dimensions in terms of scope determination;

### 1.8.1 Content scope

This study focused on the analysis of a ripple effect of three technology choices in assessing renewable energy technologies in regard to determining the sustainable development truth for both rural and urban area. Disseminating electricity technology, clean burning, fuel-efficient cook-stoves and inclusive solar power technologies: photovoltaic systems for street lighting, institutional and home applications in Acholi sub region in Northern Uganda.

### 1.8.2 Geographic Scope

The research took place in Acholi Sub Region, It is the commercial and administrative region. The districts under the study include; Gulu, Omoro, Nwoya, Amuru, Kitgum, Agago, Lamwo and Pader

### 1.8.3 Time Scope

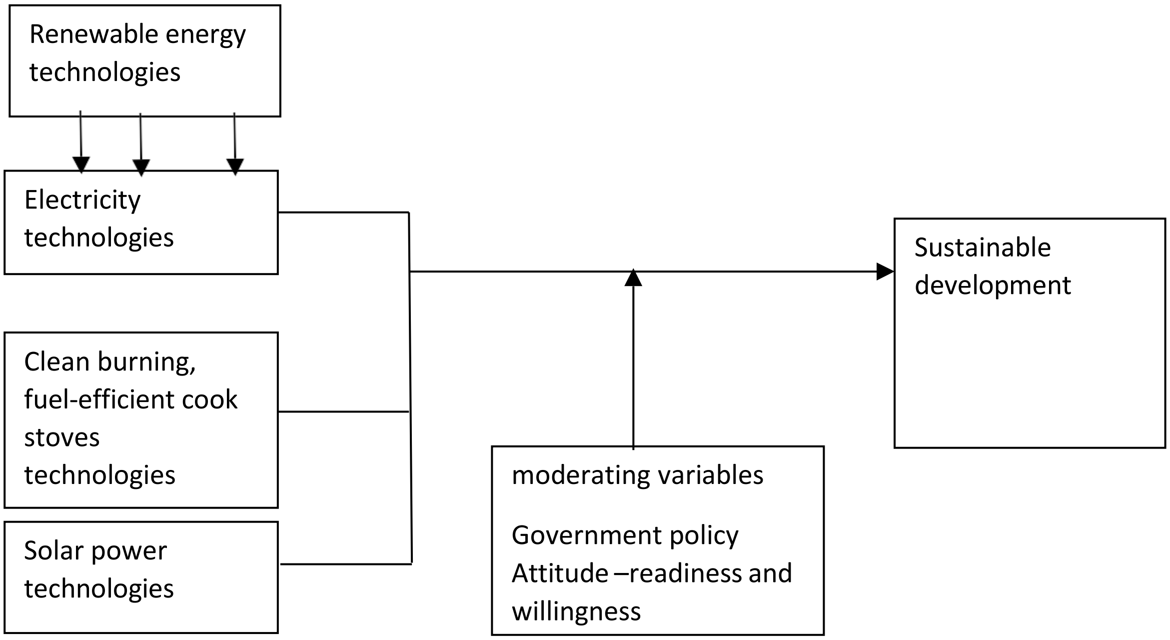
The research covered a period of 6 months and the scope was illustrated in the literature reviewed

## 1.9 CONCEPTUAL FRAME WORK

The framework below describes the independent variables that is the renewable energy technologies and this is measured by electricity, clean burning fuel efficient cook stoves, and solar power energy and these directly affect the dependent variable which is the sustainable development. However there are other factors that affect sustainable development and these include government policy and attitude in terms of people's readiness and willingness to accept the new technologies.

The dependent variable is measured in terms of environmental protection and preservation, improved health as a result of reduced smoke emissions in households, previously spent time in collecting firewood freed up and invested in other economic activities as well as improved school retention for the young girls who usually collect firewood and improved security due to solar powered street lights

Independent variables dependent variable




Source: an adaptation from Abbot, T. & Sotelo, L. S. (2014). And modified by the researcher.

‘

CHAPTER TWO: LITERATURE REVIEW2

2.0.INTRODUCTION

This chapter is the review of previous works done in relation to our research problem which was perused for purposes of shedding more light in our study.

2.1 THE CONCEPT OF RENEWABLE ENERGY AND ITS IMPACT ON SUSTAINABLE DEVELOPMENT

Renewable energy is energy produced from natural sources that are naturally replenished and do not run out. Examples of renewable energy are solar energy, wind energy, hydroelectric power, biomass energ a

On the other hand Sustainable Development is the development that meets the present needs without affecting or comprising the future generations ability to meet their own needs. Sustainable development seeks find to balance between environmental preservation, economic development and social wellbeing which are referred to as the three pillars of sustainability. The characteristics of sustainable development therefore are; minimal depletion of natural resources, improved quality of human life, respect of all other life forms.

The United Nation's General Assembly recognizes that Goal No.7 of Sustainable Development Goals has a bearing on the attainment of all other goals. Therefore, clean, modern energy is pivotal direct bearing on sustainable development however there is no empirical evidence of whether these Renewable Energy Technologies can actually affect sustainable development. Muwanga and Mwiru in "Social Cultural Beliefs and Behavioral Intentions to Adopt Renewable Energy Technologies in Uganda" examined the influence of social-cultural beliefs on behavioral intentions to adopt renewable energy in Kampala, Wakiso and Mukono and their findings are that cultural and religious beliefs did not have any influence on the adoption of renewable energy rather it was the usability, usefulness and consequences of adopting the renewable technologies that had influence on intentions of such adoption. This research clearly centered in the urban areas and thus there is need to find out if these findings will be the same in the Rural Areas hence the area of study herein. Jagger and Kittner in "Deforestation and Biomass Fuel Dynamics in Uganda" investigated whether deforestation and depletion of biomass stock affects the choice of energy sources in Western Uganda. Their findings were that less biomass availability leads to sourcing for fuel from other non-forest areas like crop residues. The research did not look at whether deforestation leads to adoption of clean or modern energy. Which is the investigation in objective 2 of this research; factors affecting adoption of the factors influencing adoption of clean burning, fuel-

## 2.3 THE RELATIONSHIP BETWEEN ELECTRICITY AND SUSTAINABLE DEVELOPMENT.

Access to electricity is widely believed to contribute to economic and social development. Barron, & Torero, (2014). The underlying assumption of this belief is that access to electricity can enhance quality of life at the household level and stimulate the economy at a broader level. (Adams, S, 2009). Intergovernmental organizations and financial institutions have therefore, supported electrification programs in many developing countries. In order to justify the international donor support, the impacts of rural electrification have received a lot of attention in the recent years. A number of studies have attempted to empirically test the relationship between rural electrification in developing countries and sustainable development indicators.

