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# Clean Energy Community Based Projects and Sustainable Livelihoods in Teso South Sub-County, Busia County, Kenya

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**Abstract:** *Project sustainability is a vital factor to consider in any project in any part of the world as many development projects have had to close down with exit of donors. This denies stakeholders the realisation of the projects outcomes. Clean energy community based projects and sustainable livelihoods are to nurture new thinking to offer more support to the community at the grass-root level for sustainable livelihoods. The main objective of this study was to investigate how clean energy community based projects can sustain livelihoods in Teso South Sub-County, Busia County, Kenya. Sustainable Livelihood Approach (SLA) guides development interventions, a framework for analysis and an overall development objective. A descriptive study design was adopted and employed both qualitative and quantitative research methods. The study sample had 98 respondents. A questionnaire and interviews were instruments of collecting data. Quantitative data were analysed using descriptive statistics using Statistical Package for Social Sciences (SPSS version 23), while qualitative data used content and thematic analysis. The study findings confirmed the SLA approach: interventions should be evidence-based rather than the top-down method without the community's knowledge, help understand what is and what can be done and development as improvement of livelihood sustainability i.e. Making capitals less vulnerable, enhancing contributions made by some capitals or improving the context of an institution. The study recommended for improved policy framework at the level of the Sub-County, County and National governments to help in the promotion and coordination of programmes for increased adoption of clean energy in the Sub-County*.

**Keywords:** *Clean energy, Community based, Projects, Sustainable, Livelihoods*

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## 1. Introduction

Clean energy is from renewables which have zero carbon emissions. It is also energy saved through efficiency i.e. reduced energy consumption. This energy plays a central role in building a sustainable world. The Sustainable Development Goals (SDGs) and the Paris Agreement of December 2015, can have their full realisation as renewable energy takes the place of fossil fuels. This is because clean energy has reduced greenhouse emissions hence enhanced human health due to improved air quality and sustainable livelihoods to the poor and rural communities. To attain 100% clean energy is necessary for the planet and for humanity. The Paris Accord that was supported by every country to reduce the global temperature increase to 1.5˚ C indicated that clean energy is inevitable and achievable. Clean energy has a package of benefits; reduce the impact of global warming, clean air and improved health (Madsen, Sargent, Dutzik, Weissman, Norman & Miller, 2016).

Clean energy community based projects contribute to community sustainable development by using resources that are locally available, improved transparency, promoting ownership, reducing the cost of the project and equitable distribution of development benefits which may impact the living standards and

the quality of life of the communities involved (Ceptureanu, Ceptureanu, Luchian & Luchian 2018). These projects work in close collaboration with concerned persons as they recognise the resilience, capacities, skills and resources of the persons concerned in order to develop solutions to the various challenges facing the community (United Nations High Commissioner for Refugees (UNHCR), first edition, January 2008).

Global trends indicate that many countries are investing heavily on clean energy. In 2018 renewable energy increased by 4% and accounted for about 25% of global energy output. China accounted for 40%, Europe accounted for 25%, United States and India combined accounted for 13% (IEA global energy report 2019). Renewable energy is expected to expand by 50% between 2019 and 2024 (IEA renewables report 2019). The global investment in clean energy was US $ 272.9 billion, this being the fifth consecutive year of investing more than US $ 250 billion from 29 countries each investing more than $1 billion in 2018, compared to 25 in 2017 and 21 in 2016. China, having the highest investment at $88.5 billion, with Europe and the US investing $59.9 billion and $42.8 billion respectively, there is an increase in investment globally on energy efficiency and renewable energy technologies which received an amount of US $ 285.9 billion in 2015 a 5% increase compared to 2014. Countries like the Netherlands, Sweden, Morocco, Russia and Taiwan saw investment increased by 100% and more in renewable energy (Frankfurt School-UNEP Centre/BNEF report for 2019).

In the United States of America, clean energy generation is on the increase from 11% in 2010 to 14% in 2013. Hydro power accounts for more than half of the power generated, but wind is significantly growing as well (International Renewable Energy (IRENA) report 2015). Public concern for climate change is on the increase with 38% of the Americans having a perception that global warming is harming people and therefore investing in low-carbon emissions and fighting climate change will be a better option (Bassett, Alexander-Kearns & Demsas, 2016). Clean energy in many parts of the United States of America is reducing in cost with wind energy being the cheapest reduced by 58% and solar by 78% between 2009 and 2014 (Madsen, Sargent, Dutzik, Weissman, Norman & Miller, 2016). As the United States of America generates 3% of its electricity from renewable sources, other developed economies like Denmark, Germany, Spain and New Zealand 25%, 20%, 16% and 8% generate their clean energy respectively (Delmas & Montes-Sancho, 2010).

