ENERGY ACCESS AND GREEN TRANSITION COLLABORATIVELY DEMONSTRATED IN URBAN AND RURAL AREAS IN AFRICA

D2.1

Baseline community, market, and ecosystem assessment

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I. PROJECT SUMMARY

The **ENERG**y access and green transition collaboratively demonstrated in urban and rural areas in Afr**ICA** (ENERGICA) project is ambitiously fostering collaboration between partners of Europe and Africa continents on energy access and sustainable energy development. Developing innovative and tailored solutions on productive use systems through innovative nano-grids in rural Madagascar, low-tech efficient biogas system, coupled with water purification demonstrated in peri-urban Sierra Leone, and solar-powered e-mobility solution for boda-boda in urban Kenya, from energy production, local renewable value chain development and e-mobility also providing flexibility services to the grid, ENERGICA applies to many different technical and socio-economic contexts. ENERGICA aims to achieve a strong market uptake and wide replication during and after the project's end, with strong local environmental and socio-economic benefits. The innovative business models developed will support this movement for local market uptake. At the same time, some of the solutions will even rely upon local production and manufacturing, and local businesses and workforce participating in capacity-building activities. Developing solutions that are based on RE (solar and biogas), and studying projected climate change impact evolution in Africa, ENERGICA will strengthen the joint European Union (EU) – African Union (AU) climate change and sustainable energy partnership effort and contribute to fighting climate change. One thousand five hundred (1,500) local stakeholders across Africa are aimed to be impacted positively and improve health and social conditions in the demonstration sites and beyond.

II. OBJECTIVE AND EXECUTIVE SUMMARY

The ENERGICA project aims to promote energy access and sustainable energy development through collaboration between partners in Europe and Africa. To achieve this, this project sought to understand the community, market, and ecosystem through a baseline evaluation survey of the local social, cultural and environmental contexts of the three demonstration locations of Nairobi, Diana region and Freetown in Kenya, Madagascar and Sierra Leone respectively.

This document presents the results of the project's baseline assessment conducted in Nairobi - Kenya, Diana region - Madagascar, and Freetown - Sierra Leone. Specifically, it provides a report on the social, cultural, and environmental contexts of the local communities, market, and ecosystem for the three demonstration sites, and shares insights on the communities' perceptions of energy generally, renewable energy, and energy transition and the roles they see themselves participating in to support the transition and inform other work packages on the implementation of their tasks.

This document first briefly introduces the local contexts before presenting the methodology used and the data obtained. It then provides the results of the questionnaire and interview data structured by the thematic fields 1. Background information, 2. Energy access, 3. Awareness of Energy and the environment, 4. Community Life, 5. Support and acceptance of innovative technologies and services, 6. Perceived risks and benefits, 7. Economic aspects, 8. Context-specific demonstrator questions (a. Transport (e-mobility) - Kenya, b. Water, and food nexus - Madagascar, and c. Waste and chemicals - Sierra Leone), and 9. Gender and energy.

Finally, the report sums up the results and discusses the implications for the further implementation process which will help assess possibilities of sustainability and management structures after the exit of support. Overall, the data obtained from key informants and the local population leave us optimistic that the project can be impactful when following appropriate communication strategies, stakeholder interaction, and citizen participation. More information on the project can be found at https://www.energica-h2020.eu/

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VI. ACRONYMS

AfDB	:	African Development Bank
AU	:	African Union
CBO	:	Community-Based Organisations
CIF	:	Climate Investment Funds
CLUB-ER	:	African Association of Rural Electrification/L'Association Africaine pour l'Électrification Rurale.
COMESA	:	Common Market for Eastern and Southern Africa
CSO	:	Civil Society Organisations
DER	:	Decentralised Renewable Energy
EAC	:	East African Community
EACREEE	:	East African Centre of Excellence for Renewable Energy & Efficiency
ECOWAS	:	Economic Community of West African Countries
ECREEE	:	ECOWAS Centre for Renewable Energy and Energy Efficiency
EDSA	:	Electricity Distribution and Supply Authority
E-Mobility	:	Electric Mobility
ENERGICA	:	ENERGy access and green transition collaboratively demonstrated in urban and rural areas in AfrICA.
EU	:	European Union
FDPs	:	Forcibly Displaced Persons
FINTECH	:	Financial Technology
FWT	:	Freetown Waste Transformers
GDI	:	Gross Domestic Income
GNI	:	Gross National Income
GNP	:	Gross National Product
GPOBA	:	Global Partnership of Output-Based Aid
HH	:	HouseHold
HUD	:	Hudara
IGAD	:	InterGovernmental Authority on Development
IMF	:	International Monetary Fund
IPP	:	Independent Power Producers
JICA	:	Japan's International Cooperation Agency
JIRAMA	:	Jiro Sy Rano Malagasy
KI	:	Key Informant
KII	:	Key Informant Interviews
KOSAP	:	Kenya Off-Grid Solar Access Project
LMCP	:	Last Mile Connectivity Programme
LPG	:	Liquified Petroleum Gas
MTF	:	Multi-Tier Framework
MW	:	Mega Watts
PPA	:	Power Purchase Agreement
PPP	:	Public Private Partnerships
RE	:	Renewable Energy
REP	:	Rural Electrification Programme

RET	:	Renewable Energy Technologies
SACREEE	:	SADC Centre for Renewable Energy & Energy Efficiency
SADC	:	Southern African Development Community
SDGs	:	Sustainable Development Goals
SME	:	Small and Medium-sized Enterprises
SREP	:	Scaling Up Renewable Energy Projects
UN	:	United Nations
UNFCCC	:	United Nations Framework Convention on Climate Change
UNHCR	:	United Nations High Commissioner for Refugees
UNIDO	:	United Nations Industrial Development Organisation
UAM	:	Université Abdou Moumouni
WEF	:	Water Energy Food
WHO	:	World Health Organisation
WTO	:	World Trade Organisation

1. INTRODUCTION

Decades ago, most communities in Kenya, Sierra Leone and Madagascar could easily access fuel within proximity to their homesteads in the form of biomass. As needs have changed throughout time, environmental and economic demand has shifted and lifestyles have diversified, energy demand has increased, and access and affordability vary from one community to the other. In most cases, the fuels required for heating and lighting must be imported from various locations to reach the targeted communities. Distance and demand have led to a host of challenges including political instabilities, environmental degradation, economic and social injustices, and health hazards. Most of these sources of energy are also finite resources (Kyayesimira, 2021).

The higher demand due to lifestyle changes and dependency on outdated approaches to electrification is one of the major factors contributing to energy inequalities. There is a bias toward traditional centralized power grids, which are not only costly, particularly for remote rural and peri-urban communities, but also provide intermittent and unreliable service in the considered contexts. Energy inequality has trickle-down effects on the social, economic, and environmental well-being of communities, especially in the health and education sectors (Churchill et al., 2020). Energy is the ability to do work and transform matter into various forms. There are various forms of energy; chemical, electrical, nuclear, light, mechanical, thermal, and muscular energies[1]. It is estimated that about thirteen% of the world's population does not have access to electrical energy, and about 40% of the world's population does not have access to clean energy for cooking (*Technical_working_group_1_energy_access_report_2021.Pdf*, n.d.). This is especially true in most parts of the Asian and African continents. According to a report by IEA, (2022), low and mid-level income earners and communities in the rural parts are more affected by these issues of availability, distribution, and access to energy (*Technical_working_group_1_energy_access_report_2021.Pdf*, n.d.). Energy inequality is specifically in Sub-Saharan Africa a major challenge, accounting for 75% of the world's population without access to electricity (Morrissey, n.d.). This has significant implications for people's social and economic life and the environment and needs urgently to be addressed. The comparison between countries in the Sub-Saharan region to other developed energy-rich countries indicates that for these countries to achieve short and long-term sustainable development ambitions, they need to boost their energy access and reduce their inability to build resilience toward health and environmental challenges (Anuga & Njenga, 2022).

