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Adoption of Green Energy Practices in Informal Settlements for Sustainable Development in Kenya

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Abstract

Worldwide, unplanned slums and informal settlements present systemic problems in the areas of; housing, health, energy and education. Providing clean and efficient energy for households in informal settlements especially in African cities remains a huge challenge. This challenge is compounded by a heavy reliance on fossil fuels such as charcoal and kerosene which often result in unintended health consequences as a result of prolonged exposure to air pollution. There exists many green technologies and systems with the goal to reduce costs and reduce hazardous effect on the human health. Despite the changes in green energy technologies, their adoption remains elusive. This paper examines the adoption of green energy practices in three informal settlements namely: Munyaka, Kamukunji and Huruma in Eldoret town, Uasin Gishu County, Kenya. The specific objectives are; examine green practices being adopted and determine factors influencing the adoption of green energy practices. Based on mixed methods approach, data was obtained using data collection instruments that included questionnaires, interview schedules, researcher's observation, document reviews and focus group discussions (FGD). Stratified simple random and purposive sampling techniques were adopted to select the samples. The findings of the study established that informal settlement dwellers have largely adopted green energy practices for lighting although the adoption of solar energy is still low.

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Further, IS dwellers have not adopted green energy practices in cooking since majority still use charcoal and firewood often considered as a non-green practice. In addition, adoption of green practices is hindered by various factors which include; high initial cost, inaccessibility to green technologies, lack of personnel and lack of policy framework. The study recommends that effective integration of green energy practices should involve all stakeholders in adopting different energy solutions that already exist in the market. A policy framework towards greening for home use is seen as a panacea to foster adoption of green energy.

Key words: Green energy practices; Informal settlements; Sustainability and adoption.

1. Introduction

Globally, access to modern forms of energy like electricity and solar and its services are prerequisites for economic and social development and poverty reduction [1]. However, around three billion people across the world still rely on solid fuels and traditional, inefficient stove technologies to meet their basic energy needs [2]. Sub-Saharan Africa (SSA) has the lowest energy access rates in the world. Electricity reaches only about half of its people, while clean cooking energy only one-third of its population [3]. Most of these households without electricity are thought to be off-grid, or located too far away to connect to the national grid. Thirteen countries in SSA have less than 25% energy access, compared to only 1% in developing Asia [4].The clean energy revolution in sub-Saharan Africa is urgently needed to win the fight against energy poverty. Clean energy provides a golden thread to deliver on the promise of Agenda 2030 Sustainable Development Goals (SDGs) and the Paris Agreement. It can unlock sustainable economic growth, improve human health and well-being and enable women and children to lead more productive lives [5, 6]. Beyond direct economic and social benefits, clean energy access will raise human security and build resilience in states and communities to help limit the risk of large scale migration across the African continent [7]. Ensuring access to clean and efficient household energy is arguably one of the major challenges that developing countries face today. Some countries and localities have very successful experiences with the development and adoption of renewable energy technologies, whereas similar projects have become highly controversial in other countries and especially in cities [8].Generally, the energy sector is facing major changes today and energy transition is one of the key points on the political agenda of countries all over the world [9].One of the major players in the global energy transition will be cities. According to the United Nations, 54% of the world's population lives in cities today and that share is expected to continuously grow, resulting in a projected 66% of the total population to be urban in 2050. In Europe alone, 73% of all the population is urban already today and it is expected that over 80% will be urban by 2050 [10]. Furthermore, urban areas account for 65% of the global energy demand and 70% of energy-related CO2 emissions. More than 1 billion people currently live in urban slums and informal settlements. These communities often lack access to legal, safe, and affordable electricity. With rapid urbanization occurring in developing countries and cities expected to house about two thirds of the world's population by 2050, dedicated efforts on energy access are needed to meet universal energy access by 2030. Bringing safe and sustainable energy to the poor living in urban slums is not only critical for reducing poverty in these communities, but also for achieving universal access by 2030. Improving the living conditions in informal settlement hinges on the sustainable development goals on access to modern energy services. While the lack of modern cooking systems affects mainly health (indoor pollution due to biomass has a strong impact on women and children health) and