Germany is one of the leading countries in the world when it comes to clean energy. The government has committed that all the buildings should be energy efficient. This is the government's effort to reduce the emission of greenhouse gases (Global Energy Network Institute (GENI), 2011). In 2018, Germany's renewable energy generated more than coal and lignite combined for the first time. The capacity increased by 6.6 GW. At the same time the consumption of renewable energy rose by 1.8% to 37.8%. The increase in clean energy production was due to installation of more solar power plants. In the transport sector, renewable energy increased from 5.2% to 5.6%. According to a German research institute 42% of all renewable power is in the hands of the citizens (Berlin Energy Transition Dialogue, 2019).

In Latin America, new investment in clean energy was about $12.1 billion. The highest investment was in solar with $7.3 billion, an increase of 12% which was mostly directed to Mexico and Chile. Second to solar was wind with an investment of $4.3 billion. Other sectors that received financing were biomass and waste and hydro at about $200 million. Mexico was leading in the region with $3.8 billion investment into clean energy. Argentina increased her investment by 15% to an amount of $1.9 billion and Chile had new investments of $1.3 billion for clean energy with solar and wind attracting $1.2 billion and $100million respectively (Frankfurt School-UNEP Centre/BNEF report for 2019).

In Asia, India committed $11billion to clean energy of which $6.9 billion was invested in solar and wind received an investment of $4.1 billion. Taiwan committed $1.8 billion an increase of 163% for clean energy. Pakistan invested more than a half a billion dollars in renewable energy and Japan invested $17.6 billion for green energy. China is quickly turning to clean energy. In 2017, 53 gigawatts of solar power capacity was installed and this was 13% of all the solar capacity installed in the world. In addition, of the US $279.8 billion spent globally on renewable energy in 2017, 45% that is, $126.1 billion was spent in China. The major part of the Chinese share $86.5 billion (68%) was invested into solar power. For electric-vehicle market out of the 1.1 million cars produced in 2017, half of them were made in China (Jeffrey ball, The Brookings Institution report may 2019).

In Africa, the continent has the most promising markets for clean energy for example solar. It is naturally endowed with more hour of sunlight which is a great advantage to tap into the solar clean energy. The rapid economic and population growth in the continent has profound implications for the energy sector (IEA Africa energy outlook, 2019). In 2017, non-hydropower renewable energy grew by about 9% some of the significant in non-hydropower countries in the continent were South Africa, Egypt and Kenya (Renewables 2018 global status report).

The countries of the Eastern African region have shown strong economic growth some doubling their per capita Gross Domestic Product (GDP) while others like Rwanda and Ethiopia had a GDP grow by more than 180% between 2000 and 2011 (United Nation Economic Commission for Africa, 2014). In most of these countries in the Eastern region of Africa, 90% of the population relied on biomass as the main source of energy. In South Sudan only 1% has access to electricity while 9.3 million people have no access to electricity. In the DRC 11% have access to electricity while about 60 million have no access. In Ethiopia 22.5% have access while almost 64.5 million have no access to electricity. In Uganda 12% have access while 27 million people have no access to electricity. In Tanzania 18% have access while 38 million have no access. In Kenya 16% have access while more than 32 million have no access (International Renewable Energy (IRENA) report 2017). Due to these inadequacies in electricity more research and innovative ways of producing clean and sufficient electricity are needed for the region.

In Rwanda, biomass accounts for 85% of primary energy consumed of which wood contributes 57%, Charcoal 23%, crop residues and peat 5%. Non-biomass contributes 14% of which petroleum products account for 11% and electricity accounts for about 4%. The country is developing her electricity from a number of sources of clean energy: 150MW from methane gas, 120MW from peat, 18.5MW from solar and 45MW from hydropower project (Uwisengeyimana et al., 2017).

In Tanzania biomass continues to be the main source of energy accounting for 85.5%, petroleum accounts for 6.6%, gas accounts for 1.5%, hydroelectricity at 0.6% while coal and peat account for 0.2% (Energy Agency Statistics for Tanzania, 2012). In most developed economies the access to electricity is 100% while Uganda has only 15% of her population access electricity and only 10% have modern stoves energy (Fische, 2014). Uganda is rich with renewable energy resources estimated at 5,300 Megawatts (MW). These resources are unexploited due to perceived technical and financial risks involved. The renewable energy is quickly expanding with over 900MW of power generation capacity of which 18% comes from small hydro projects, biomass and solar plants. More than 30,000 solar Photovoltaic (PV) have been installed in rural areas (Mokveld & Eije, 2018).