"ENERGy access and green transition collaboratively demonstrated in urban and rural areas in Africa" (ENERGICA) is a project funded by the European Union's Horizon 2020 program and aims at smart energy solutions to decarbonize the energy systems and provide access to energy. It is particularly interested in involving citizens and end users in the process. The project will be implemented in Africa in three countries' contexts: Kenya (East Africa) Sierra Leone (West Africa) and Madagascar (Southern Africa). The project focuses on three case studies to develop knowledge and experience to address energy challenges as well as to provide people with solutions to improve their social and economic life and improve their environments.

The project focuses - in addition to some general aspects related to energy access and sustainability - on contextual concerns relevant to the three locations. These are in Kenya means for environmentally

[1] Natural Resources Canada.

friendly transportation, in Madagascar the implementation of nano-grids in rural difficult-to-reach locations and in Sierra Leone efforts to transform biomass into power.

Kenya has an inefficient transportation system with old vehicle fleets and congestion in the urban city of Nairobi and other cities that have caused a myriad of challenges including elevated levels of pollution and traffic jams. Despite the country's 73% of its energy derived from renewable resources, with 75% of the households (HHs) connected to the national grid, it is still faced with challenges of energy access and utilisation, especially in the field of transport. With such, the country is uniquely positioned to support ENERGICA's demonstrator solution on e-mobility.

In Madagascar, only 15 per cent of the population has access to electricity from the national grid, with most of this population living in rural areas and only 2% in cities. Having a centralized energy structure translates into 98% of the population not being connected to the national grid. To react to the electricity infrastructure challenges of both cost and accessibility, ENERGICA will develop nano grid solutions to support Madagascar's 2015 energy policy which targets an accelerated electrification rate through Renewable Energy (RE) to 70% by 2030.

Sierra Leone is endowed with energy potential in various forms including biomass from agricultural wastes, and hydro and solar power, but they remain underutilized as is the case for most countries in Sub-Saharan Africa. 26 per cent of Sierra Leone's population has access to electricity which is mostly spread in the urban regions. Through waste transformation, ENERGICA will work on the Water Energy and Food nexus through the production of water, fertilizer, and energy.

ENERGICA acknowledges these energy challenges and seeks to foster collaboration between the European Union and African Union to support efforts in improving energy access and sustainable energy development through Renewable Energy Technologies (RETs). This is in backing of the Sustainable development goals 2[2], 6[3], 7[4] & 11[5], and countries' favourable policies that aim at green transition and energy access in urban and rural Africa for the multidimensional sustainable ecosystem in social, technical, economic, and environmental aspects.

An important feature of the ENERGICA project is its wider scope of activities than strictly technical, focusing also on societal, economic, and environmental challenges tied to energy, and fostering sustainable solutions for a wide range of stakeholders and decision-makers. Consequently, from the design to commissioning and operation, partners and associated stakeholders will ensure that technical, environmental, social, and economic positive impacts are generated through the implementation of collaborative methodologies.

The concept is to develop appropriate and easy-to-replicate methodologies for energy access technologies' uptake throughout both the African and European continents. Four specific objectives are prioritized:

Social objective – To support local communities, especially those who are marginalised or living in disadvantaged circumstances, it is the goal to establish capabilities for energy solutions through collaborative implementation with the community. This will be done through the creation of local

[2] Zero hunger
[3] Clean water and sanitation
[4] Affordable and clean energy
[5] Sustainable cities and communities

energy communities composed of and supported by all relevant local stakeholders. End users will participate in feasibility studies, inform on energy needs, adaptation to their contexts, and installation and viability of the solutions at local and regional levels.

Environmental objective – To seek environmental impact throughout the implementation stages and after, it is of utmost importance that renewable technologies are fostered, and sustainability is ensured. It is expected to reduce CO2 emissions by using decarbonized technologies, to foster the circularity of solutions and improve air, water, and food quality through the ENERGICA solutions.

Technological objective – To design innovative technologies and enhance knowledge locally that will ensure optimization of available resources on-site, efficient production of water, food, and energy, and add as much value as possible.

Economic objective – To accelerate the creation of jobs and to make all possible activities and actions more efficient and productive in the everyday life of local people, the economic viability adapted to each context will enhance significantly. ENERGICA will particularly emphasize business models adapted to a specific context and foster the creation of a qualified local workforce, to replicate the processes to other locations.

There is a big opportunity to use clean and RE to power economies. However, it is challenging to switch from using unsustainable energy sources to sustainable ones due to factors like prohibitive costs, consumer prices, and government policies . To solve these challenges, there is a need to ensure that innovative technology is developed, that it is affordable, and that everyone can access it. Favourable policies that support this change to remove any obstacles that might stop it from happening are necessary (Verbruggen et al., 2010). Kachapulula-Mudenda Kachapulula-Mudenda (2018) showed in a case study performed in Zambia, that adoption of renewable technologies and its practices has remained low, despite several efforts by various parties to promote their use of it. Hence the need for an inquiry into the specific energy demand, HH capabilities and needs for their acquisition, and adoption is an important matter. It is crucial to understand and pre-empt barriers hindering the successful implementation and suggested solutions by the end users before the start of the actual project implementation process.

Kachapulula-Mudenda et al., (2018) indicated in their study in Zambia that the underserved populations, policy inadequacies, underexploited RE sector, among others, were the main barriers to the successful adoption of clean energy technologies. The study concludes that as most of the challenges are institutional, baseline assessment studies are recommended to understand knowledge, perceptions, attitudes, and drivers and hindrances for renewables adoption among HHs.

Sustainability does not only depend on the reliability of the technology itself but also a sense of ownership, user satisfaction, availability of adequate knowledge and skills as well as network connections, and commitment of the implementing organisations. Local people will have to feel directly how the new energy implementation will positively impact all aspects of their lives. The people in the communities should explicitly benefit from the new technologies, be involved in the implementations, and not have the impression that they are a mere target for market interests without being really involved in shaping their environment, their living space and their use of resources. Therefore, baseline context-sensitive studies are encouraged to derive lessons that can improve future development interventions in terms of impacts for local people, uptake of the solutions, sustainability, and opportunities for dissemination and replication through bottom-up approaches. This is important in the selection process, project design, implementation phase, and follow-up of future projects based on the lessons learned from the study and comparison of similar projects globally (Terrapon-Pfaff et al., 2014).

The goal of this study is to understand the specific energy needs, identify available sources of energy, and knowledge gaps, explore opportunities for collaboration and gain insights into the possible solutions to the energy challenges from RE end users focusing on Kenya, Madagascar, and Sierra Leone contexts and hence advise the ENERGICA consortium on the implementation of the project's activities and tasks. An extensive background analysis will inform on the social, cultural, and environmental contexts of the local communities, markets, and ecosystems for the three contexts which would provide a guide and unmask the possibilities for the implementation of the ENERGICA project. This includes an outline of communities' perceptions of energy, RE, and the energy transition and the roles they see themselves participating in to support the transition. The results of this study seek to inform other Work Packages (WPs) on the implementation of their tasks.

The research questions are as follows:

- Do people in the three project locations have access to reliable, affordable, and sustainable energy?
- Are people aware of climate change and the impact it has on their environments?
- How is the social fabric in the project locations? Do people see themselves as belonging to a community?
- How receptive are people to RETs and its services?
- What are the perceptions of risks and benefits associated with the usage of RETs and solutions?
- Do the participants of the study believe that RE solutions have an impact on marginalized communities?
- And what are the energy needs and challenges in the respective contexts considering the specific technical solution?