Abbot & Sotelo (2014), argue that apart from job creation and the development of training skills, there are various benefits of electricity access to the communities. These benefits range from increased income generation, which is visible in businesses to improved quality of life.

The bulk of the existing literature is based upon evidence from Asia and Latin America; although some impact studies have also been conducted in Africa (Abbot, T. & Sotelo, L. S. (2014). Researchers argue that electricity has a positive impact on development through the effect on the three components of the Human Development Index (HDI) and the environment.

According to Attigah and Mayer-Tasch. (2013), Income is by far the most studied impact indicator throughout the body of literature. Papers examine how electrification affects household income through the usage of electrical appliances and engagement in non-farm activities that in turn, will stimulate business activity and improve productivity at the broader level. Two recently published studies from India found a strong positive relationship between electricity and firm and household ear

In the African context, studies on the effects of electricity on household income give conflicting results. Adams, (2009), found a substantial increase in female labor supply in the wake of electrification in South Africa. She ascribes this effect to the shift from using wood to the use of electric cooking and lighting. This allows women to save time on fuel collecting activities and can thus devote more time to productive work. On the contrary, African Development Bank. (2013). found that electricity only supports economically productive activities to a very small extent in his study in Kenya. His results show that the central driver for electricity demand is the desire to use "connective appliances" such as television and telephones.

Furthermore, researchers have also examined how electrification affects the time children spend studying after school. Positive effects on the study time of children are found in two separate studies from Bangladesh. Attigah and Mayer-Tasch, (2013)

This paper investigates the possibilities and limitations of solar energy as a sustainable and renewable power source to help end the current power deficit in Zambia. The study focuses on solar energy and harnessing sunlight ignoring other forms of power generation, including wind power, hydroelectric power and biogas power. This leaves the research vulnerable

Jianzhong, Assenova and Erokhin 2018 based their research on Kazakhstan and the paper identifies the areas in the country with the highest emission reduction potential and elaborates the policies to encourage the selection of wind farm locations based on their economic potential environmental effect ratio. The approach allows assessing the opportunities which decentralized wind energy systems offer to transition away from a dependence on fossil fuels and to enable sustainable economic growth. This research therefore seeks to find an answer as to whether electricity has any impact on sustainable development in the study area.

## 2.4 AN ANALYSIS OF THE BENEFITS OF MODERN CLEAN COOK STOVES

Sub Saharan Africa is in the lead when it comes to reliance on biomass fuels for cooking with 95% of the population in Uganda, Ethiopia, Burundi, Rwanda and Tanzania using solid fuels for cooking. Several factors account for this over reliance including ignorance of the benefits of clean energy, high capital costs and coupled with poor infrastructure. ( deforestation and biomass fuel dynamics in Uganda by Pamela Jagger and Noah Kittner 2017) these conducted research in Western Uganda on how changes in land use affects use of biomass for cooking. Thus the need to investigate the factors which affect adoption of clean, modern energy efficient cooks stoves and its impact on Sustainable Development in the North of Uganda especially Acholi Sub region.

it is also recognized that access to clean, affordable energy has an impact on the attainment of all other sustainable development goals. Furthermore, charcoal is commonly utilized in both semi-urban and urban areas of Uganda. According to UBOS, 2017 wood fuel accounted for 84% of the energy consumed for cooking by households in 2014. The use of wood has, therefore, escalated the rate of deforestation in the country. To reduce the rates at which forests are disappearing and shortage of firewood Uganda, the Ministry of Energy and Mineral Development in collaboration with the German Agency for International Cooperation (GIZ) and the Energy Advisory Project (EAP), integrated with private partnerships to disseminate clean burning, fuel efficient cook stoves (a.k.a. improved cook stoves) in the country.

These stoves are one of the best practices in the utilization of biomass in Uganda. They are now locally produced after being adapted to the standards of the sustainable development status of all the classes of the Ugandan population. Their diffusion is becoming established country wide due to innovations and creativity in the use of locally available materials such as clay, cement, sand, metal as well as

The adoption of the clean burning, fuel efficient cook stoves is expected to influence the Ugandan population by impacting the environmental and sustainable development standards of the country. AFDB. (2013).

## 2.5 THE EFFECT OF SOLAR POWERED TECHNOOGY ON SUSTAINABLE DEVELOPMENT

Solar powered street lights provide different benefits to various categories of people in the community, ranging from social, economic to environmental welfare Solar-powered street lighting also presents an opportunity to develop a domestic solar market by training solar technicians and manufacturing the street lights locally (Johansson, 2011). Both Kampala and Jinja have nascent solar markets that trade components and community-based organizations that provide skills training to local people. This was especially apparent in Jinja, where, due to the involvement of NSDFU and their links with SDI (Shack/Slum Dwellers International), local businesses were contracted to produce the poles. Young people from the informal settlements were provided with training to do this, which has enabled them to continue to gain work in the sector and to pass on their skills to others in the community through workshops. This could contribute to job creation at a national scale. Improved street safety can support a wide range of social and economic activity which can enhance prosperity nationwide. When lighting is installed on busy roads and junctions, accidents are reduced and traffic is eased, which helps address congestion and air pollution. Better lighting enables street traders to work for longer and during the busiest part of the day for trading (early evening). Interviewees reported a reduction in actual and perceived crime rates, thereby making an area more appealing and helping make pedestrians feel safe. This is especially important for women, whose safety and wellbeing have been directly linked to the level of lighting on city streets (Boomsma, C. and Steg, L., 2014), Female street vend

Achieving gender equality in this area can help to boost national economic growth and lead to better development outcomes. Better lighting also improves access and perceptions in affected areas, increasing the value of properties. It enables recreation and community activities by providing safe, accessible and usable public spaces and access routes for pedestrians. Again, these benefits are particularly important for empowering women and enabling them to reap the social and economic benefits of urban life. So far, in both cities, development has focused on central areas of economic activity – where city governments can extract the most revenue – but, if solar lighting was rolled out to poorer parts of the city, these wider non-economic co-benefits would be considerably greater.