family expenditure, lack of electricity access has a strong impact on education and on productive income-generating activities [11]. Studies by [12,13] provide some evidence that emissions from kerosene used for light or cooking may impair lung function and increase infectious illness (including tuberculosis), asthma, and cancer risks. They argue that there is a strong and consistent body of evidence indicating that exposure to fine particulate matter increases the risk of respiratory and cardiovascular disease, cancer, and mortality. For this reason, access to modern energy services for informal settlement dwellers is a crucial need for improving their quality of life and promoting the development of low income urban areas. For many governments, the task to meet the goal of expanded access is complex, expensive, and requires long term vision, commitment to policies that will meet the energy needs of the poor and concentrate efforts from a variety of stakeholders from the energy sector and community representatives [9]. Greening the energy sector requires improvements in energy efficiency and a much greater supply of energy services from renewable sources, both of which will lead to reducing greenhouse gas emissions (GHG) and other types of pollution [14]. In addition, enhanced access to modern forms of energy in most instances leads to improved health and eventually achievement of the Sustainable Development Goals 15]. According to [2], Kenya faces an enormous task of meeting energy needs due to the high expectations in growth to power the economy. The country therefore needs to come up with strategies and investment plans to secure sustainable supply of energy to meet the growing demands. According to the Energy Environment and Development Network for Africa [16], Kenya's energy needs is primarily derived from three sources: wood fuel, petroleum and electricity (which account for 69%, 22% and 9% of total energy respectively). This indicates that for a country that is looking to make leaps in development, this backward energy composition should be a cause of concern and forward looking governments must put in place strategies that promote renewable energy use [14]. Generally, the use of these inefficient energy sources increases indoor air pollution leading to poor health outcomes for households in informal settlements. The problem of indoor air pollution is compounded by the nature of housing in the settlement, very tiny and improperly ventilated. As a result, the community is faced with an energy-health-housing nexus problem, a complex situation where the factors worsening the life of urban informal settlements enforce and reinforce each other. Despite the fact that many of the green technologies are available to tackle the energy-health-housing nexus problem, success in adoption of these practices in informal settlements remains elusive.

1.1 Energy Accessibility

The global energy system which includes supply, transformation, delivery, and use is one of the dominant contributors to climate change, representing around 60% of total greenhouse gas (GHG) emissions [17,14]. Current patterns of energy production and consumption are widely considered by the scientific community as unsustainable, and are threatening the environment on both local and global scales [18]. For attainment of sustainable development goals, and in order to meet the needs of their inhabitants, cities in developing countries will require access to modern energy services in a way that is economically viable, sustainable, affordable and efficient, with a low impact on GHGs emissions [17, 15]. Access to modern energy services emphasizes the availability of energy that is widespread, diverse, reliable, secure, and affordable. This is fundamental in providing for basic social needs, propel economic growth and fuel human development. Lack of , or inadequate, access to energy has a direct impact on a number of issues that include, but are not limited to; low levels of industrial and agricultural productivity; poor human and environmental health; deficient education; unsound

water management practices; unreliable communication services; and insufficient access to information [4]. Access to electricity via national grids will continue to play a key part in energy access solutions, yet technological advances in renewable energy, especially solar, can dramatically expand options for increasing access to those not served or underserved by grids. Recent progress in solar and wind technologies provides the means to leapfrog the traditional fossil-fuel dependent and centralised power system [4]. The cost-effective development of individual and household solar devices is already providing access to millions. Renewable technologies and emerging markets is increasing the number of new options to improve access, and in many cases, can reach people faster and in a more targeted way than grid-expansion alone [19]. On the other hand, low income dwellers lack a legal address and often unable to access social services and modern energy services. Often times, modern energy services - such as electricity and clean and safe cooking systems - are available, but low income dwellers cannot afford their use**.** Low income dwellers are often unable to access social services and modern energy services that include; reliable and affordable access to clean cooking facilities, connection to electricity and an increasing level of electricity consumption over time [1]. The World Bank Energy Progress Report (2019) says "In recent years, pronounced progress in expanding access to electricity was made in several countries, notably India, Bangladesh, and Kenya. Among the 20 countries with the largest populations lacking access to electricity, India, Bangladesh, Kenya, and Myanmar made the most significant progress since 2010". Reference [20] study on Influence of the Kenya Power Slum Electrification Programme on Electricity use in Slums in Kenya, established that subsidized connection cost has had a positive influence on electricity usage. He asserts that highly reduced connection cost enables IS dwellers to get connected to the national electricity grid as they were able to afford the capital contribution as set out in the slum electrification program. In addition, the author opines that the well-constructed electricity network has also reduced meter vandalism and tampering as the residents were sensitised on taking care of the electricity network infrastructure for the common good of all and thus contributing to the great reduction of cases of electrocution and fires. Also, cases of illegal electricity connections are minimal since concrete electric poles are in place unlike the past where wooden poles were used. Reference [21] did a study in Metro Manila informal settlement in the city of Philippines on energy security analysis of households based on three sustainability objectives; accessibility to modern affordable energy for all, availability based on uninterrupted and quality of energy supply, and acceptability from the perspective of social and environmental goals. The findings of the study were that; the most common forms of fuel for cooking was charcoal, followed by gas, firewood and finally kerosene. On lighting, the study found out that majority use electricity but the study pointed out that it was not the complete picture because informal settlers acquired electricity through different ways. These were; formal, informal and free offer. However the gap in this study was that the study did not review alternative energy solutions like use of solar which is considered a green practice and which if implemented could increase the energy security of the informal settlement. Therefore this study came in to fill the gap by examining adoption of green energy practices among informal settlement dwellers.