2. LITERATURE REVIEW

Climate change mitigation is a top priority for most countries, regular citizens, politicians, and decision-makers. Technology transfer is essential to move towards environmentally sound and sustainable practices, institutions, and techniques. According to Coburn & Farhar (2004) energy is the capacity of a physical system to do work, or alternatively, to produce heat. On the other hand, Renewable Energy (RE) is energy that is derived from a supply that is constantly and naturally replenished over a relatively short time (Coburn & Farhar, 2004). RE is often generated from hydro, solar, biomass, wind, and geothermal resources and offers immense prospects for environmentally friendly and sustainable development while at the same time might reduce energy dependencies from world markets if locally sourced. Renewable Energy Technologies (RETs) is an umbrella term that stands for energy production using RE sources like solar, wind, water (tidal and hydro), biomass and geothermal heat (Zepf, 2020). RETs provide innovative solutions that relieve communities, especially women and children living in disadvantaged situations, of manual labour and associated health challenges. The productive use of RE has improved communities' access to sustainable energy hence improved livelihoods and education, promoted environmental sustainability, reduced discrimination among minority and marginalized members of communities and therefore reduced social inequalities. To ensure sustainable uptake of clean energy technologies, an understanding of the awareness, needs, perceptions of communities, and possible local solutions to energy inequality challenges is vital. This can be achieved through the effective involvement of stakeholders all along the value chain and throughout the development of tailored technologies' energy solutions to communities' requirements.

Karakosta et al., (2010) emphasize the importance of technology transfer in reducing global vulnerability to climate change, while (Kachapulula-Mudenda et al., 2018) stresses on the significance of RETs in improving the livelihoods of communities, promoting environmental sustainability, and reduced inequalities through increased productivity and reduced physical labour to access, distribute and utilize energy. Additionally, (Colmenares-Quintero et al., 2020) argue that the involvement of stakeholders and tailored technologies' energy solutions to communities' requirements are crucial for ensuring the sustainability of the project.

2.1. Energy Access

Poor access to modern sustainable forms of energy affects development and leads to energy inequality. The effects of energy inequality are mostly felt by people living in the Global South in socio-economic sectors like health and education. In energy access-deficit countries particularly, in Sub-Saharan Africa, a quarter of health facilities have no access to electricity at all, and another half have only unreliable electricity (WHO and World Bank, 2014). As two-thirds of schools lack reliable electricity, distance learning - as it was for example necessary as a response to the COVID-19 crisis - remains a far-off aspiration (World Bank and SEforALL, 2020). This poses serious future development challenges for these countries and risks accentuating inequalities, widening the gap between poorer and richer populations.

The positive news is that the number of people without access to affordable and reliable energy services has reduced over the last two decades. Nevertheless, there are still 2.6 billion people worldwide lacking access to meet their basic energy needs. Most of these people live in rural areas in the Global South or belong to the urban poor. To achieve the SDGs, expanding energy access is critical. If building energy supply focusses on sustainable solutions, the drawbacks of conventional energy sources such as harmful emissions, noise, high fuel costs and supply insecurities will be avoided. This call for sustainable energy access for development is further emphasized by the declaration of the decade 2014–2024 as the Decade of Sustainable Energy for All by the United Nations General Assembly. The initiative supports Resources as a key technology to reach the energy poor, offering clean electricity, heating, cooking, and lighting solutions to people and communities who currently depend on traditional energy sources and/or expensive fossil fuels.

RETs are regarded as particularly suitable because they can provide small-scale solutions and decentralized energy supply that meet the needs of the population most widely affected by energy inequality. Further, innovations and cost reductions over the last decade have made renewable energies more economically competitive than traditional fuels which have also helped to strengthen the case for renewables. However, this is not the case in all contexts and these technologies still face a range of social, economic, and structural challenges, requiring not only further technological development but also a deeper understanding of both the success factors and the barriers to accomplishing widespread dissemination (Terrapon-Pfaff et al., 2014).

Access to modern energy can be defined as an HH's ability to obtain an energy service, should it decide to do so. Access is a function of availability and affordability. For energy to be considered available to a HH, the HH must be within the economic connection and supply range of the energy network or supplier. The ability of the HH to pay the up-front connection cost and energy usage costs is referred to as affordability (Churchill et al., 2020).

Energy is essential for most activities of modern society. Its use or consumption is taken as an index of the standard of living. Energy, both in renewable and non-renewable forms, is used to make life comfortable and convenient. 940 million (13% of the world) do not have access to electricity. Three billion (40% of the world) do not have access to clean fuels for cooking. This comes at a high health cost for indoor air pollution. Energy has both positive and negative impacts on societies. Access to abundant, affordable, secure, safe, and clean energy is beneficial for humans. But energy extraction, transportation, and use can have negative consequences on the health, environment, and economics of a society.

High upfront costs often discourage marginalized communities and low-income earners from switching to modern forms of energy and RE technology solutions. This is often the reality of the urban poor and most communities in rural setups. They instead rely on traditional sources and power theft from the national grid. This lack of, and insufficient energy access has negative implications on the economy and productivity of HHs and communities. These traditional sources have caused health-related complications. (Ezzati & Kammen, 2002), provide strong evidence that exposure to indoor air pollution from the combustion of traditional fuels in Kenya enhances the risk of acute respiratory infection. They show that affordable environmental interventions, such as the use of improved stoves, and other modern technologies to access energy can reduce respiratory infections among children and infants by 25%.

The COVID-19 pandemic has magnified energy access challenges and especially the health and economic challenges, as well as its inherent opportunities and inequalities in most developing economy countries. Underlying chronic diseases that are predictive of the severity and outcome for

COVID-19 patients are exacerbated by exposure to air pollution. The Russian-Ukrainian war has affected access to the major source of energy for most countries worldwide, even though non-renewable – petroleum and petroleum products. Most HHs that could initially access cooking gas, can no longer afford it, and are forced to go back to other traditional sources of energy. This linkage suggests a heightened risk for women across all age groups who lack clean cooking solutions and continue to endure economic and health challenges from having to use traditional fuels and technologies. In the poorest and most vulnerable countries, resources for COVID-19 responses and immediate health priorities are likely to further constrain the already limited fiscal capacity and increase the risk of energy insecurity. For this reason, most countries have awoken to the urgency of developing their RE sectors by creating policies that will promote the utilisation and sustenance of RET solutions and create enabling environments for RE sector investors and consumers to thrive (*Technical_working_group_1_energy_access_report_2021.Pdf*, n.d.).

2.2. Awareness of Energy and the Environment

The impacts of a warming world due to climate change are already being felt globally but are particularly devastating in regions like Sub-Saharan Africa. The interplay between climate change, environmental degradation, and lack of energy access is leading to growing inequalities, conflict and persecution, and inequalities[6].

Human activity is one of the major driving factors of climate change, which has led to a worldwide consensus that positive initiative-taking environmental behaviour must be encouraged in all spheres from production to consumption and recycling. The threat of climate change has become so great that many scientists and lobby groups are declaring a "climate emergency." It is not only relevant to production but also to consumption (*MPRA_paper_90251.Pdf*, n.d.).

HHs use energy through cooking, heating, and transportation, which directly generates emissions; on the other hand, they spend on other consumer goods, which indirectly generate emissions in the production process. Adding the direct and indirect emissions together makes the share of emissions from HHs a substantial part of total emissions. In the US - for example - (Bin & Dowlatabadi, 2005) indicate that HHs are responsible for close to 70% of total emissions. While this number is much smaller in countries in the Global South, it remains significant and is possible to increase in the future. The challenge is creating awareness of HH pollution and practical solutions to prevent further environmental degradation. Another example is China, the largest emitter in the world, accounting for 30% of the total world's CO_2 emission. Here, emissions from HHs account for around 40% of the national total emissions, and this share is increasing along with China's fast economic growth and booming consumption demands from the HH sector (Shan et al., 2018). This is also applicable to the fast-growing population of Sub-Saharan Africa where most countries, including Kenya, Madagascar, and Sierra Leone, are still widely using biomass for HH energy uses.