Securing the most efficient, effective and appropriate street lighting service is an essential aspect of inclusive development in every country today for ensuring strong visual identity and public safety, most especially among women. Initially, there have been very few street lights in Ugandan cities and towns; moreover, they were powered by the grid and were highly energy inefficient, one of the reasons for rampant load shedding in the previous years, especially during peak hours. It should be noted that street lighting involves the consumption of a great deal of energy due the types of lights used and being lit for a longer duration, throughout the night. The United Nations, established that around 15% of the world's electricity is utilized on lighting accounting for over 5% of global greenhouse gas emission, of which public lighting constitutes 8% of the electricity consumed (UNDP, 2017). More still, the global yearly energy expenses for street lighting only are projected to rise between $23.9 billion and $42.5 billion by the year 2025 (Sedziwy, 2016).

To reduce the high energy consumption and increase maximum energy efficiency, affordability, reliability and sustainability in the supply of energy, the Government of Uganda has opted to go green by embar

# CHAPTER THREE: METHODOLOGY

## 3.1 INTRODUCTION

This chapter presents the methodology that was used in conducting the research. It explains the research design, study population, sample size determination and sampling strategies, data collection, data quality control, data analysis, measurement of variables and ethical consideration.

## 3.2 RESEARCH DESIGN.

To investigate the effect of renewable energy and sustainable development in Northern Uganda ( Acholi Sub Region), this study employed a quantitative method. The design is founded on the assumption that if two variables have a statistically significant association, it is possible to forecast one variable using data from the other variable (Kothari, 2011). The study was cross-sectional in that it was conducted once and thus represents a snapshot of a single point in time.

## 3.3 AREA OF STUDY

The research took take place in Acholi Sub Region , The districts covered include; Gulu, Omoro, Nwoya, Amuru, Kitgum, Agago, Lamwo, and Pader

## 3.4 STUDY POPULATION

The population of concern in this research comprised of the sampling frame of civil servants and the selected stake holders in Acholi Sub Region: Gulu, Omoro, Nwoya, Amuru, Kitgum, Agago, Lamwo and Pader Districts.

## 3.5 SAMPLE SIZE DETERMINATION

A sample of 110 respondents from a population of 140 was selected randomly using Krejcie and Morgan (1970) formula:

$$s = \frac{X^2 NP(1-P)}{d^2(N-1) + X^2 P(1-P)}$$

Where,

$s$=the required sample size;

$X^2$ = the table value of chi-square for 1 degree of freedom at the desired confidence level (3.841);

N=the population size;

P=the population proportion (assumed to be 0.50 since this would provide the maximum sample size);

d=the degree of accuracy expressed as a proportion (0.05).

Table 1: Showing sample size

| Category | Target Population | Sample size | Sampling techniques |
|---|---|---|---|
| Households/ Users | 60 | 50 | Simple random sampling |
| Business/ Shop owners | 40 | 35 | Simple random sampling |
| Solar/electricity/clean energy | 20 | 15 | Purposive sampling |

| | | | |
|---|---|---|---|
| admins | | | |
| Factory Owners | 10 | 10 | Purposive sampling |
| | 130 | 110 | |

Source: primary data (2022)

## 3.6 SAMPLING TECHNIQUES

To select eligible respondents, the study employed simple random and purposive sampling techniques. For the household and business/. shop owners simple random was used such that any one could stand a chance of participating in the research without any bias. Whereas for the administrators and factory owners purposive sampling was used because the researcher came up with some criteria to use i.e. level of education of the administrators, their participation in energy policies formulation and implementation, type of the factories and number of years in operation.

## 3.6 DATA COLLECTION METHODS

In this study the researcher applied both primary and secondary data collection techniques.

### 3.6.1 Questionnaire

A questionnaire was used to elicit firsthand information over a short period of time from res pondents. The choice for the questionnaire is because it is practical, collect data from large number of respondents in a short period of time. Additionally, a is questionnaire is cheap and fast to administer.

### 3.6.2 Interviews

Interviews were used to get detailed information from the following key respondents;

households/users, business owners/ shops, administrators and factory owners through verbal communication bet

## 3.7 DATAQUALITY CONTROL

### 3.7.1 Reliability

To ensure reliability of quantitative data, the Cronbach's Alpha Reliability Coefficient for Likert-Type Scales test was used. In statistics, Cronbach's alpha is a coefficient of reliability. It is commonly used as a measure of the internal consistency or reliability of a psychometric test score for a sample of examinees/respondents. As a rule of thumb, require a reliability of 0.70 or higher (obtained on a substantial sample) before they use an instrument. The reliability testing formula was;

$$\alpha = \frac{k}{1-k}\left(1-\frac{\sum_{i=1}^{k}\sigma_{Y_i}^{2}}{\sigma_{X}^{2}}\right)$$

$\sigma_X^2$= the variance of the observed total test scores, $\sigma_{Y_i}^2$=the variance of component $i$ for the current sample of persons. Upon performing the test, the results that were 0.7 and above were considered reliable.

### 3.7.1 Validity

Validity and reliability are meant to increase transparency, and bias in research (Singh, 2014). This was taken care of by use of content validity, where the questionnaires developed was given to five expert judges to mark questions according to their relevance to the study constructs. Later on, a content v

$$CVI = \frac{\text{No of item declared valid by the judges}}{\text{Total No of items on the questionnaire}}$$

A trusted rule of thumb, according to Haradhan (2017), is that the CVI value above 0.7 is considered satisfactory.