1.2 Green Energy Practices Awareness and Adoption

Households play a crucial role in the transition of the energy system. They can make major contributions to sustainable development by adopting "green" innovations since such energy options have a substantial impact on overall energy consumption. Reference [22] argue that innovations are first adopted by persons with specific

dispositions, i.e., people with a high level of technical interest, relevant knowledge, and pro environmental orientation. As an innovation spreads, early adopters yield social influences on others encouraging them to adopt, too. In addition, awareness of locally available energy alternatives can positively influence adoption of good practices while social acceptance is influenced by both the awareness of climate change and its impacts, and the knowledge of the renewable energy technology in question. There is an evident positive relation between people's awareness about climate change and its impacts, and their preparedness to act. Increased awareness generally increases the willingness to counteract climate change and the acceptance of climate-friendly technologies [23, 24 , 25]. Apart from awareness about climate change, it is important that the public is sufficiently familiar with the renewable energy generation technology. For new technologies, timely, complete and balanced knowledge needs to be provided in order to raise awareness on its costs, risks and benefits. Experience shows that potentially useful technologies will not be considered if the public is unfamiliar with them, so that many new and existing technologies are not commonly used [19]. Adoption of renewable energy could lead to environmental quality, and creating awareness about environmental protection and sustainable development would promote people's adoption behaviour. It is anticipated that a shift in public awareness on environmental issues would result into a significant changes in the public understanding and acceptance of climate change [19].This is based on the premise that awareness of renewable energy would affect willingness to adopt it and eventually affect its adoption. Reference [26] researched on analysis of green energy adoption on household development in Kibera, Kenya. The findings indicated that there is high awareness of green energy technology but it does not translate to high adoption. It also found out that there is high usage of green energy in places supplied with technology by Non-Governmental Organisations (NGO's). Reference [27] carried out a study on urban adaptation to energy insecurity in Uganda. Results indicates that, although charcoal use is uniform across all households, a large percentage of the IS population is heavily dependent for its energy services on multiple energy sources. It further, revealed that households are burdened with relatively high retail prices for energy, electricity instabilities and wood shortages and wasteful/inefficient energy use. This study further, found out that adaptation strategies to energy insecurity include self-generation, use of improved energy technologies, adjustments in cooking practices and energy substitutions. An interdisciplinary approach to exploring the forces underpinning the adoption and non-adoption of solar PV in rural Ghana revealed that Ghana has abundant renewable energy resources, especially solar radiation [28]. Significantly, adoption and non-adoption prospects for solar PV in rural Ghana and the sustainability of installed solar PV systems, as well as the disparate levels of solar PV dissemination in Ghana, Kenya and Zimbabwe, are predicated on multi-dimensional circumstances. This is in contrast with other literature that emphasizes cost as the sole determining factor of the non-adoption of solar PV in the developing world. Reference [22] found out that households' adoption of innovative technologies depends on several factors like social influences and policy framework.