According to Renewables Global Status 2018, renewable energy accounts for over 70% of Kenya's installed capacity compared to the world's average of 24%. In 2018, Kenya produced 700 megawatts of geothermal power being the largest in the continent. Most rural homes and peri-urban settlements in Kenya use traditional biomass (wood, charcoal), dung and residues from agricultural plants are commonly used for cooking while kerosene for lighting. Biomass accounts for about 90% of energy used in rural households. The country's poor continue to lack clean energy as they remain vulnerable to respiratory diseases due to poor air quality (United Nations Development Programme (UNDP) and Nationally Appropriate Mitigation Action (NAMA), 2016).

About 92,000, that is less than 1% of Kenyan households use clean energy for cooking. Majority (70%) of the Kenyan households use charcoal and wood for cooking. This situation is quite different in Western and Nyanza where about 90% of households use charcoal and wood for cooking. Western has the least penetration of Kenya power at 14%, Eastern 38% and Nyanza 42%. In these areas the use of kerosene for lighting is highest (Infotrak Research & Consulting survey carried out in January 2017). According to the Kenya National Bureau of Statistics (KNBS) and Society for International Development (SID), 2013 study, less than 1% of Busia residents use liquefied petroleum gas (LPG), about 2% use paraffin, 84% use firewood and 13% use charcoal.

Teso South Sub-County, Busia County is located in Western part of Kenya and as underlined by Infotrak, 9 out of 10 households use charcoal and wood for cooking in this part of the country. This has led to a lot of pressure on forests for charcoal and wood as the main source of energy for cooking. Hence causing deforestation, soil erosion, air pollution, climate change and global warming which are great threats to livelihoods. This study investigated how clean energy community based projects can sustain livelihoods in Teso South Sub-County, Busia County, Kenya. This was done by establishing varieties of clean energy initiatives, assessing the preparation process of clean energy sources, investigating on the influence of the trading processes and assessing the utility of the income gained from clean energy.

## 1.1 Statement of the Problem

Project sustainability is a vital factor to consider in any project in any part of the world as many development projects have had to close down with exit of the donors. This denies stakeholders the realisation of the projects outcomes. Clean energy community based projects and sustainable livelihoods are to nurture new thinking to offer more support to the community at the grass-root level for sustainable livelihoods. Clean energy community based projects are initiated to spur development at the level of the community which contributes to the sub-county, county, national and global development agenda.

In Western part of Kenya 9 out of 10 households use charcoal and wood for cooking (Infotrak, 2017). There have been numerous community development projects in Teso-South Sub-County, Busia County, implemented by various church-based institutions, non-governmental and government organisations. These initiatives have not adequately addressed the issue of sustainable livelihoods in the Sub-County. This study intends to bridge this gap as it focuses on sustainable livelihoods in Teso South, Busia County. If this problem is not solved, the communities will remain vulnerable to shocks and stresses hence a continuous circle of poverty, degradation of the environment hence climate change and global warming.

## 1.2 Research Objectives

The overall objective of this study was to investigate how clean energy community based projects can sustain livelihoods in Teso South Sub-County, Busia County, Kenya. The study was guided by four specific objectives.

## 1.3 Specific Objectives

i. To establish varieties of clean energy initiatives that enhance sustainable livelihoods in Teso-South Sub-County, Busia County, Kenya.

ii. To assess how the preparation process of clean energy sources has contributed towards sustainable livelihoods in Teso-South Sub-County, Busia County, Kenya.

iii. To investigate the influence of the trading processes of clean energy products towards sustainable livelihoods in Teso-South Sub-County, Busia County, Kenya.

iv. To assess the utility of incomes gained from clean energy community based projects on sustainable livelihoods in Teso-South Sub-County, Busia County, Kenya.

# 2. Literature Review

Sustainability is something that will last into the future that is, it will be resilient to the turbulence of politics, economic systems and environmental change of our world. Sustainability is all about people and livelihood is people-centred concept with the environment important for people's livelihoods and survival. Sustainable livelihood is the connection between day-to-day lives and the means by which it lasts into the future without damaging anyone's prospects along the way (Morse & McNamara, 2013).