### 3.7.2 DATA PROCESSING AND ANALYSIS

Quantitative technique was utilized in the analysis of data. Data obtained from the questionnaires was edited, coded, characterized and analyzed using Statistical Package for Social Sciences (SPSS23), computer software using descriptive and inferential statistics as explained in the ensuing sections.

#### 3.7.2.1 Descriptive Analysis

Descriptive analysis involved exploring variables separately using summary statistics. Summary statistics included percentages for categorical variables, mean and standard deviation for continuous variables.

#### 3.7.2.2. Inferential Statisitics

Under inferential statistics, Pearson product moment statistics and linear regression was used. Pearson Product Moment coefficient was used to indicate the direction and strength of the relationships between each dimension of renewable energy technologies and sustainable development dimensions, while probability (p) values was used to test the significance of each of the exploratory variables at alpha levels one, five and ten per cent. The formula is defined as follows:

$$\rho_{xy} = \frac{Cov(x, y)}{\sigma_x \sigma y}$$

Where;

$\rho_{xy}$=Pearson product-moment correlation coefficient,

$Cov(x, y)$=covariance of variables $x$ and $y$,

$\sigma_x, \sigma_y$=standard deviation of $x$ and $y$ respectively.

Linear regression was used to determine the influence of a set of independent variables (renewable energy) on dependent variable (sustainable development), this is due to the fact that the items of sustainable development was averaged to a continuous variable. The model is specified as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon$$

Where □□ is sustainable development, dependent variable; □□ is the error term, □□ is dimensions of renewable energy technologies and sustainable development, □□ is the standardized regression coefficient, □□□□ is the constant,

$X_1$=electricity technologies

$X_2$=clean cooking stoves

$X_3$=solar energy technologies

In testing the significance of the model, the coefficient of determination ($R^2$) was used to measure the extent to which the variation in sustainability is explained by the variations in renewable energy technologies. F-statistic was also computed at 95% confidence level to test whether there was

## 3.8 CONCLUSION.

The researcher conducted this research in a professional and ethical manner. The researcher received a letter of introduction from the University Research Coordinator, and appointments with respondents was organized through local authorities, with interviews conducted in the strictest of confidence. For the success of this study, the researcher maintained a strong contact with the respondents, and data was collected without fabrication. With this in mind, the researcher ensured that any information gathered was handled with the utmost discretion.

# CHAPTER FOUR

# PRESENTATION, ANALYSIS AND DISCUSSION OF THE FINDINGS

## 4.0 INTRODUCTION

This chapter is on the presentation, analysis and discussion of the findings of the impact of renewable energy technologies on sustainable development of rural livelihoods in Uganda, particularly looking at Acholi Sub Region in Northern Uganda. The presentation, analysis and discussion has been done in the subsequent sections as seen therein.

The subsequent sections also show; effect of electricity technology on sustainable development, factors influencing adoption of clean burning, fuel-efficient cook stoves technologies on sustainable development, benefits of solar power technologies in the sustainable development of rural livelihood

## 4.1 RESPONSE RATE

The sample for the study consisted of 110 respondents obtained from a population of 140 respondents. Out the sample size of 110 Self Administered questionnaires distributed to the respondents, 90 were returned yielding a response rate of 81%. The response rate was considered appropriate because any response above 75% is classified as best (Sekaran, 2003). The responses are shown in Table 4.1.

TABLE 4.1: RESPONSE RATE

| No | Response | Frequency | Percentage (%) |
|---|---|---|---|
| 1. | Responded | 90 | 81 |
| 2. | Not responded/invalid | 20 | 19 |
| *Total* | | *110* | *100* |

*Source: Primary Data (2022)*

## 4.2 DESCRIPTIVE STATISTICS

This section presents descriptive statistics of the effect of electricity technology on sustainable development, factors influencing adoption of clean burning, fuel-efficient cook stoves technologies on sustainable development, benefits of solar power technologies in sustainable development of rural livelihoods

### 4.2.1 IMPACT OF ELECTRICITY TECHNOLOGY ON SUSTAINABLE DEVELOPMENT

Descriptive statistics on electricity technology and sustainable development encompassed the use of means and standard deviation. The respondents were asked various questions on issues surrounding electricity technology and sustainable development including, among others, as to whether:

- Access to electricity is widely believed to contribute to economic and social development,
- access to electricity can enhance quality of life at the household level and stimulate the economy at a broader level
- Electricity access leads to increased income generation hence improved quality of life.
- there is a strong positive relationship between electricity and firm and household earnings respectively
- Electricity creates shift from using wood to the use of electric cooking and lighting.
- Electricity allows women to save time on fuel collecting activities and can thus devote more time to productive work
- The responses on each of these items are presented in Table 4.3.

Table 4.2.1 DESCRIPTIVE FOR EFFECT OF ELECTRICITY TECHNOLOGY AND SUSTAINABLE DEVELOPMENT

| Item | N | Min | Max | Mean | Std. Dev. |
|---|---|---|---|---|---|
| Access to electricity is widely believed to contribute to economic and social development. | 90 | 3.00 | 5.00 | 4.0556 | .56809 |
| access to electricity can enhance quality of life at the household level and stimulate the economy at a broader level | 90 | 2.00 | 5.00 | 3.8889 | .64380 |

| | | | | | |
|---|---|---|---|---|---|
| access to electricity leads to increased income generati | on | nce | impro | ed qual | y of life. |
| | 90 | 2.00 | 5.00 | 3.8333 | .62261 |
| There is a strong positive relationship between electricity and firm and household earnings respectively | 90 | 1.00 | 5.00 | 3.7667 | .71971 |
| Electricity creates shift from using wood to the use of electric cooking and lighting. | 90 | 2.00 | 5.00 | 3.6889 | .72893 |
| Electricity allows women to save time on fuel collecting activities and can thus devote more time to productive work | 90 | 2.00 | 5.00 | 3.6889 | .91975 |
| *Composite Mean* | *90* | *1.00* | *5.00* | *3.8204* | *0.70048* |
| Scale: *1.00-1.90 represents strongly disagree; 2.00-2.90 represents disagree; 3.00-3.90 represents moderate; 4.00-4.90 representing agree; and, 5.00 represents strongly agree.* | | | | | |