1.3 Factors influencing adoption of Green energy in informal settlements

1.3.1 Initial Cost of Green Practices

According to [29], poorer households spend much larger proportion of their incomes on basic infrastructure services. Households in the lowest income quintile (earning up to Ksh. 6,000 per month) spend 12 percent of their income on water and 18 percent on electricity. This contrasts with households in the highest income

bracket, earning from KSh 22,500 to 100,000 per month, who spend an average of 2 percent of their income on water and 3.2 percent on electricity. This is due to the fact that poor households have lower connection rates to the public network and they therefore resort to alternative sources, which are often more expensive and of lower quality than services from public utilities. In addition, this report opines that the cost of connection to services through public networks without any subsidies is unaffordable for households in lower income quintiles. The same was pointed out by [20] that the urban poor are often unable to afford the cost of infrastructure like meters, wires or even pay their electricity bills in a consistent manner, as required by Kenya Power Company. [30]on the other hand pointed out that solar have high upfront costs compared to traditional fuel but has a number of technological and financing advantages such as pay as you go solar. He argues that payments made by mobile phones are helping deal the high cost problem. Reference [31]also argues that although the households in informal settlements in Zambia had reasons to embrace energy saving measures, the cost of technology was a significant barrier which shows a willingness to reduce energy consumption but households were discouraged by the barrier. In another study, Reference [32] found out that the major constraint to the adoption of renewable energy technologies is that the initial capital outlay for these technologies tends to be high. Further , as world attempts to adopt new or improved technologies often fail because they focus on the "hardware" and ignore the complex mix of interconnected social, institutional, economic and policy issues that can limit success [33].

1.3.2 Accessibility to Green Technologies and lack of personnel with green practices

A study by [31] revealed that landlord control in the informal settlements was a highly significant barrier to using energy efficient technologies. This is because some households use electricity that had been connected from a main house to an extension or stand-alone house within the same yard and not from the service provider. This meant that the household in the extension or second house used the electricity prepaid meter in the primary house. Therefore the landlord was responsible for buying of the credit for all the households within the yard. Some landlords therefore included an amount in the rent to cater for the electricity. He further, argues that the landlord would not allow the tenants to use certain electric appliances like stoves and pressing irons as they believe that these appliances consume too much electricity. This 'landlord control' had the effect of preventing the households from adopting energy efficient technologies. Further, research by [26] on analysis of green energy adoption on household development in informal settlement of Kibera found out that lack of extension and distance to green enterprise dealers affects the adoption of green technology.

1.3.3 Policy and Legal Framework

A study by [34] on Comparative Analysis of Energy Usage and Energy Efficiency Behaviour in Low- and High-Income Households in Zambia found out that high cost of the technologies was one of barrier in the adoption of the energy efficiency measures by low-income households. They argue that although the government has tried to help in this regard by giving tax incentives to those importing energy-efficient technologies, there is however, no clearly defined policy on energy efficiency in Zambia. In Kenya, Republic of Kenya National Slum Upgrading and Prevention Policy [35] noted that there are no specific laws that address the informal settlement issue. Existing laws are mainly designed to address issues of planning and development control. The Constitution and the land laws do not provide a comprehensive legal framework for addressing the specific

informal settlement issues. It is therefore difficult to effectively deal with such issues like land tenure systems, institutional management regulatory procedures, coordination and protection against forced evictions among others.

1.3.4 Awareness of Green Practices by the Community

A study conducted by [36] among household in Kenya on the factors affecting the adoption of solar power technology for domestic power usage. The study revealed that level of knowledge and awareness of solar technology, level of income of households, and availability of substitute power source influence the adoption of domestic solar technology. Reference [37] remarks that IS upgrading initiatives are disadvantaged by IS dwellers ignorance, lack of knowledge and skills to cope with challenges. The author recommends that effective IS upgrading should include rights awareness and sustainability of local initiatives and capacity building of beneficiaries to enhance independence. According to [38] lack of information, coupled with the general failure of several past IS upgrading projects to benefit the targeted IS dwellers has led to a general distrust towards the project. Reference [39] established that lack of awareness of an existing IS policy; inadequate financing and security of tenure, high population growth; were the challenges hindering implementation of the IS upgrading programme. He argues that lack of awareness of an existing policy may have been due to lack of adequate consultations with the local community. The findings of [31] revealed that lack of knowledge about energy efficiency technologies can hinder households from adopting and employing energy reduction strategies in Zambia. Reference [40] research also revealed that the major stumbling blocks towards promoting the sense of efficiency are the lack of information and awareness by householders, and the lack of monitoring and regulation by relevant authorities. Most studies have looked into energy security, adaptation and barriers of energy in informal settlements but little has been done on adoption of green energy practices in informal settlements.