The Livelihoods approach has six core concepts; –people-centred in this concept people are at the centre of development at all levels of the society. –a holistic concept identifies the most pressing constraints and opportunities available to the people. –a dynamic concept just as people and institutions are dynamic, so too is the concept to be able to understand and learn from the change and support positive patterns of change and mitigate negative patterns. –building on strengths concept starts with the strengths rather than the needs. That is, it recognises everyone's inherent potential i.e. strong social network, access to physical resources etc. –The macro-micro links concept, this is the interconnectedness at all levels of the society i.e. the high level for policy making and the people at the local level. –The concept of sustainability is the resilience in the face of external shocks and stresses, not dependent on external support and maintaining long-term productivity (Department for International Development (DFID), 1999).

## 2.1 Varieties of clean energy initiatives and sustainable livelihoods

Different countries, organisations and individuals have undertaken a number of clean energy initiatives and sustainable livelihoods. They include; improved cook stoves, solar power and bio-briquettes. Improved cook stoves play an important role in combating global warming and climate change by reducing greenhouse gas emissions with a consumption rate of 71.2% less firewood than the traditional cook stoves (Flores et al., 2011). Globally, cooking accounts for about 2% of all greenhouse gas (Grupp, 2004). According to the study carried out in Burkina Faso, improved cook stoves accounted for improved health, reduced cooking time and the consumption of firewood by 28% (Bensch, Grimm & Peters, 2015).

One out of five people in the world lives without electricity in their homes. Most of the 1.1 billion people without electricity are in Sub-Saharan Africa and South Asia. About 80% are in rural areas using kerosene lamps, candles, wood for lighting (IEA and World Bank, 2017). The Global Off-Grid Solar (OGS) in 2017 improved access to electricity of about 73 million households that is more than 360 million people's lives were transformed from relying on kerosene and solid fuels to solar energy for the lighting needs. By 2017 OGS had recorded progress with South Asia having 80% coverage while Sub-Saharan Africa having about 40% (Off-Grid Solar Market Trends Report, 2018).

In spite of the increased rate of production in developing countries, waste collection rates are lower than 70%. In Sub-Saharan Africa, an estimated 62 million tonnes per year and more than 50% of household waste is disposed in uncontrolled land filling as 15% is unsafely processed and recycled (UNEP, 2013; Mohammed & Elias, 2017). Despite the increase in waste generation, the collection and disposal mechanisms are poor (Edwards, 2010). However, from a sustainable perspective, organic waste should be viewed as a valuable resource as it can be reused or recycled. Organic waste can be transformed into marketable products like bio-briquette which offer employment, better environment, sustainable incomes and improved quality of life hence better livelihoods (Iyyanki V. Muralikrishna & Valli Manickam, 2017).

## 2.2 Preparation process of clean energy sources and sustainable livelihoods

This process was interested in bio-briquettes in rural areas using locally available materials e.g. crop residues; straws of wheat, millet, sorghum, maize stalks and cobs, sugarcane trash, leaves, fibrous materials, roots, branches and twigs. Other materials for the briquettes are the agro-industrial residues; rice husks, groundnut shell, cotton waste, coconut shell, tamarind shell, mustard husks, coffee husk, saw dust, wood husk, cassava peel, bagasse etc. Some important binders; paper, clay, starch, cow dung and gum Arabica (Mary Njenga et al., 2013). According to Njenga et al., (2013) there are seven main steps in making of briquettes; preparation of biomass waste materials and binders, crushing and soaking of materials, pounding the materials, testing the readiness of the material for compaction, compaction of paste into briquettes, drying process, packaging, storage and use.

The biomass briquette preparation process created a number of jobs as the various steps of the bio-briquette-making process are driven by human capital. For instance, the collection of waste materials; dry leaves, wood husks, saw dust, paper, pounding the material which creates employment to the rural people (Kumar, Subbaiah & Rao, 2010). Bio-briquettes also create jobs for vulnerable groups i.e. the youth and single-mothers therefore, curbing idleness and crime (Njenga et al., 2013).

Bio-briquette process offers ready market for local products. The need for biomass as the primary material for briquettes is fundamental like saw dust, paper and wood husk as they were readily available in the local market at a cost. Equally, ready briquettes had available markets locally and could also be exported to other parts of the country.

The use of bio-briquette as clean energy helped in saving time that would be wasted in travelling long distances for firewood. This time was used in other productive projects and activities which generate income hence improved livelihoods. Making bio-

briquette is a skill which makes a person an important human resource to earn income therefore, enhanced livelihood. As bio-briquettes burn for a long time they reduce the consumption of fuel. This reduces indoor pollution and dependency on fossil fuels. As a renewable source, it helps in curbing deforestation hence mitigating on climate change and global warming.