Encouraging green lifestyles and promoting pro-environmental behaviour during the planning and implementation of projects promotes sustainable energy consumption behaviours. Assessing the level of knowledge and awareness on energy and the impact it has on the communities in their immediate

[6] www.humanitarianenergy.org

environment is key as it sets the basis for capacity-building programs during the implementation and gives a critical analysis of the implementation framework of the project's sustainability gaps when the project closes.

Most studies focus directly on working with the energy solutions' end users as the direct consumers but very few studies have been conducted to assess communities' knowledge and attitude towards RE solutions and the possibility of a shift. (Bauwens & Devine-Wright, 2018) indicate that in most cases, communities avoid both strongly positive and strongly negative opinions, especially on change-related projects and instead prefer avoiding the possibility to take positions that could have them criticised by either objectors or supporters of the initiative in their communities.

Currently, there are noticeable efforts by governments to promote RE to replace traditional fossil fuel energy to reduce carbon and other greenhouse gas emissions. Adopting a green/environmentally friendly consumption lifestyle has also attracted a lot of attention in recent years. It is important to create an informed community of consumers as much as for producers. Even more importantly, empowering consumers to have more RE solution options. There is a global focus on sustainable energy generation models that are environmentally conscious and bring positive social-economic impact. RE fits the description and is currently being implemented in most parts of the world. However, evidence indicates that despite the general public acceptance of RET there is laxity in its implementation and replication. A study was conducted in Nigeria to assess the public's understanding (inclusive of knowledge, beliefs, perception, and attitude) of RET (hydro, wind, biomass, and solar), which indicates that lack of information about how RET works, cost of installation and maintenance, and corruption created negative perceptions about RET among the public. The results also indicated significant positive correlations between perceived usefulness, perceived ease of use and intention to use RET. The study concluded that both formal and informal energy education is necessary for the country for the success and sustainability of RET (Wojuola & Alant, 2017).

2.3. Community Life

A local community is a basic unit of society by proximity of its members. There are different forms of people consider themselves close or members of a group that can be according to believes, values, interests, heritage or other, but in the ENERGICA project we focus on proximity according to locality. The people within a local community network share similar social, economic, and environmental conditions and resources, face challenges and concerns and share common successes. The sense of place, localism, identity, shared values, and ideologies vary from context to context. Hence, understanding the social fabric of a community and leveraging its power, knowledge and needs is one step closer to achieving sustainability (Bauwens & Devine-Wright, 2018) and strengthening positive social aspects and general community life. Projects offering RET solutions have the potential to offer economic, social, and environmental benefits as well as technological and institutional advantages. Communities, when involved throughout the project cycle, could be well-placed to identify local energy needs, take proper initiatives and mobilise themselves to achieve common goals such as self-sufficiency, resiliency, and autonomy (*Koirala et al. 2017_ Phd Thesis ICESs.Pdf*, n.d.).

Most community-based natural resource management studies suggest that the community stands at the core of many movements and influences the success of a governments or other stakeholders' intervention (*Community-Based_management_of_environmental_challe.Pdf*, n.d.). Community energy projects are formal or informal citizen-led initiatives which propose collaborative solutions to local needs and facilitate the development of sustainable energy technologies and practices and produce local benefits (Bauwens et al., 2016; Walker and Devine-Wright, 2008).

The willingness of communities to support and participate in RE projects is vital for the success of community-based RET and solutions. A study (Koirala et al., 2018) on the willingness of Danish communities to participate in the renovation of their homes to adapt to RET and solutions indicated that 53% of them were willing to participate only if their social-institutional factors like community trust and energy independence, environmental, demographic and economic requirements were met. This research reveals that a large share of the surveyed citizens is aware of local energy initiatives and exhibited positive interest towards community energy systems. This indicates a large potential for local energy initiatives not only in the Netherlands. The results of this research help in the formation and operation of community energy systems by indicating the factor influencing citizens' participation. It indicated the possibility of increasing the share of renewable energies as already more than 500 local energy initiatives were in place. This study teaches us that, despite the several benefits of energy innovations, there were challenges to motivating homeowners to participate in the renovation of their homes. Although community objectives such as economic incentives, environmental concerns and resiliency were important, different demographic and socioeconomic factors such as age, family situation, home ownership, occupation and income affected citizens' willingness to participate. A similar study conducted in Germany indicated that despite the positive attitude of its local citizens to support and participate in RE projects their willingness to participate was also affected by several socio-institutional and environmental factors such as social norms, trust, and environmental concerns (Koirala et al., 2018).

Another study describing community inclusion in a wind energy project pilot conducted in Australia indicated that it was important to ensure fairness. Perceptions of fairness did influence how people perceive the legitimacy of the outcome and that a fairer process will increase acceptance of the outcome. A key research finding was that different sections of a community are likely to be influenced by various aspects of justice, namely by outcome fairness, outcome favourability and process fairness. Based on this finding, a community fairness framework was developed which had potential application in community consultation to increase social acceptance of the outcome. The public's perceptions of other community members' opinions provide cues for social acceptance of social and environmental projects (Gross, 2007).

In the United Kingdom (UK) policymakers have regarded community energy initiatives as a remedy to perceived backlash against large-scale onshore wind farm projects, fostering a cheerful outlook towards RET and wind energy specifically (Walker et al., 2007). Specific attitudes towards projects are influenced by the environmental and visual impacts of the project, previous similar projects, involvement and the ownership model, the perceived fairness of how costs and benefits are distributed and the degree of the actual involvement of ordinary citizens (Bauwens & Devine-Wright, 2018). Outcomes that are perceived to be unfair result in protests, damaged relationships, and divided communities particularly when decisions are made that benefit some sections of the community at the perceived expense of others. It is crucial to understand the social fabric of the community before initiating projects and to anticipate the potential role that community members may play in a project.

2.4. Acceptance of Innovative Technologies and Services

"Acceptance," reflects an active involvement regarding new technologies by both individuals, producers and consumers and the community in which these three are situated (Tsoka et al., 2018).

The ability and motivation of a community to participate in a project define their support and acceptance of the solution that the project provides to their needs. Local communities are well-placed to identify local energy needs, take proper initiatives and mobilise to achieve common goals such as the reduction of energy costs, CO2 emissions, and reliable and sustainable RE solutions (Koirala et al., 2018).

A study focusing on the factors that promote or inhibit biofuels acceptance by end users was conducted on a sample of thirty-two expert European stakeholders who were interviewed as relevant actors in the field of biofuels for sustainable energy solutions. They expressed their expert stakeholders' views on the factors that facilitate or inhibit acceptance and sustainability of RET amongst end users in general. The characteristics of the technologies, their economic and market features, administrative and policy aspects, and social-psychological factors emerged in the qualitative study on thirty-two expert EU stakeholders. They shared their views as subject matter experts and representatives of organisations implementing similar projects. The study findings indicated several factors that could limit the adoption and acceptance of biofuels as economic benefits - end-users would consider only the economic side rather than the environmental and social benefits of the adoption of biofuels. Thus, knowledge of the economic benefits is required to support its acceptability and adoption; the limited market availability of biofuels compared to fossil fuels was a challenge to most end users and was found unreliable. Factors that could influence the acceptance and adoption of biofuels were: societal norms, values, and social pressure to adapt to change and relating the technology to what members of their community approve or disapprove of and if it would lead to socially favourable judgment; trust based on competence and moral integrity of the actors responsible could play a key role in the acceptance for the technology; the outcome efficiency of the technology could also influence the acceptability; positive opinions from people who already have experience with the sustainable technology tends to be more favourable to persuade their community members into switching to the technologies hence, crucial to have technology ambassadors at the community level during the planning, training and execution stages of the project; and lastly Knowledge, which can influence the acceptance of renewable technologies or discourage its adoption.