1.4 Materials and Methods

Conceptually, the study focused on one dimension of green practices (green energy), in upgrading of informal settlements in Eldoret town. However, this is not be the only dimension that is adopted in IS upgrading. Information from literature indicate that there are other factors for instance green water, green waste and green infrastructure. The study adopted mixed methods approach. The approach was considered desirable because it allowed complex issues to be exhaustively investigated, interpreted and disseminated within a relatively short period. However, use of different methods to collect both qualitative and quantitative sources information was tiresome, time consuming and financially expensive. The processes were executed diligently to provide requisite and adequate data for the research. A sample size of 370 household heads was randomly selected from the target population of 9958 households based on Robert V. Krejcie and Daryle W. Morgan's [41]. In addition, 7 key informants were interviewed while Settlement Executive Committee provided 30 respondents, 10 from each settlement for the Focus Group Discussions.

1.5 Results and Discussions

1.5.1 Adoption of Green Practices

1.5.1.1 Source of Energy for Lighting

The study revealed that various sources of energy are utilized for lighting by the informal settlement dwellers. This concurs with [29] that Kenya's energy needs for cooking and lighting are derived from various sources such as wood, fuel, gas, and electricity. The figure below shows the sources of energy for lighting among IS dwellers in the study area.

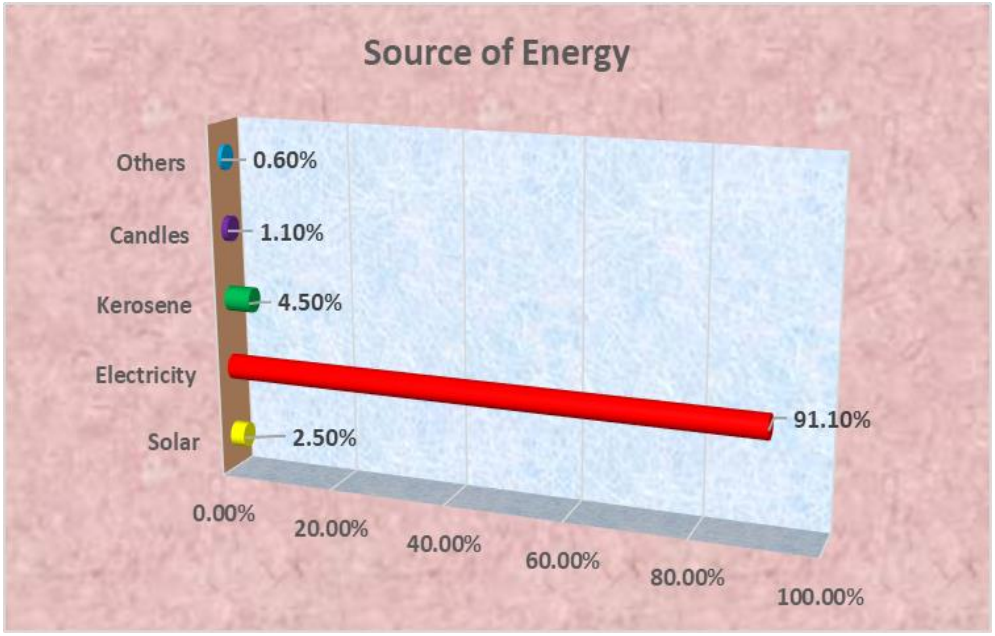

Figure 1: Source of Energy for Lighting

Figure 2: Electricity Connection in some parts of Huruma

Arising from the study, it can be deduced that majority of the informal settlement dwellers use electricity as a source of energy for lighting. This concurs with the findings of [20, 21] who found out that majority of informal settlement dwellers use electricity for lighting. The study therefore opines that the increased use of electricity could be attributed to the slum electrification program by the Government of Kenya and World Bank. Further, the study revealed that most of the households, who use electricity as a source of power used energy saving bulbs which has a greater electricity saving potential. This can also be attributed to the free distribution of 1.25 million energy saving bulbs by the Kenya Power and Lighting Company project in the country with an aim of saving the national power grid [42].Electricity use, considered as a green practice, is clean, does not have any by-products, it does not cause any kind of pollution and that it is much cheaper than most of the other forms of energy.