## 2.3 Trading processes of clean energy products and sustainable livelihoods

Marketing is the art of understanding consumers and their needs (Nielsen, 2018). This could be done through fairs, exhibitions and sales. Fair is a gathering of people at regular intervals for barter or sale of goods and services (Morrow and Sandra, 2002). Trade fairs/shows, consumer/public shows, mixed shows, specialised trade fair, virtual fairs.

The word exhibition/exposition comes from the Latin word *expositio* which means displaying or putting on a show, it came into use as early as 1649 (Morrow & Sandra, 2002). Exhibitions are human activities, enterprises that are carried out for specific reasons and results. According to Morrow and Sandra (2002) this was aimed at promoting business as manufacturers displayed their products. The earliest market places for exhibitions can be traced in Champagne in France. Exhibitions have been an important part of development in different countries because new products are introduced, sales are initiated and relationship between management and customers is created (Jörg Beier & Simon Damböck, 2005).

In this study, the main message for exhibition is; bio-briquette is clean energy that saves our lives and the planet. The themes being; how the national and county governments have shaped clean energy sector and how clean energy has changed people's lives. For the learning goals; let us save our planet by reducing greenhouse gas emissions. So let us turn domestic waste into useful products and let us choose clean energy, bio-briquette. By so doing we save our planet, we keep our environment clean and save our lives. By choosing clean energy we choose life and every minute we put our domestic waste into the right place, we chose to save our planet.

Sales can be increased by using appropriate marketing strategies, that when available resource are invested to maximise the available opportunities in order to increase sales (Mohammed et al., 2014) and achieving a competitive advantage (Rotich, 2016). In this study, the marketing strategies that will be used include; sampling, word of mouth referral, advertisements, posters, bill boards and exhibitions. The sales from the bio-briquettes will be an important income for individuals as well as for the community hence improving the livelihoods.

## 2.4 Utility of the income gained from clean energy and sustainable livelihoods

The Sustainable Development Goal 4 echoes that we should ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. However, this dream has been a headache to many developing countries as an estimated 260 million children and young people are neither enrolled in primary nor secondary schools and hundreds of millions of children become adults without any basic skills in life (UNESCO Global Education Report, 2016).
In spite of the achievements, there are still an estimated 58 million children aged between 6-11 years worldwide who are out of school (UNESCO Institute for Statistics and Education for All Global Monitoring Report, 2014a). To maintaining this trend will be catastrophic to the future as 43% of the children that is, 15 million girls and 10 million boys will never go to school and Sub-Saharan Africa will have about 30 million children out of school. Globally, in 2012 about 63 million young adolescents aged between 12-15 years were out of school, though in South Asia the numbers have reduced by one-third, there are still approximately 26 million while Sub-Saharan Africa has about 22 million young adolescents out of school (UIS and EFA GMR, 2014a). According to UNESCO Institute for Statistics and UNICEF report (2015), globally one out of five adolescents does not go to school. The report further underlines that as children get old their chances to go to school reduce.

In the world an estimated eight million people die annually because they were too poor to live (Sachs, 2005). Most Sub-Saharan countries after attaining independence invested heavily in education to have sufficient human capital for national development and respond to other social needs like poverty. In Kenya, the recurrent expenditure on education was estimated at 30% (Mualuko, 2007).

The income earned from the bio-briquettes clean project fostered education well delivered education contributed to solving a myriad of social ills; employment, income, health, poverty reduction, human capital, effective choices, innovation, strengthens institutions and fosters social cohesion. Education aimed at equipping the student with the needed skills to lead a healthy, productive and meaningful life. Some education systems were struggling due to lack of; prepared leaners, effective teaching, learning focussed inputs, skilled management and governance (World Development Report on learning, 2018).

The income from clean energy community based project (bio-briquettes) helped many families increase their savings as they spent less of their income buying cheap and clean energy as compared to charcoal which is more costly and causes indoor pollution. The savings were used in others needs like foods, health, planting more trees, expanding the clean energy projects and enhancing family life (Njenga et al., 2013).

# 3. Methodology

A research design is a structure that holds all the research elements together, to show how the major parts work together to

address the research problem (Kombo & Tromp, 2006; Akhtar, 2016). The design seeks to show the strategy for data collection and analysis, the research question, and tools and procedures for data collection and analysis.