*Source: Primary Data (2022)*

As illustrated in Table 4.2.1, the respondents (mean = 4.0556, std. dev. = 0.56809) agreed that Access to electricity is widely believed to contribute to economic and social development of the livelihood of people in the study area. However, the items on access to electricity can enhance quality of life at the household level and stimulate the economy at a broader level contributes to (mean = 3.8889, std. dev. = 0.64380), There is a strong positive relationship between electricity and firm and household earnings respectively (mean = 3.8333, std. dev. = 0.62261), Electricity creates shift from using wood to the use of electric cooking and lighting (mean = 3.7667, std.

dev. = 0.71971), Electricity creates shift from using wood to the use of electric cooking and lighting. (mean = 3.

(mean = 3.6889, std. dev. = 0.91975) were moderate. Based on the scale of 1 to 5, the composite mean for all the responses was 3.8204 with standard deviation was 0.70048 implying that most of the respondents were neutral with the statements on electricity and its contribution toward sustainable development of the livelihood in the Acholi Sub Region in Northern Uganda.

### 4.2.2 CORRELATION OF THE IMPACT OF ELECTRICITY TECHNOLOGY ON SUSTAINABLE DEVELOPMENT

In order to ascertain the effect of electricity technology on sustainable development, a correlation was first performed to assess if a relationship existed between electricity technology and the sustainable development and how significant this relationship was. The results of the bivariate correlation are summarized in Table 4.12:

TABLE 4.2.2 CORRELATION BETWEEN ELECTRICITY TECHNOLOGY AND THE SUSTAINABLE DEVELOPMENT

| | | Electricity technology | Sustainable development |
|---|---|---|---|
| Electricity technology | Pearson Correlation | 1 | .324** |
| | Sig. (2-tailed) | | .002 |
| | N | 90 | 90 |
| Sustainable development | Pearson Correlation | .324** | 1 |
| | Sig. (2-tailed) | .002 | |
| | N | 90 | 90 |

**Correlation is significant at the 0.01 level (2-tailed).

*Correlation is significant at the 0.05 level (2-tailed).

The results presented in the Table 4.2.2 shows that there is a weak positive significant correlation between Electricity technology and Sustainable development in Acholi Sub Region [r (90) = .324, p < 0.01]. The implication of this is that an effective Electricity technology enhances Sustainable development.

Secondly, a regression analysis was also carried out to actually test the first objective which was to establish the effect of Electricity technology on Sustainable development in Acholi Sub Region. The results of the regression are shown in Table 4.13

TABLE 4.2.3: MODEL SUMMARY

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .324[a] | .205 | .195 | .58954 |

a. Predictors: (Constant), electricity technologies.

The model summary for regression in Table 4.2.3 shows an adjusted $R^2$ of 0.195 which means that about 20% of the variation in sustainable development can be explained by Electricity technology.

Thirdly, in order to establish whether there was at least one slope coefficient of the simple regression model that is not equal to zero and therefore infer on the overall significance of the model, an ANOVA (F-test) was performed. The results are shown in the table below.

TABLE 4.2.4: ANOVA[A]

| Model | Sum of | Df | Mean | F | Sig. |
|---|---|---|---|---|---|

| | | Squares | | Square | | |
|---|---|---|---|---|---|---|
| 1 | Regression | 3.599 | 1 | 3.599 | 10.356 | .002[b] |
| | Residual | 30.585 | 88 | .348 | | |
| | Total | 34.184 | 89 | | | |

a. Dependent Variable: sustainable development

b. Predictors: (Constant), electricity technologies

The F test result of 10.356 with a significance of 0.02 means that there is a significant relationship between Electricity technology and sustainable development because the probability of the results occurring by chance was less than 0.05 ($p < 0.05$) at a 89% significance level.

Fourthly, a t-test for Electricity technology and sustainable development was also performed and the results are shown in Table 4.15.

TABLE 4.2.5: COEFFICIENTS[A]

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 1.896 | .375 | | 5.057 | .000 |
| | Control Environment | .367 | .114 | .324 | 3.218 | .002 |

a. Dependent Variable: sustainable development

From the coefficients table (Table 4.2.5), the t-test results for Electricity technology was 3.218 with the probability of this occurring by chance being equal to 0.002, that is, $p < 0.05$ (95% confidence interval, two tailed) implying this was statistically significant. These results are in tandem with the findings of Kayondo (2018) and Umar et al. (2018)

who concluded that there was a significant association between Electricity technology and sustainable developm

## 4.3 IMPACT OF CLEAN BURNING, FUEL-EFFICIENT COOK STOVES TECHNOLOGIES ON SUSTAINABLE DEVELOPMENT

In order to ascertain the effectiveness of clean burning, fuel-efficient cook stoves technologies on sustainable development in the study area, respondents were assessed on the following items:

- Cutting down fuel and sustainability
- Increased thermal efficiency
- Conservation of forests by reducing fuel wood consumption
- Reduction in women's drudgery
- Reduction in indoor air pollution and hence smoke related disorders and prevention of fire hazards
- Reduction of smoke emissions to the environment and heat emissions that re a health hazard to the cooks

The results obtained on each of the items are presented in Table 4.9.