The study further established that that solar use and adoption is low (2.5%). The findings agrees with [2] findings that despite the high solar installation cost in Kenya, adoption of this technology was 1%. It can be argued that low adoption could be attributed to high initial cost of acquiring it and partly due to lack of awareness and mobilization. The low use of kerosene as per the findings imply that there is a shift away from this source of fuel which has been associated with a lot of health problems, poor lighting and a source of fire in the IS .This was clearly captured in an FGD. One of the participants had to say:

"*Thanks to the county government for bringing electricity to the IS because my family's health is no longer at risk from using paraffin, we no longer spend a lot of money on kerosene and children can comfortably do their homework. They used to find it hard to complete their homework or revise when we were using kerosene lamps because of poor lighting but now they can read better without straining and it seems it's enjoyable to them".*

1.5.1.2 Source of Energy for Cooking

Energy demand patterns of urban households, especially the poor, largely revolve around household energy end-uses such as cooking. The figure below shows the type of fuel used for cooking.

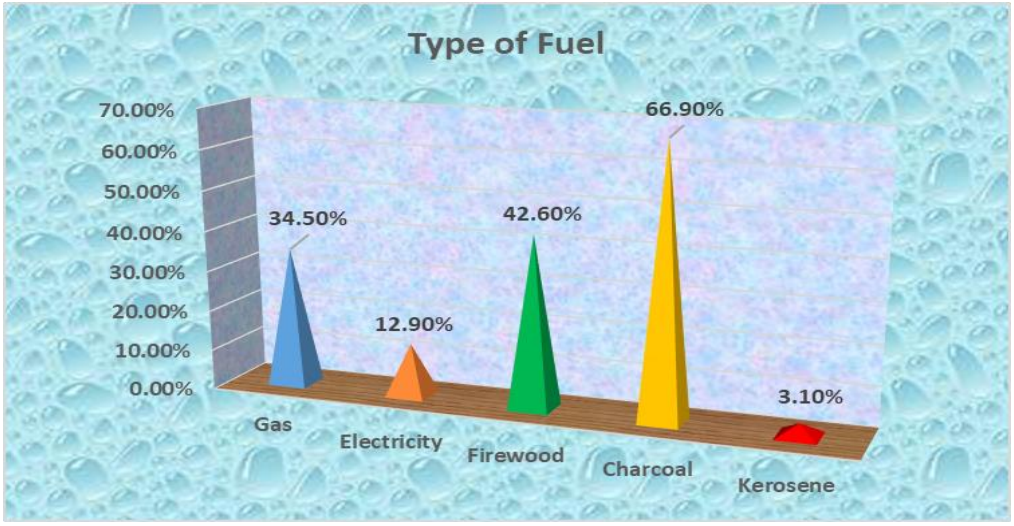

Figure 3: Type of Fuel Used for Cooking

It is evident from the findings that majority of the IS dwellers use charcoal and firewood. The findings are in line with previous studies by [21, 26] who found out that charcoal was the most generic form of fuel used in informal settlements. However, Reference [21] adds that the second common form of fuel used in the informal settlement was gas, followed by firewood then kerosene. One of the explanations why charcoal was rated highest is the fact that the informal settlement residents prefer charcoal due to its availability, ease of use, low cost and because it lasts longer especially when it is used with improved technologies such as the Kenya Ceramic Jikos. The use of Firewood and gas accounted for 42.6% and 34.5% respectively. IS dwellers consider firewood to be cheap and readily available. In the recent past, gas was not commonly used by the urban poor because of the high upfront cost and its appliances considering their income. Gas refilling costs have not been affordable to most urban poor. The emerging increase in the use of gas among the informal settlements dwellers, is attributed to multi-national oil companies marketing strategies that promote gas access to informal settlements dwellers by opening outlets nearer and within the settlement [43] there are also efforts to sensitize residents on the use and safety measures of gas usage. These efforts have resulted into gas becoming more acceptable among the residents in the three IS. Use of Kerosene was low accounting for 3.1% of the total consumption in this study area. It continues to pose a health threat by downgrading indoor air quality. Observation during the field study as shown from the pictures below, revealed that the IS dwellers can easily access charcoal, firewood, and gas within the settlements.

Gas Point (Huruma) ***Charcoal (Kamkunji)*** ***Firewood (Munyaka)***

Figure 4: Types of fuel used for cooking

Although the findings of the current study show that charcoal and firewood are highly used, they are not considered as green practices. However, the use green technologies for the consumption of charcoal and firewood is considered a green practice. It is argued that, traditional stoves and open fires are inefficient at converting energy into heat for cooking and local environmental problems can result where demand for local biomass outstrips the natural regrowth of resources). The study by [44] asserts that alternative technologies such as the Kenya Ceramic Jiko has the ability to reduce fuel consumption by 20–50% therefore reducing the demand

for wood as a fuel resource. They add that Ceramic Jiko increases child safety as the ceramic liner prevents the stove from becoming extremely hot. Further, Reference [45] also allude that many governments and development organizations have attempted to combat indoor air pollution by disseminating cleaner-burning cook stoves, but the adoption and use of these non-traditional cook stoves in the developing world has, with few exceptions, remained disappointingly low.