Social acceptance is a positive response in the form of attitude, intention, behaviour and towards a proposed technology by members of a given social unit According to Upham et al., (2015) there are three dimensions of social acceptance of RE innovations; s**ocio-political acceptance** which is the general societal climate and uptake towards technology or innovation within a society, indicating how positively or negatively the technology or innovation is perceived by the public and opinion leaders, a **market acceptance** which describes the market success of innovation and refers to the supply and demand side as well as intermediate factors like the behaviour of users, makers and repairers, and **community or local acceptance** that relates to the attitudes and behaviours exhibited by those indirectly affected by the innovation or technology. These could comprise drivers of fossil-fuel-powered vehicles, fossil fuels sellers and retailers and electricity distribution facilities (Wüstenhagen et al., 2007). It includes - foresight of participation and building of energy communities as well regular members of the community. These three dimensions of social acceptance are manifest in the attitudes, effects and actions of individuals and groups and are therefore intricately linked to both individual and collective actors. Social acceptance could either positively or negatively influence the sustainability of a RET project (Burghard et al., n.d.).

Das (2020) conducted an analysis study of customer perception and awareness toward electric two-wheelers was conducted in Pune city of India. The results showed that the respondents expressed skepticism about the performance and longevity of the two-wheelers. Based on the result the study suggested that innovators and marketers should educate two-wheeler owners, and the public about the benefits and, long-term cost efficiency and profit of a project or product for ease of uptake and acceptance.

Qualitative analysis and empirical evidence obtained from research in Mexico City on social acceptance of solar water heaters as a RE innovation solution indicated that adoption comes about through a decision-making process that occurs through knowledge, persuasion, participatory implementation, and confirmation processes. Several factors were realized to contribute to these processes; relative advantage, the complexity of use, and how easily potential adopters can explore the innovation (trialability). The research further summarizes that participatory implementation and technology transfer play key roles in ensuring the sustainability of RET and innovations, and social acceptance and uptake of the energy solution (Mallett, 2007).

2.5. Perceived Risks and Benefits

Tingchi Liu, M., et al. (2013) describes perceived risks are the potential losses to be incurred in case the product or project does not perform as previously intended while perceived benefits are beliefs about the possible positive outcomes associated with a behaviour in response to a real or perceived threat (Chandon et al., 2000). Energy is essential for most activities of modern society. Its use or consumption is taken as an index of the standard of living. As people in poorer areas gain more access to electricity, clean water, and other amenities, the overall energy use of that area increases. This increased quality of life from improved health care centres and better living conditions is aided by access to electricity. The provision of electricity solutions to the energy needs of all members of a community is still a challenge. Most of these communities are often energy poor and the most vulnerable in society. They need support in agriculture, clean cooking, and economic activities. Aligning their needs to the solutions and factoring in affordability and financial viability is still a complex task. Understanding the concerns, fears, needs, and benefits of RE solutions to these vulnerable groups is one of the crucial steps to finding a viable long-term solution to energy inequality. Poor, vulnerable (including disabled, displaced persons, or other vulnerable groups) or female headed HHs/female beneficiaries are at risk of being left behind if targeted support is not provided to them to deliver electrification solutions targeted to their needs at prices they can afford. These population segments require special consideration when business and financing models are being prepared that are likely to include end-user subsidies; consumer awareness-raising and efforts targeting their conditions.

Environmental and societal energy consumption challenges have spurred the development of sustainable RET in most countries of the Global South. Public acceptance of these technologies is crucial for their successful introduction into society. Communities' attitude towards these technologies is influenced by perceived costs, risks and benefits, positive and negative feelings in response to the technology, trust, and procedural and distributive fairness. Individual behaviour is influenced by perceived costs, risks and benefits, outcome efficacy and awareness of adverse consequences of not accepting the innovative technology (Huijts et al., 2012).

Research conducted in India, for example, on the adoption of Solar power in HHs indicated that consumers could adopt solar power technology if they could see the real advantages of using it over non-renewable resources. The research also established that consumers are more receptive to adopting new technologies if they believe in the innovative benefits of technology. Thus, in the initial stages of project implementation, emphasis on the benefits of RET must be promoted to boost end users' confidence which will grow over time (Tanveer et al., 2021).

Considerable progress has, however, been achieved in reducing connection fees for grid electrification in recent years. For example, as evidenced by the MTF surveys, high connection fees, and associated expenses to get a connection continue to be the primary reasons why most HHs are not connected (World Bank, 2020. MTF surveys). It is important to note that most income-generating activities are also tied to the availability of reliable energy, and hence solutions to access to energy should also focus on promoting equitable distribution of resources, knowledge, and services hence reducing unemployment rates, increasing HH income and promoting health and education.

Acknowledging the significance of public knowledge and its relationship to perceived benefits and public acceptance of projects is one step toward achieving sustainability. Managing perceived risks through public engagement and awareness programs can significantly improve public acceptance of projects (Wang et al., 2019). Individuals tend to evaluate the expected result of a given technology in terms of its perceived benefits and risks, and these perceptions contribute to their acceptance or rejection of the technology (*Slovic_241.Pdf*, n.d.).

2.6. Economic Aspects

Access to electricity and clean cooking have both been historically unevenly distributed across income groups. Off-grid solar companies targeting primarily rural and primarily lower-income customers have started to close this income divide, but affordability gaps persist. Recent estimates show that at least 112 million people, including vulnerable and female headed HHs, are unable to afford the most basic electricity service (Tier 1 system), even if this is offered with a consumer financing option (World Bank, 2020). This number is likely to have increased because of the COVID-19 pandemic and the Russian-Ukrainian war, leading to the economic crisis. Many last-mile HHs live on under $4 a day and are not being served by current commercial off-grid energy services.

An increasing number of countries have adopted integrated national electrification strategies and plans. However, only eleven out of fifty-four electricity access-deficit countries in Africa have advanced electrification plans that capture all the best-practice attributes, including service level targets, the inclusion of both grid and off-grid technologies, community, and productive services, and social inclusion, gender sensitivity, and use of geospatial data and tools. These plans intend to pay more attention to access to electrical appliances and machinery, including energy-efficient cooling appliances, electric mobility, and farm tools. In addition, without simultaneous improvements in the grid, mini-grid, and off-grid frameworks, and other sustainable RE solutions through a participatory approach, the ambition in these strategies and plans will remain unrealized (*Technical_working_group_1_energy_access_report_2021.Pdf*, n.d.).

In 2020, the drop in market growth due to the impacts of pandemics resulted in an estimated 10–fifteen million people and 300,000–450,000 enterprises missing improved energy access (GOGLA, 2021b). HH income has dropped significantly, and the pandemic and the Russian-Ukrainian War are pushing an estimated 150 million additional people into extreme inequalities, exacerbating energy affordability constraints. This means that, without external support, less privillaged HHs have no access to clean energy and are left to rely on traditional fuels for lighting and biomass for cooking, with their adverse effects on health, gender equity, and the environment (Shupler *et al.*, 2020). More than ever now, the importance of RE solutions that are cost-effective and address the specific needs of the communities is realised.

2.7. Gender and Energy

Access to energy has tremendous effects on social determinants, especially on different gender realities. Women and men have varied energy consumption patterns and energy access has a significant impact on making work easier, especially for a woman living in rural settings in the Sub-Saharan region. Taking a bottom-up gendered approach to energy access is crucial, both because there is immense potential for women to benefit from energy access and because without including them in the conversation these benefits cannot be realised.