TABLES 4.3:1 descriptive statistics

| Item | N | Min | Max | Mean | Std. Dev. |
|---|---|---|---|---|---|
| Cutting down fuel consumption and sustainability | 90 | 2.00 | 5.00 | 3.6667 | .76438 |
| Increased thermal efficiency | 90 | 2.00 | 5.00 | 3.8444 | .61646 |
| Conservation of forests by reducing fuel wood | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| consumption | 90 | 2.00 | 5.00 | 4.1556 | .79197 |
| Reduction in women's drudgery | 90 | 2.00 | 5.00 | 3.8111 | .70143 |
| Reduction in indoor air pollution and hence smoke-related health disorders and prevention of fire hazards | 90 | 2.00 | 5.00 | 4.4556 | .56412 |
| Reduction of smoke emissions to the environment and heat emissions that are a health hazard to the cooks | 90 | 1.00 | 5.00 | 4.0556 | .75493 |
| *Composite Mean* | *90* | *1.00* | *5.00* | *3.9982* | *0.69888* |
| Scale: *1.00-1.90 represents strongly disagree; 2.00-2.90 represents disagree; 3.00-3.90 represents moderate; 4.00-4.90 representing agree; and, 5.00 represents strongly agree.* | | | | | |

*Source: Primary Data (2022)*

The findings in Table 4.3.1 indicates that clean burning, fuel-efficient cook stoves technologies on sustainable development mean of 3.9982 is moderately practiced by the Acholi Sub Region. The study also established that Cutting down fuel consumption and sustainability (mean = 3.6667, std. dev. = 0.76438), Increased thermal efficiency (mean = 3.844, std. dev. = 0.61646), Conservation of forests by reducing fuel wood consumption (mean = 3.8111, std. dev. = 0.70143).

Moreover, Reduction in indoor air pollution and hence smoke-related health disorders and prevention of fire hazards (mean = 4.1556, std. dev. = 0.79197), Reduce on smoke emissions to the environm

4.3.1 EFFECT OF CLEAN BURNING, FUEL-EFFICIENT COOK STOVES TECHNOLOGIES ON SUSTAINABLE DEVELOPMENT

The second objective of the study was to assess the effect clean burning, fuel-efficient cook stoves technologies on sustainable development in Acholi Sub Region. In an attempt to achieve this, a Pearson's bivariate correlation was first run. The result of the correlation are shown in the Table 4.16.

TABLE 4.3.2: BIVARIATE CORRELATION BETWEEN CLEAN BURNING, FUEL-EFFICIENT COOK STOVES TECHNOLOGIES AND SUSTAINABLE DEVELOPMENT

| | | clean burning, fuel-efficient cook stoves technologies | Sustainable development |
|---|---|---|---|
| clean burning, fuel-efficient cook stoves technologies | Pearson Correlation | 1 | .329** |
| | Sig. (2-tailed) | | .002 |
| | N | 90 | 90 |
| Sustainable development | Pearson Correlation | .329** | 1 |
| | Sig. (2-tailed) | .002 | |
| | N | 90 | 90 |

**Correlation is significant at the 0.01 level (2-tailed).

*Correlation is significant at the 0.05 level (2-tailed).

The results of the bivariate correlation in Table 4.3.2 yielded a correlation coefficient of .329, with a p-value less than 0.01 [r (90) = .329, p < 0.01]. The interpretation of these results is that there was a weak positive relationship between clean burning, fuel-efficient cook stoves technologies and sustainable development in Acholi Sub Region

The model summary of the regression test produced an Adjusted $R^2$ of .198, which meant that clean burning, fuel-efficient cook stoves technologies contributed about 20% to suitable development delivery in Acholi Sub Region. The remaining 80% was contributed by other factors outside the scope of the study – for results see Table 4.17.

TABLE 4.3.3: MODEL SUMMARY OF REGRESSION ANALYSIS

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .329[a] | .208 | .198 | .58864 |

a. Predictors: (Constant), clean burning, fuel-efficient cook stoves technologies

From the ANOVA table, a linear relationship [F (1, 88) = 10.654, $p < 0.05$] revealed that the more Acholi Sub Region assesses, see Table 4.18 for the results.

Table 4.3.4: ANOVA[a]

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 3.692 | 1 | 3.692 | 10.654 | .002[b] |
| | Residual | 30.492 | 88 | .347 | | |

| Total | 34.184 | 89 | | | |
|---|---|---|---|---|---|

a. Dependent Variable: sustainable development

b. Predictors: (Constant), clean burning, fuel-efficient cook stoves technologies

Lastly but not least, the coefficient of the regression was also determined in this study and the results are shown in Table 4.3.4.

TABLE 4.3.5: COEFFICIENTS

| Model | Unstandardized Coefficients | | Standardized Coefficients | T | Sig. |
|---|---|---|---|---|---|
| | B | Std. Error | Beta | | |
| 1 (Constant) | 1.913 | .365 | | 5.241 | .000 |
| clean burning, fuel-efficient cook stoves technologies | .380 | .116 | .329 | 3.264 | .002 |

a. Dependent Variable: Sustainable Development

The results from the coefficients table yielded a Beta of .329 with a $p < 0.05$. This points to the fact clean burning, fuel-efficient cook stoves technologies alone had a strong positive significant contribution to sustainable development in Acholi Sub Region. In sum, the findings of this objective comply with Banura (2018) and Umar et al. (2018) who documented positive significant effects between clean burning, fuel-efficient cook stoves technologies and sustainable Development.

Table 4.4: IMPACT OF SOLAR POWER TECHNOLOGIES ON THE SUSTAINABLE

DEVELOPMENT OF RURAL LIVELIHOODS

In order to establish the impact of solar power technologies the respondents were assessed on the following questions;

- enables recreation and community activities by providing safe, accessible and usable public spaces and access routes for pedestrians
- Solar powered street lights provide different benefits to various categories of people in the community, ranging from social, economic to environmental welfare
- Trade components and community-based organizations that provide skills training to local people.
- Reduction in actual and perceived crime rates especially night hours
- Female street vendors in particular benefit because they depend on the use of otherwise unsafe public spaces for their livelihood
- Low maintenance costs by the administrators