This study used a descriptive research design. A descriptive research design aims to accurately and systematically describe a population, situation or phenomenon (McCombes, 2019). This design aims at accurately identifying and obtaining information on characteristics of a particular issue for example a community, group or people. The research design describes social situations, events, structures etc. The researcher describes what he or she finds and studies the current situation (Akhtar, 2016). Descriptive research design was significant in this study to inform the researcher of the current situation of the phenomena without changing the state. Descriptive research answers the questions, who, how, when, what and where (Akhtar, 2016). This study gathered responses on clean energy community based projects and sustainable livelihoods in Teso South Sub-County, Busia County, Kenya.

## 2.1 Study and Target population

According to the Encyclopedia of Survey Research Methods (2008), a target population is the entire set of units for which the research data are to make inferences. This is the population for which the findings of the study can be generalised. This is the entire group of people, individuals or objects the researcher has chosen to study. This is the group of people to whom the study results will apply. The study population are the people who meet the operational definition of the target population (Vonk, 2017). The target population in this study was the population of Teso South Sub-County in Busia County. Busia County had a total population of 893,681 with females numbering 467,401 (52.3%), males numbering 426,252 (47.70%) and intersex 28 (KNBS, 2019 Census).

Teso South Sub-County in Busia County is located in Western part of Kenya with a population of 168,116 with male 80,484, female 87,630 and intersex 2. The number of households is 36,569 with an average household size of 4.6, the land area in sq.km is 302.9 with a population density of (No. persons per sq.km) 555 (KNBS, 2019). Teso South Sub-County is one of the 7 Sub-Counties of Busia County, the others include; Teso North, Nambale, Matayos, Butula, Funyula and Budalangi. It borders Nambale to the East, Matayos to the South, Teso North to the North and Republic of Uganda to the West. It is divided into six wards; Amukura East, Amukura Central, Amukura West, Ang'orom, Chakol South and Chakol North (Independent Electoral and Boundaries Commission (IEBC) preliminary report, 9th January 2012).

## 2.2 Sample and Sampling Techniques

A sample is a selected subset of individuals from within a population to estimate the characteristics of whole population. The selection of the subset is done by either probability or non-probability. Sampling is a faster way of collecting data which is less costly (Singh & Masuku, 2014). A sample also defined as a finite part of statistical population whose properties are studied to gain information about the target population (Kombo & Tromp, 2006). The population of Teso South Sub-County was 168,116 (IEBC Census, 2019). In this research to calculate the sample size of the target population of 168,116 we adopted Taro Yamane's formula, $\mathbf{n=N/[1+N(e)^2]}$ (Matula et al., 2018). Where n is the sample size, N is the population size (168,116), 1 is the constant value and e is the level of precision/the margin of error (0.1).

For example: $n=168,116/[1+168,116 \times 0.1^2]$

$n=168,116/[1+168,116 \times 0.01]$

$n=168,116/[1+1681.16]$

$n=168,116/1682.16$

$n=99.94055$ (approximately 100 respondents)

Sampling is a procedure used by the researcher to gather people, places or things to study. This is a process of selecting some people or objects from a population such that the selected group contains elements representative of the characteristics found in the entire group. A sampling technique or design is part of the research plan that indicates how cases are to be selected for observation (Kombo & Tromp, 2006). There are two main categories of sampling; probability i.e. simple random sampling, systematic random sampling, stratified random sampling, cluster random sampling and multi-stage random sampling. The other is non-probability i.e. purposive sampling, snowball sampling, convenience sampling and quota sampling. This study used purposive and simple random sampling methods.

**Table 1: Sample matrix**

| Category | Population | Sample | Percentage | Sampling Technique |
|---|---|---|---|---|
| **Members of County Assembly** | 6 | 6 | 100% | Purposive |
| **Ministry of energy (Amukura)** | 1 | 1 | 100% | Purposive |
| **Members of Community based projects** | 120 | 92 | 76.67% | Simple random |
| **Akukuranut Micro-finance Bank** | 1 | 1 | 100% | Purposive |
| **Total** | **128** | **100** | **78.12%** | |

## 2.3 Research instruments

Research instruments are tools used to collect data needed to address a research problem (Matula et al., 2018). The study used both primary and secondary data. The primary data was collected using questionnaires and interviews while the secondary data was collected by reading reports, journals, websites, periodicals and text books that were relevant to the study.