The failure to recognize that gender realities are an essential determinant of social outcomes impacting projects and policies is referred to as the gender-blind approach. A gender-blind approach assumes gender is not an influencing factor in projects, programs, or policy. This has been the case in the energy sector and unfortunately also a factor affecting the success of most RE projects currently (Nelson & Kuriakose, n.d.).

Energy efficiency and RE projects can contribute to the global imperative of reducing greenhouse gas emissions (*ESMAP_CEETI_MayoralNote_6_PlanningEE Livable Cities_optimized. Pdf*, n.d.), while having potential for broad and far-reaching benefits, especially, when gender equality is considered.

Taking gender into account requires identification and assessment of a project's potentially different impacts on the men and women involved and ensuring equitable benefit sharing (*Mainstreaming Gender Equality through the Project Approach*, 2010). This requires, for example, identifying the roles women and men play and the activities in which they are involved in their HHs and communities to pinpoint how they may be impacted by RE initiatives. It also means understanding women's and men's different knowledge, experiences, needs, and interests along the RE value chain (*765710ESM0P1230to0Energy0Operations.Pdf*, n.d.).

Gender issues in RE have been examined in detail at the small-scale level, where women play active roles in energy provision and consumption at the HH level and through community networks (Nelson & Kuriakose, n.d.). Women have made tremendous gains in the small-scale and off-grid subsectors through employment as researchers, retailers, installers, and maintenance workers; entrepreneurs starting and/or growing their enterprises; and HH members with improved health and quality of life for themselves and their families. However, in small-scale systems project development, men's and women's distinct roles and knowledge can still be overlooked, and numerous gender-based challenges need to be addressed. Sector benefits in small-scale and off-grid RE value chains can provide women, as well as men, with development opportunities.

For example, in India, the Lighting a Billion Lives initiative (featuring solar microgrids; solar lanterns; solar home lighting systems; and cook-stoves) provides opportunities for women's employment in sales, rentals, and repairs of solar lanterns (Baruah, 2015). Elsewhere, the Lighting Ethiopia program, with funding of USD 1.6 million from the Scaling Up RE(SREP) program of the Climate Investment Funds (CIF), supports people to access clean, affordable, quality off-grid lighting and energy products and shows how gender-sensitive programming can help meet this objective. The program encourages women's participation in the sector, increases their access to energy to improve their livelihoods, and collaborates with women's groups to access financing for energy products (International Finance Corporation, 2014; Chen and Kuriakose, 2015).

Women's economic empowerment is a key ingredient in overall development (World Bank, 2011). While men are already involved in energy projects, women are not always involved equitably. Energy sector investments can contribute direct economic benefits to women through formal sector employment and by providing them with opportunities to improve their livelihoods through small-scale enterprises, skills development, and training. Such investments can also indirectly positively affect the education, health, and nutrition of women and their HHs, for example through the provision of lighting and heat (*ESMAP_CEETI_MayoralNote_6_PlanningEE Livable Cities_optimized. Pdf*, n.d.). However, all actors along a RE value chain do not automatically benefit. For example, discriminatory gender norms may limit women's mobility and thus their ability to work outside the home or community, attend training activities, or engage in selling, installing, and maintaining renewable energies. These norms also make it less likely for women to be considered, or qualified for, the types of jobs developed through RE projects (*ESMAP_CEETI_MayoralNote_6_PlanningEE Livable Cities_optimized. Pdf*, n.d.). On the other hand, there is potential to create and strengthen women's livelihoods across RE value chains. Such efforts can also help reinforce the implementation of strong social policies like quality social welfare infrastructure and public services. (Baruah, 2015).[7]

The new mini-grid and off-grid solar supply chains being built present socio-economic opportunities for new employment and entrepreneurial activities for women, but the available evidence shows that these opportunities are not yet being fully realized. A recent study of three countries found that women's participation in the Decentralised Renewable Energy (DRE) sector still has room for improvement: women made up less than 30% of the workforce: 23% in India and Kenya and 27% in Nigeria (Power for All, 2019).

Female-Headed Households (FHHs) and women in the energy business, in particular, face inequalities and challenges, because: there is a lack of data and market information about women customers, their needs, and the characteristics of their energy demand; unequal access to assets and land ownership, and limited control over them, directly affects women's ability to purchase energy products and prevents them from having collateral for loans from formal finance institutions; as discriminatory gender norms and decision-making power resides with men, women's influence over a decision on whether or not to purchase energy products is weak; seasonal and informal jobs, and income fluctuation throughout the year, make it difficult for women to make regular payments on an energy product; and systemic barriers to education and lack of training opportunities for advancement may dictate women's ability to enter the workforce and to become leaders in energy companies or enterprises.

[7] *Sibyl Nelson and Anne T. Kuriakose (2017)*

A study to account for equitable participation and energy democracy using qualitative empirical research showcasing human behaviour through women's inclusion in the decision-making processes, for the promotion and uptake of solar energy was conducted in Makueni Kenya. This study indicated that current conceptualizations of energy democracy are limited as theorists and activists have failed to look at the phenomenon through a gendered lens. Although energy democracy is principally concerned with breaking down power structures and increasing public participation in energy-related decisions, it has hitherto failed to recognize the inherently gendered dimension of the transition to distributed RE production that it promotes. The empirical findings from Makueni highlighted that women's empowerment can serve as a useful means of evaluating the holistic reach of energy democracy. The research concludes that for energy to move closer to the people, it is important to interrogate who is winning and who is losing in the transition; therefore, energy democracy theorising can be advanced by incorporating feminist epistemologies, which analyse constructions of the self and social hierarchies (MacEwen & Evensen, 2021).

The government of Sierra Leone in partnership with the AfDB, ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE), and United Nations Industrial Development Organisation (UNIDO) developed an action plan on Women's Economic empowerment through energy access after a successful conference aimed at fostering multi-stakeholder dialogue. On mainstreaming gender in energy access at the institutional, policies and project levels in the region (*GUIDANCENOTE_FINAL_WEB_s_0. Pdf*, n.d.). This initiative among several others tends to address institutional-level challenges, leaving a gap at the community and HH levels. Therefore, adopting a gender perspective on RE development is critically important in ensuring women's contributions – their skills and views – represent an integral part of the growing industry. Increased women's engagement expands the talent pool for the renewables sector. In the context of energy access, engaging women as active agents in deploying off-grid RE solutions is known to improve sustainability and gender outcomes. In recognition of these opportunities, the UN 2030 Agenda for Sustainable Development adopted in 2015 introduced a dedicated goal on gender equality, noting that the "systematic mainstreaming of a gender perspective in the implementation of the agenda is crucial".

2.8. Case studies

This section assessed the different solutions chosen in the implementation sites of the ENERGICA project and the communities' willpower to participate and contribute to RE projects and initiatives as elaborated in the context of demonstrators**.**

2.8.1. Kenya - Transport (e-Mobility)

The transportation industry is one of the contributors to noise and air pollution in urban areas despite the evolution of other sectors to use RE sources. Productive activity time is lost because of traffic congestion, health complications due to pollution, and accidents.

Therefore, there has been a rapid technological rush aimed at the development of new devices for the photovoltaic conversion of solar energy and the storage of electricity using systems batteries in the last decade. Since then, technology has evolved to develop energy solutions through the integration between conversion and storage systems of harvested solar power (Fagiolari et al., 2022). This is a key step in the revolutionizing of the transport sector which for a long time has been reliant on fossil fuels.

This leads to flexibility of use, portability of the batteries and on the other hand technological and safety challenges. Since the reduction of greenhouse gases is the top priority of energy transition, the focus is on primary electricity being converted to material energy carriers whereby it can be stored and made accessible for other remote mobility applications for a holistic approach to the e-mobility sector.