The results are as displayed in the table below

TABLE 4:1 Descriptive Statistics

| Item | N | Min | Max | Mean | Std. Dev. |
|---|---|---|---|---|---|
| enables recreation and community activities by providing safe, accessible and usable public spaces and access routes for pedestrians | 90 | 2.00 | 5.00 | 3.9556 | .66891 |
| Solar powered street lights provide different benefits to various categories of people in the community ranging from social, economic to environmental welfare | 90 | 2.00 | 5.00 | 3.9000 | .54153 |
| Trade components and community-based organizations that provide skills training to local | 90 | 3.00 | 5.00 | 3.9222 | .37410 |

| | | | | | |
|---|---|---|---|---|---|
| people. | | | | | |
| Reduction in actual and perceived crime rates especially night hours | 90 | 2.00 | 5.00 | 3.9111 | .48908 |
| Female street vendors in particular benefit because they depend on the use of otherwise unsafe public spaces for their livelihoods | 90 | 2.00 | 5.00 | 3.9111 | .46554 |
| Low maintenance costs by the administrators | 90 | 2.00 | 5.00 | 3.8556 | .50971 |
| Composite Mean | 90 | 2.00 | 5.00 | 3.9092 | .508145 |
| Scale: *1.00-1.90 represents strongly disagree; 2.00-2.90 represents disagree; 3.00-3.90 represents moderate; 4.00-4.90 representing agree; and, 5.00 represents strongly agree.* | | | | | |

*Source: Primary Data (2022)*

As shown in Table 4.3.6, and basing on the overall mean of 3.9092 it can be stated that the respondents neither disagreed nor agreed on the question as to whether the solar power technologies impacted their sustainable development of rural livelihood, this actually implies that there still more need to have vigorous sensitization on the ways of enhancing solar technologies and to create more awareness so as to improve the lives of people in Northern Uganda.

## 4.4 EFFECT OF SOLAR POWER TECHNOLOGIES ON THE SUSTAINABLE DEVELOPMENT OF RURAL LIVELIHOODS IN ACHOLI SUB REGION

This section documents information on the effect of solar power technologies on sustainable development in Acholi Sub Region. The objective was tested first using a bivariate correlation which yielded the following results: r (90) = .313, $p < 0.01$. The interpretation of these results is that there was a weak positive significant relationship between solar power technologies and sustainable development delivery in Acholi Sub Region. The results of th

TABLE 4.4.1: CORRELATION BETWEEN SOLAR POWER TECHNOLOGIES AND SUSTAINABLE DEVELOPMENT

| | | solar power technologies | Sustainable development |
|---|---|---|---|
| solar power technologies | Pearson Correlation | 1 | .313** |
| | Sig. (2-tailed) | | .003 |
| | N | 90 | 90 |
| Sustainable development | Pearson Correlation | .313** | 1 |
| | Sig. (2-tailed) | .003 | |
| | N | 90 | 90 |

**Correlation is significant at the 0.01 level (2-tailed).

*Correlation is significant at the 0.05 level (2-tailed).

The objective was also subjected to a linear regression matrix in order to determine how much solar power technologies contributed to sustainable development delivery in Acholi Sub Region. The regression test produced results as shown in the Table 4.2.2.

TABLE 4.4.2: Model Summary of regression analysis

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .313[a] | .298 | .288 | .59199 |

a. Predictors: (Constant), solar power technologies

The model summary of the regression test produced an Adjusted $R^2$ of .288, which meant that solar power technologies contributed about 29% to sustainable development in Acholi Sub Region. The remaining 71% was contributed by other factors outside the scope of the current study.

The F test results also revealed that there was a significant linear relationship between solar power technologies and sustainable development [$F(1, 88) = 9.543$, $p < 0.05$]. From this statistic, it is possible to conclude that the more Acholi Sub Region improves its solar power technologies, the better its sustainability of lives. The results of the F test are shown in Table 4.4.3.

TABLE 4.4.3: ANOVA[A]

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 3.344 | 1 | 3.344 | 9.543 | .003[b] |
| | Residual | 30.840 | 88 | .350 | | |

| Total | 34.184 | 89 | | | |
|---|---|---|---|---|---|

a. Dependent Variable: sustainable development

b. Predictors: (Constant), solar power technologies

Furthermore, a t-test was carried to draw out the statistical significance between solar power technologies and sustainable development, and the results are shown in the following coefficients table - Table 4.4.4.

TABLE 4.4.4: COEFFICIENTS[A]

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 1.979 | .364 | | 5.436 | .000 |
| | Control Activities | .343 | .111 | .313 | 3.089 | .003 |

a. Dependent Variable: sustainable development

From the results of the coefficients table, a t-value for solar power technologies of 3.089 with the probability of this occurring by chance being equal to 0.003, that is, $p < 0.001$

(95% confidence interval, two tailed) was obtained implying that this was statistically significant. The above find

4.5 Multivariate Analysis

In order to answer the primary research objective of the study, the overall effect of renewable energy technologies on sustainable development in Acholi Sub Region was tested using a multiple linear regression model (MLRM)) and the results of the model summary are presented in Table 4.5.1.

TABLE 4.5.1: MODEL SUMMARY

| MODEL | R | R SQUARE | ADJUSTED R SQUARE | STD. ERROR OF THE ESTIMATE |
|---|---|---|---|---|
| 1 | .433[a] | .388 | .359 | .56822 |

a. Predictors: (Constant), electricity technology, clean energy cooking stoves technology and solar energy technology

The results from model summary in Table 4.5.1 show that all the constructs under Renewable Energy Technologies (electricity technology clean energy cooking stoves technology, solar energy technology) combined yield an Adjusted $R^2$ of .359. The explanation for this is that about 36% of the changes in sustainable development in Acholi Sub Region is contributed by the Renewable Energy Technologies (electricity technology, clean energy cooking stoves technology and solar energy technology), and that the remaining 64% is contributed by other factors beyond the scope of the current study.  In addition, the ANOVA results yielded a linear relationship [F (3, 86) = 6.625, p

TABLE 4.5.2: ANOVA[A]

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 6.417 | 3 | 2.139 | 6.625 | .000[b] |
| | Residual | 27.767 | 86 | .323 | | |
| | Total | 34.184 | 89 | | | |

a. Dependent Variable: sustainable development

b. Predictors: (Constant), electricity, clean energy cooking stoves, solar energy

Lastly, the coefficients table further yielded beta values of 0.161 with a p-value > 0.05, 0 .249 with a p < 0.05, and 0.171 with a p-value > 0.05, for electricity technology clean e nergy cooking stoves technology, solar energy technology, respectively. This means that electricity has a positive but insignificant effect on sustainable development in Acholi Sub Region, clean energy cooking stoves has a positive significant effect on sustainable development in Acholi Sub Region and solar has a positive insignificant effect on sustainable development in Acholi Sub Region as illustrated in Table 4.5.3.