### 2.3.1 Questionnaire

A questionnaire is a research instrument for collecting data consisting of a series of questions and other prompts for the purpose of gathering information from respondents (Abawi, 2013). It is a cheap and effective way of collecting data in a structured and manageable form. It can be very detailed covering many subjects or issues, or simple and focussed on one important area (Wilkinson & Birmingham, 2003). It is an ideal instrument for gathering large information within a short time. The questionnaire for this study will consists of both open and closed ended questions to help the researcher gather more and in-depth information for the study. The study used; rating scales and multiple choice questions to help the respondents remain focused as well as facilitate coding for the researcher. The themes of the questionnaire were developed in the way that helped the researcher collect relevant responses to the study. The questionnaire had five parts; the first was about the background information of the respondent i.e. name, ward, age, gender, number of children, level of education, income level, marital status and occupation. The other four parts were focused on the four objectives of the study; varieties of clean energy initiatives, the preparation process of clean energy sources, the trading processes of clean energy products and the utility of income gained. The questionnaire was self-administered, that is, respondents filled in the questionnaire by themselves without the influence of the researcher.

### 2.3.2 Interview guide

An interview guide is a research instrument for collecting data through interview. According to Wilkinson & Birmingham (2003), in interviews, a researcher elicits information from the respondents on one-to-one basis. This offers the researcher with more insight on the meaning and the significance of what is happening, though resource intensive. An interview guide is in three forms; structured, unstructured and semi-structured. This study used unstructured interviews as this enabled the researcher to collect in-depth information on the study. The researcher on face-to-face probed the respondents on the objectives of the study to collect more and detailed information. The researcher chose the unstructured interviews because it is flexible, that is, clarifications can be made, more explanation can be given or change of items can be done if need be.

## 2.4 Data Analysis Procedures

The instruments for data collection were a questionnaire with open and closed ended questions, and unstructured interview to gather relevant data to the objectives of the study. The researcher was assisted by a trained and qualified research assistant who administered the questionnaire. After data had been collected, the instruments for data collection were checked and numbered for consistent and accurate data entry. A numeric value was assigned to all the responses to facilitate the data entry and processing by Statistical Package for Social Sciences (SPSS) version 23.0 programme. Descriptive and inferential statistics such frequency tables and Chi-Square were used to report data. For qualitative data, the study used content analysis by classification, tabulation, and evaluation of key symbols and

themes in order to derive meaning and possible effects to the study, which was presented in a narrative manner. The data from closed ended questions was quantitative while data from open ended questions and interviews was qualitative, therefore, this study adopted a mixed method approach where the numbers and the narrative were put together to make the data more meaningful.

### Response rate

The study had a sample size of 100 respondents from which 98 filled and returned the questionnaires making a response rate of 98%. 100 questionnaires were administered to the respondents and 98 of them returned. This translates to 98 percent return rate of the respondents of which the study considers sufficient to make analysis, conclusions and recommendations.

# 4. Results and Discussion

**Table 2: Respondents' Ward**

| Ward | Frequency | Percentage |
|---|---|---|
| Ang'orom | 2 | 2.0 |
| Chakol South | 2 | 2.0 |
| Chakol North | 84 | 85.7 |
| Amukura West | 5 | 5.1 |
| Amukura East | 1 | 1.0 |
| Amukura Central | 4 | 4.1 |
| **Total** | **98** | **100** |

The data shown on Table 2 indicates that most (84 out of 98) of the respondents were from Chakol North Ward that is 85.7%. This indicated that the researcher had a majority of the respondents for the community based projects from one Ward the other five Wards were mainly represented by the office of Members of the County Assembly (MCA). These Wards were; Ang'orom, Chakol South, Amukura West, Amukura East and Amukura Central. This was done in line with the MoH and the Kenya Government restrictions on COVID-19 to reduce the number of public gatherings as to curb the spread of the virus.

**Table 3: Pearson's Chi-Square test for Varieties of clean energy initiatives and level of education**

| | Value | df | Asymptotic Significance (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 25.959[a] | 8 | .001 |
| Likelihood Ratio | 22.788 | 8 | .004 |
| Linear-by-Linear Association | 14.447 | 1 | .000 |
| N of Valid Cases | 98 | | |

*Source: researcher, 2021*

The table 3 above shows that there is a significant relationship between the varieties of clean energy initiatives and level of education, $\chi^2$ (8, N=98) =25.96, p=.001. The respondents who had no formal education were 20% (20), primary education were 57% (56) and secondary education were 13% (13) while only 4% and 5% had attained tertiary and university education respectively. Most of those who used clean energy had tertiary and university education. Majority of the respondents (77%) utmost had primary education which explains the limited use of clean energy in Teso South Sub-County. As underlined by Sawin (2017) that more than 69% of the population use biomass especially by inefficient technologies as the most reliable source

of fuel for cooking. The Sustainable Development Goal number 7 underlines the importance of universal access to affordable, reliable and modern energy; the world is far from realising this goal (IEA and World Bank, 2017).