1.5.1.3 Street Light and Security Light

Providing street or flood lighting in public spaces, such as public transport terminals, markets, schools, social halls, police posts, playing fields and walking routes is considered as a measure to improve security.

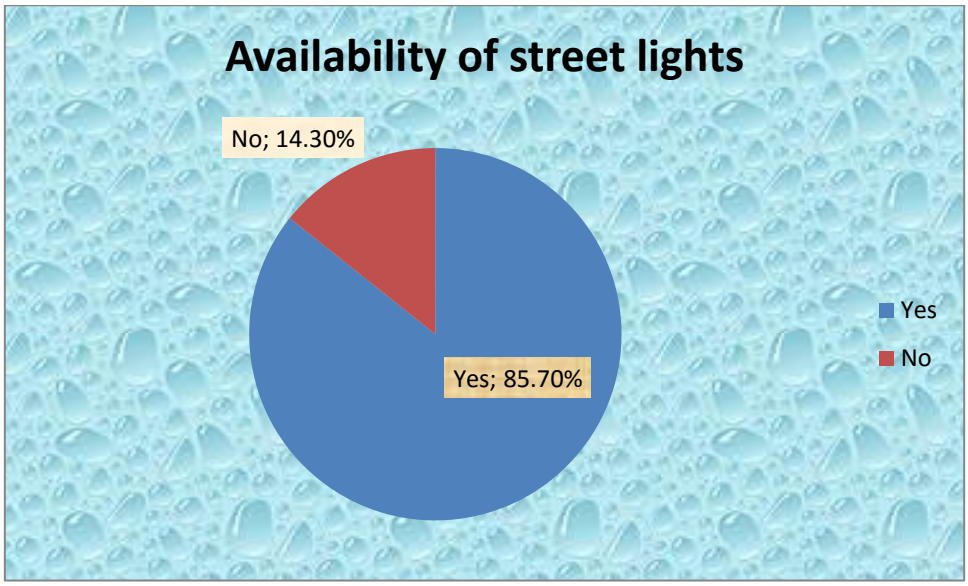

Figure 5: Availability of Street Lights

Informal settlement dweller receive light from the street light and flood light. However, it was confirmed from the FGD that most of street lights use electricity and a few solar energy along the highway. This implies that it will be expensive in the long run for the county government to pay electricity bills. The study further established that there three floodlights installed in Huruma, one in Kamukunji and four in Munyaka. Through FGD, it was noted that installation of street lights and floodlights had led to extension of business hours and thus increased income among IS dwellers. Reference [46] concurs that access to energy can create new income opportunities, expanding existing activities and realize cost savings on current practices. In addition, majority of the IS dwellers agreed that streetlight installation had led to increased security in the informal settlement. Many informal settlements are synonymous with insecurity often considered a den of crime. The presence of streetlights and flood lights have probably exposed hiding places that criminals may lurk with an intention to commit crime. It was further established through the interview with the KISIP *Project Component Three Manager*, that the floodlights and street lights had automatic timers and some especially those on the highway, used solar while those in the interior of the IS use electricity. The use of automatic timers and solar are green practices there is need to embrace the use of solar energy to help reduce the electricity bill for the county

government and for the project to be sustainable.

Figure 6: Flood Light in Huruma

1.5.2 Factors Influencing Adoption of Green Energy Practices

There are factors influencing adoption of GP in the three informal settlements. The table below shows the chi square values of various items tested. The findings show that the chi square values were statistically significant for all the items tested at p = 0.000 <0.05. In conclusion, all the variables tested are key in the adoption of Green Practices in upgrading of informal settlements. The findings for each of the variables is further discussed in the section below.