TABLE 4.5.3: COEFFICIENTS[A]

| Model | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|
| | B | Std. Error | Beta | | |
| 1 (Constant) | .999 | .472 | | 2.116 | .037 |
| Electricity technology | .183 | .135 | .161 | 1.352 | .180 |
| Clean energy cooking stoves | .288 | .117 | .249 | 2.464 | .016 |
| Solar technology | .187 | .129 | .171 | 1.451 | .150 |

a. Dependent Variable: sustainable development

Overall, the results of the multivariate analysis augur well with the findings of Ong'unya and Kalenzi (2019) in which renewable energy technologies were found to considerably influence the quality of sustainable development in greater Iganga Local Government and Ntongo (2012) whose findings revealed a significant positive relationship between renewable energy and sustainable development in the improvement of livelihoods in Kampala Districts

# CHAPTER FIVE SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

## 5.0 INTRODUCTION

This chapter covers the summary, conclusions and recommendations of this study. The main purpose of the study was to examine the effect of renewable energy technologies and sustainable development on the livelihood of people in Northern Uganda focusing on Acholi Sub Region as a case study

## 5.1 SUMMARY

A summary of the specific objectives of this study are indicated in the ensuing subsections with special attention paid to answering the three primary research questions.

### 5.1.1 EFFECT OF ELECTRICITY TECHNOLOGY AND THE SUSTAINABLE DEVELOPMENT IN ACHOLI SUB REGION

In this study, the effect of electricity technology on sustainable development in Acholi Sub Region produced an adjusted $R^2$ value of 0.195, which meant that about 20% of the variation in sustainable development of Acholi Sub Region can be explained by electricity technology. The F test result of 10.356 with a significance of 0.002 meant that there was a significant relationship between electricity technology and the sustainable development because the probability of the results occurring by chance was less than 0.05 ($p < 0.005$) at a 95% significance level.

### 5.1.3 EFFECT OF CLEAN BURNING, FUEL-EFFICIENT COOK STOVES TECHNOLOGIES ON SUSTAINABLE DEVELOPMENT IN ACHOLI SUB REGION

The responses on the effect of clean burning, fuel-efficient cook stoves technologies on sustainable development in Acholi Sub Region produced an Adjusted $R^2$ of .198, which meant that clean burning, fuel-efficient cook stoves technologies contributed about 20% to sustainable in Acholi Sub Region. The results from the ANOVA table further exhibited a significant linear relationship [F (1, 88) = 10.654, p < 0.05] between clean burning, fuel-efficient cook stoves technologies and sustainable.

### 5.1.3 EFFECT OF SOLAR POWER TECHNOLOGIES ON SUSTAINABLE DEVELOPMENT OF RURAL LIVELIHOODS IN ACHOLI SUB REGION

As far as the effect of solar power technologies and sustainable development, an Adjusted R Square of .288 was obtained. This meant that solar power technologies contributed about 29% to sustainable development of rural livelihoods in Acholi Sub Region. The results from the ANOVA table also produced a significant linear relationship [F (1, 88) = 9.543, p < 0.05] between solar power technologies and sustainable development.

### 5.1.4 EFFECT OF RENEWABLE ENERGY TECHNOLOGIES ON SUSTAINABLE DEVELOPMENT OF LIVELIHOOD IN ACHOLI SUB REGION IN NORTHERN UGANDA

All the constructs under Renewable Energy Technologies (electricity technology clean energy cooking stoves technology, solar energy technology) combined yield an Adjusted $R^2$ of .359. The explanation for this is that about 36% of the changes in sustainable development in Acholi Sub Region is contributed by the Renewable Energy Technologies (electricity technology clean energy cooking stoves technology , solar energy technology), and that the remaining 64% is contributed by other factors beyond the scope of the current study.

Lastly, the coefficients table further yielded beta values of 0.161 with a p-value > 0.05, 0 .249 with a $p < 0.05$, and 0.171 with a p-value > 0.05, for electricity technology clean energy cooking stoves technology, solar energy technology, respectively. This means that electricity has a positive but insignificant effect on sustainable development in Acholi Sub Region, clean energy cooking stoves has a positive significant effect on sustainable development in Acholi Sub Region and solar has a positive insignificant effect on sustainable development in Acholi Sub Region

## 5.2 CONCLUSION

A number of conclusions can be drawn from the results of the regression analysis of this study. First, the researcher concludes that renewable energy technologies to a limited extent affects sustainable development. Secondly, it can also be concluded that because of access to electricity technology in Acholi Sub Region enhances quality of lives in the district.

Thirdly, the study also concluded that clean energy cooking stoves and solar technologies significantly affects sustainable development in Acholi Sub Region.

## 5.3 RECOMMENDATIONS

Drawing from the findings and the conclusions of this study, several recommendations are made. Firstly, there is a need to improve the current picture of the renewable energy technologies all aimed at improving sustainable status in Acholi Sub Region.

The management of Acholi Sub Region should also start thinking in terms of incorporating information technolo

Finally, the researcher also recommends a thorough review of the existing renewable energy technologies with the aim of strengthening them through policy implementation, willingness and readiness of people because their apparent contribution towards sustainable development based on the results of the multivariate analysis is relatively low compared to the results from prior studies.

## 5.4 AREAS FOR FUTURE RESEARCH

One possible area for future research would be investigate the effect of renewable energy technologies and sustainable development in other regions of Uganda so as to bring out a general picture on the association between renewable energy technologies and sustainable development

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