**Table 4: Pearson's Chi-Square test for preparation process of clean energy sources and age**

| | Value | df | Asymptotic Significance (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 15.432[a] | 6 | .017 |
| Likelihood Ratio | 16.964 | 6 | .009 |
| Linear-by-Linear Association | .355 | 1 | .551 |
| N of Valid Cases | 98 | | |

*Source: researcher, 2021*

The table 4 above shows that there is a significant relationship between the preparation process of clean energy sources and age of the respondents, $\chi^2$ (6, N=98) =15.43, p=.017. As 26% of the respondents were within the age bracket of 18-35, 42% had 36-53 years while 28% were within the age bracket of 54-71. The findings further indicated that more than half of the respondents (68%) engaged in clean energy are youth and middle age a sign of a future for clean energy community based projects. Bio-briquettes also create jobs for vulnerable groups i.e. the youth and single-mothers therefore, curbing idleness and crime (Njenga et al., 2013).

**Table 5: Pearson's Chi-Square test for trading processes of clean energy products and income level**

| | Value | df | Asymptotic Significance (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 37.566[a] | 9 | .000 |
| Likelihood Ratio | 30.488 | 9 | .000 |
| Linear-by-Linear Association | 25.010 | 1 | .000 |
| N of Valid Cases | 98 | | |

*Source: researcher, 2021*

The table 4 above shows that there is a significant relationship between the trading processes of clean energy products and income level, $\chi^2$ (9, N=98) =37.57, p=.000. The trading processes of clean energy products were enhanced by the marketing strategies and the exhibitions for increased sales volume. The majority of the respondents (89%) had an income of Ksh 0-5,000 and only 8% had an income of more than Ksh 30,000 per month. Sales were increased by using appropriate marketing strategies (Mohammed et al., 2014).

**Table 5: Pearson's Chi-Square test for utility of the income gained from clean energy and gender**

| | Value | df | Asymptotic Significance (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 14.179[a] | 4 | .007 |
| Likelihood Ratio | 11.750 | 4 | .019 |
| Linear-by-Linear Association | 6.128 | 1 | .013 |
| N of Valid Cases | 98 | | |

*Source: researcher, 2021*

The table 5 above shows that there is a significant relationship between utility of the income gained from clean energy and gender, $\chi^2$ (4, N=98) =14.17, p=.007. The income gained from clean energy was invested in improving the level of education, income generating projects and savings with 81% and 19% of the respondents being female and male respectively. The findings

further indicated that 62% and 8% of the female and male respectively had no formal education. The women are the most affected when there is indoor pollution as Nahar (2016) underlined, an estimated 2 million more women and children die annually in developing countries because of indoor pollution, as they are exposed to carbon monoxide and the volatiles in the form of smoke.

## 5. Conclusion and Recommendations

The study concluded that clean energy community based projects can sustain livelihoods in Teso South Sub-County, Busia County, Kenya. This was because the study realised its objectives; identifying the varieties of clean energy initiatives, the benefits of the preparation and the trading processes of clean energy to the local community and the utility of the income gained from clean energy. As resilience was enhanced, income levels improved and dependency reduced.

There is an urgent need for the national and county governments to invest in clean energy projects in Teso South Sub-County i.e. improved cook stoves, solar energy, bio-briquettes and liquefied petroleum gas with an objective of cutting down on the use of firewood for cooking. The national government should zero rate taxes for all clean energy initiatives. This will save forests, enhance health, environment and promote sustainable livelihoods.

There is need for sensitisation and should be part of the education system in Teso South Sub-County the importance of clean energy. The Sub-County and County governments should undertake some concrete activities in clean energy that can help inspire the residents to engage in the same initiatives.

The Teso South Sub-County government in collaboration with other stakeholders should be proactive in creating more awareness and importance on the use of clean energy. The objective will be to increase the uptake from 50% to 75% and eventually to 100% of the clean energy products produced locally.

The banks and the microfinance institutions in the Teso South Sub-County should create more awareness and importance on the culture saving income with financial institutions for security and technical financial advice. The national government should offer subsidises in agricultural sector to cushion the farmers on the cost of production hence increasing their income and sustaining livelihoods.

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