An empirical study, aimed at identifying influencing factors on the acceptance of electric vehicles was conducted in Germany. The study sought to understand individual arguments on e-mobility, how high usage rate of these e-vehicles could be reached in the public and what are perceived benefits. It was also about the identification of possible pro-using motives as well as perceived drawbacks for sensitive tailor-made solutions as fears and concerns. Focus group discussions were conducted before the questionnaire study; the outcomes indicated that traditional cars are perceived as much more comfortable and received high truthfulness in comparison to e-cars. User diversity in terms of age and gender was found to consider the perceived benefits and barriers differently. Female users but also aged persons indicated higher levels of acceptance, which could be due to their higher environmental consciousness in contrast to male persons and younger participants. Interestingly, the self-reported level of domain knowledge was significantly higher in men than in women, but this did not influence their levels of acceptance (Ziefle et al., 2014)

Globally, people are getting increasingly conscious of environmentally friendly living making it the right time for the two-wheeler industry to move towards its eco-friendly option of electric vehicles. Electric two-wheelers can solve global challenges of oil availability, urban traffic congestion, and pollution control. An analysis of customer perception and awareness toward electric two-wheelers was conducted in Pune city of India. Data was collected from two-wheeler owners who were interviewed about their expectations, awareness, and perception of electric vehicles. Results suggested that two-wheeler owners perceived electric two-wheelers as a costlier and less efficient option than fuel-based two-wheelers. They also expressed scepticism about the performance and longevity of the product. Based on the result the study suggested that innovators and marketers should educate two-wheeler owners, and the public about the benefits and long-term cost efficiency and profit of the product. The study recommended that communities could switch from fossil fuel-powered two-wheelers to electric two-wheelers if; companies and marketers can educate potential customers on the innovative solution, awareness campaigns can help develop positive customer perception, and providing test rides to potential customers can help clarify concerns as they will be able to check on the performance efficiency of the product at no cost (Das, 2020).

Kenya is currently at the forefront of the transition to a low-carbon economy through the Climate Change Act of 2016 and the Energy Act of 2019. About 85 % of Kenya's energy is derived from renewable sources i.e., Hydro Power (826.23 MW), Wind (336.05 MW), Solar (52 MW), Biomass (2 MW), and Geothermal (828.04 MW), and excess production of about 800MW, the country still faces challenges with energy access, transport, pollution and congestion as a result of an inefficient transportation system and old vehicle fleets. (Source: renewableenergy.go.ke). The latter is especially responsible for the most hazardous particle emissions affecting the environment and public health.

2.8.2. Madagascar - The Water and Food Nexus

Systems have been developed to help homes perform effectively and manage power consumption and provide an on-demand supply of surplus energy to the societies around them powered by RE sources, identified as nano grids. Palladam created a low-cost prototype of a Peer-to-Peer Solar Energy trading platform called "Saur Sikka." It enabled users, who use their Solar Energy to harvest surplus power with an opportunity to sell. A survey conducted to assess the possibility of independently distributed nano grids around Palladam in India indicated that the proposed system works effectively in the prototype set and can be used to test the effects of real energy trading in a life-scale model. The prototype served as an effective guide to help understand the complexities of building a Peer-to-Peer solar trading network. The prototype also revealed immense potential for replicability as there was high social acceptance by the local communities (Salvi et al., 2020).

Despite this positive potential only a small proportion of the population uses solar energy technology. A study aimed to understand the social acceptance of solar-powered water pumps in rural Pakistan and the farmers' willingness to pay extra for green electricity was conducted from a sample of 1200 farmers in rural Punjab using a well-structured questionnaire. The results indicated that the intention to install water pumps was positively associated with the attitude towards environmental protection, subjective norms of sustainable behaviour, lack of electricity access, perceived behaviour control and relative advantages. The installation and maintenance costs were negatively associated with the farmers' intention to install it. The probability of 'willingness to pay extra for green electricity was increased with education, HH income, and lack of access to grid electricity but decreased with age and the cost of green energy technology. The findings indicated that young, more educated, and wealthier farmers were more likely to accept green energy. The lack of financial resources, availability of fossil fuel alternatives, and lack of understanding of green energy technology were the main reasons for the stated unwillingness to pay extra for green energy. The study recommended providing awareness programs about using a solar-powered water pump and other alternative benefits of using solar power to rural populations could enhance public acceptance of the technology (Elahi et al., 2022).

Madagascar has one of the lowest electrification rates (17%) in the SADC and has an extremely low population density of 43.4 people/KM^2 making it challenging for grid extension to reach the sparsely populated region. The energy supply is inadequate and prone to frequent outages. This technological solution would be ideal for demographic and infrastructural challenges.

2.8.3. Sierra Leone - Waste and chemicals

Waste management through recycling is a process of converting waste into new products such as energy, water, and fertilizers. This process involves sorting and processing waste materials like plastics, metals, paper, biowaste and glass. Recycling waste can produce water through the process of wastewater treatment. During this process, wastewater is treated to remove contaminants and pollutants, making it safe for reuse or discharge into the environment. The treated water can be used for irrigation, industrial processes, or even drinking water in some cases. Recycling can also produce energy through waste-to-energy and biogas processes and composting to produce fertilizers that improve soil health. Waste Management is crucial for reducing waste, conserving natural resources, and reducing greenhouse gas emissions.

A study to assess the perceptions, determinants, and constraints of organic fertilizer adoption by cocoa farmers conducted in Ghana, indicated a generally positive perception of '*Asaasenufosuo*' organic fertilizer for cocoa production. However, less than half of the cocoa farmers had adopted '*Asaasenufosuo*' organic fertilizer. This was influenced by education on organic fertilizer, the experience of use, farm size, income, secondary occupation, distance to agro-input outlets like shops, group membership, source of information, and extension services contact. The major constraints included the slow release of nutrients into the soil, high transportation cost, emission of offensive odour, inflated cost of the product, and limited availability. The study recommended that to improve the uptake of organic fertilizers in cocoa production, manufacturers should take steps to reduce the offensive odour of the product. Also, sellers of the product should make it readily available to farmers by expanding the distribution network into cocoa-growing communities (Avane et al., 2022).

A considerable number of communities advocate for the responsible use and reuse of water as a scarce commodity to most. Recycled water is a sustainable and technologically reliable source of urban water but the least implemented innovation. These reactions stem from the actual usage of recycled water especially when ingestion or personal contact is involved (Ching, 2015). On the contrary, grey water use has been socially accepted for farming activities. A study was conducted to assess public attitudes and perceptions towards greywater reuse in a low-cost housing development in Durban, South Africa. Structured questionnaires were administered to residents within the communities through field visits. The findings indicated a complex relationship between attitude and perception towards the reuse of greywater. The major factor affecting the public attitudes and perception towards the reuse of greywater as observed in this study was found to be the need for reuse and their level of education. The study reinforced Field's (Ching, 2015) study that the willingness to reuse grey water which involves low human contact is acceptable by individuals compared to other uses with high chances of personal contact hence they recommended it for farm activities (Bakare et al., 2016).

In Peri-urban and urban contexts, access to energy and fertilizer for efficient local food production is one of the key global sustainability challenges. Food security is intimately tied to access to fertiliser and the long-term sustainability of agricultural production relies on the replenishment of soil organic content to maintain fertility.