Table 1: Chi Square Test on Factors Influencing Adoption of Green Energy Practices

Factors Influencing Adoption of Green Energy Practices	Chi-Square	Df	Asymp. Sig.
Initial cost of adopting green energy practices depends on the level of income of informal settlement dwellers	553.706	5	0.000
Accessibility of green technologies lead to adoption of GP	172.314	4	0.000
Availability of personnel with green skills affects implementation of GP	190.717	4	0.000
Appropriate policy and legal frame work on green energy practices affects integration of GP	209.457	4	0.000
The community's level of awareness influences adoption of green energy practices	186.849	5	0.000

1.5.2.1 Initial Cost of Adopting Green Practices Depends on the Level of Income

The study revealed that there was a significant statistical association between initial cost of adopting green practices and level of income among informal settlement dwellers. The chi square value was 553.706 at p =0.000 <0.05. The findings concurs with those of [30] who pointed out that solar installation has high upfront costs compared to traditional fuel which hinders its adoption. In addition, Reference [31] argues that although the households in informal settlements in Zambia had reasons to embrace energy saving measures, the cost of technology was a significant barrier. Reference [32] found out that the major constraint to the adoption of renewable energy technologies is that the initial capital outlay for these technologies tends to be high. This finding therefore suggests that low income at the household level attributes to low adoption. Additionally, the county government has limited power to act on their own to invest in huge projects like solar installation.

1.5.2.2 Accessibility of Green Technologies Lead to Adoption of GP

There was a significant statistical association between accessibility of green technologies and adoption of GP with a chi- square value of 172.314 at p =0.000 <0.05. The finding agrees with [31] who revealed that landlord control in the informal settlements was a highly significant barrier to using energy efficient technologies. They further argue that landlords would not allow tenants to use certain electric appliances like stoves and pressing irons as they believe that these appliances consume too much electricity. Reference [26] affirm that lack of green energy extension officers and distance to green enterprise dealers affects the adoption of green technology.

1.5.2.3 Availability of Personnel with Green Skills Affects Implementation of GP

The results show that there is a significant statistical association between lack of personnel with green skills and the adoption of green practices since the value of chi square value was = 190.717 at p =0.000 <0.05. From the FGD, one of the respondents in Kamukunji IS complained that she had acquired a home based solar gadget that later developed a problem. She took it back to the dealers but was not assisted, a clear indication that there is lack of technical expertise in green energy sector. These finding however contradicts with [26] who argue that personnel with green skills are available.

1.5.2.4 Appropriate Policy and Legal Frame Work on Green Practices Affects adoption of GP

From the findings, we conclude that appropriate policy and legal framework on green practices positively affected the adoption of GP. The chi square value was 209.457 at p =0.000 <0.05, showing a clear statistical association between lack of policy and the adoption of GP. The findings are consistent with [26] who say that informal settlement dwellers or poor urban residents have a problem in accessing household green energy technology in developing countries due to poor policies. They further argue that the government of Kenya has not come up with policies that would encourage the private sector to provide affordable, renewable, clean lighting, off grid lighting units to poor urban people living in the informal settlements. It was also noted through the interview with County development officer that energy policies and strategies developed at national level did not encourage adoption of household green energy at regional level.

1.5.2.5 The Community's Level of Awareness Influences Adoption of Green Practices

The findings show that there existed a statistical association between community's level of awareness and the adoption of green practices by the fact that the chi square value =186.849 at p =0.000 <0.05. The same was pointed out by [36] that level of knowledge and awareness of solar technology, influence the adoption of domestic solar technology. The findings also agrees with [37,39,31,40] who found that IS dwellers' ignorance, lack of awareness due to lack of adequate consultations with the local community and lack of knowledge about energy efficiency technologies can hinder households from adopting and employing energy reduction strategies. The finding therefore implies that majority of the informal settlements, dwellers were unaware of the green energy that they can access or use.

6. Conclusion

The study examined the adoption of green energy practices in informal settlements in Eldoret town, Kenya. While there is change in behaviour on adoption of green energy practices from non-green to green practices, the need for cost reduction measures on initial cost of acquiring green infrastructure especially for IS dwellers is long overdue. Uptake of green energy can be enhanced though creation awareness on green energy, instituting legal framework and increasing the number of personnel with green skills. In addition, green innovations such as energy saving bulbs and government incentives to IS dwellers may spur the adoption of green energy practice. Further, the change in behaviour towards green practice provides a business opportunity for supply of green technologies among residents in the informal settlement. The study recommends proper policies and legislation for acquiring and adoption of green practices and technologies in order to counter the barriers of adopting green practices. Secondly, infrastructural developments for energy practices should be integrated in the planning and upgrading processes. Further, more efforts should be geared towards promoting a culture of green practice especially among individual households in order to achieve sustainable energy use practices.

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