3. METHODOLOGY

3.1. Scope

3.1.1. Kenya

The Republic of Kenya is a presidential representative democratic country in the Eastern Region of Africa, with diverse geography, climate, and population. It ranges from cold snow-capped mountaintops on Mount Kenya, surrounded by vast forests and wildlife, to fertile agricultural regions, temperate climates in western and rift valley counties, and dry, less fertile arid and semi-arid areas, including the Chalbi Desert and Nyiri Desert. Kenya is a lower-middle-income economy, the largest in eastern and central Africa, with a Gross National Income (GNI) of 1,847 USD. Nairobi is its capital city and a major regional commercial hub. Kenya has forty-seven administrative divisions known as County Governments and headed by governors. Swahili and English are the official languages. English is commonly used in formal settings while Swahili widely used in social and formal settings. Sheng is also commonly used in urban social settings with each city having their own dialect of the sheng. The country's largest sector is agriculture, with tea and coffee as traditional cash crops and fresh flowers as a fast-growing export. The service industry is also a major economic driver, especially tourism and Financal Technology (FINTECH). Kenya is a member of regional blocks like the East African Community (EAC), COMESA, and The Intergovernmental Authority on Development (IGAD).

The energy sector in Kenya is dominated by biomass, representing 68% of the national energy consumption, with electricity (9%) and imported petroleum (21%) as the other sources (Energypedia, 2021a). The Kenyan government is actively pursuing new local and international technologies to expand and upgrade the transmission and distribution networks as well as promote the transition to a renewable-based energy system. The government prioritizes the "Big 4 Agenda" focusing on Food and Nutrition Security, Healthcare, Manufacturing, and Affordable Housing that accelerates SDGs 2,3, 8, and 11 (GOK, 2020). Access to affordable, reliable, quality, safe, and sustainable energy remains an integral part of achieving the "Big 4 Agenda." Kenya possesses significant potential sources for clean and affordable power generation in geothermal, wind, hydro, and biomass energy.

According to the Directorate of Renewable Energy, and the Ministry of Energy of Kenya (2019), 75% of Kenyans had access to electricity, and the number of connected HHs tripled from 2.3 million in 2013 to 6.9 million in 2018. Kenya aims to achieve the target of 100% use of clean energy by 2030 and 100% access to clean cooking by 2028. Traditional biomass use, especially in rural and urban deprived areas, coupled with the rapid growth of motorized transport, has caused environmental implications, and created regional energy planning and investment challenges. Climate change impacts are already negatively affecting the existing energy systems, particularly hydropower, which is the main source of electricity, thereby affecting the country's economy and health sectors.

As an economic hub of the EAC, the region acknowledges these challenges and addresses them by creating new favourable opportunities for clean and efficient energy services through regional policies, the EAC 2050 vision, and supporting Kenya's energy and renewable energy policies and implementation strategies (*REN21-EAC-Web-EN. Pdf.Pdf*, n.d.). As a result, Kenya is uniquely positioned to support e-mobility using electric motorcycles, which have been assessed in Nairobi and end-user demand verified for innovative services of swappable batteries and swapping stations. The project will focus on the urban regions of Nairobi and later replicate them in the small cities of Kisumu and Homa Bay Counties.

3.1.2. Madagascar

Madagascar is the fourth largest island in the world, located in the Indian Ocean part of the African Region. It has a geographical area of 587,295 km2 and a population of 25,674,196 inhabitants according to the 2018 general population census. The country is divided into twenty-two regions, with Antananarivo serving as the capital city. The official language Malagasy is spoken by 99.9% of the population, while French and English are spoken by 23.6% and 8.2% of the population, respectively.

Madagascar experiences two main seasons: wet and hot seasons from November to April and cold and dry seasons from May to October. The country has one port, the Port of Toamasina, and is an affiliated member of the AU, COMESA, and SADC regional blocks. Most of the island’s energy is generated from diesel and heavy fuel, with demand coming from the residential customer category. Madagascar's primary energy supply is sourced domestically; however, the country relies on imports of fossil fuels (SACREEE, 2018).

The infrastructure in Madagascar poses a challenge to accessibility to generation sites, and load shedding is common, with the national power utility, Jiro Sy Rano Malagasy (JIRAMA), estimating 799 outages in 2015 (World Bank, 2020). The country's 2015 Energy Policy targets an acceleration of the electrification rate through renewable energies to 54% by 2020, and 70% by 2030, which translates to 260,000 HHs being connected annually (World Bank, 2020).

Madagascar has one of the lowest electrification rates in the SADC region, with an average of 17%, and the population density of 43.4 people/KM2 makes it challenging for grid extension to reach the sparsely populated region. The energy supply is inadequate and prone to frequent outages. Also, despite the high production of rice, cocoa, sugarcane, cashew nuts, shrimp, and other farm produce, most of it goes to waste due to poor post-harvest handling systems. On the other hand, the island has significant hydro, wind, solar, and biomass resources. Small-scale hydropower has increased, and several independent solar PV projects have kicked off with these selling power to JIRAMA through a long-term Power Purchase Agreement (PPA). The Biomass potential lies with sugar production in the south stimulating biogas cogeneration. Exploration of geothermal potential is still in the preliminary stages.

The Island country is an ideal location for the project because it has a low electrification rate and poor post-harvest handling systems. The few nano grid solutions implemented have not exhibited any negative impact on the flora and fauna (Brunet et al., 2022). The ENERGICA's Demonstrator project will develop nano-grid solutions to support Madagascar’s 2015 energy policy. The project will demonstrate integrated productive use systems in innovative nano-grids addressing the Water, Energy, and Food (WEF) nexus. The targeted villages will be in Diana Region (Ambanja, Ambilobe, and Diego II districts) and will be sought out as a representation of the most common use cases of Malagasy rural areas, including coastal and mountainous villages, agricultural plains, and forests depending on size accessibility.

3.1.3. Sierra Leone

The Republic of Sierra Leone is in West Africa with a population of 7,092,113 inhabitants in 2015. Its surface area is 71,740 km², and its population density is about 1,224 habitants/km². Freetown is the capital city, and English is the official language. Sierra Leone has a tropical climate with two seasons: Wet (May to November) and hot and dry (November to June). It has a diverse environment ranging from savannah to rainforests and three ports: Freetown, Pepel, and Sherbro Island. Sierra Leone is affiliated with various organizations such as the UN, AU, ECOWAS, Mano River Union, Commonwealth of Nations, IMF, World Bank, WTO, AfDB, and Organisation of Islamic Cooperation.

The energy sector in Sierra Leone faces significant challenges due to a lack of sufficient installed power generation capacity for its population of approximately eight million people. The total installed capacity is estimated to be 113 MW in 2019, with up to 75 MW from hydropower, 4 MW from solar, and 34 MW from bioenergy. The rate of electrification is among the lowest in the sub-region at about 5%, and only about 150,000 customers are connected to the grid. The electricity access rate is approximately 10% to 12% in urban areas and about 2% in rural areas. However, the country has significant potential in Renewable Energy Resources (RER) such as solar, hydro, wind, and biomass.

To reduce the lack of grid energy access, more than 33,000 diesel generators are estimated to be used in the country, leading to a capacity of approximately 180 MW. The electricity generated from fossil fuel and hydroelectric plants represents respectively 33.3% and 66.7% of the total installed capacity. The government of Sierra Leone has developed a national strategic plan in the energy sector to diversify the production from fossil fuel to RE, namely thermal generation, hydroelectricity, and solar energy generation in various parts of the country. Institutions such as the World Bank, JICA, and the development of PPP are deeply involved in the sector's development.

Sierra Leone's middle class is composed of the educated elite and entrepreneurs in both formal and informal sectors. Access to energy and fertilizer for efficient local food production is a global sustainability challenge, but more so in Sub-Saharan Africa (Kahn, n.d.). The ENERGICA's Water, Energy & Food nexus demonstrator for Sierra Leone will be in the peri-urban setup of Freetown, aligned with the local policies to tackle the risks and vulnerability of poor waste management systems, proper reuse of agricultural waste and production of RE, and will be implemented successively.

3.2. Sample

A general population survey and Key Informant Interviews (KII) were conducted in Nairobi Kenya, Diana region in Madagascar, and Freetown in Sierra Leone. The sample drawn was categorised into the respective subgroups targeted by the project in the different locations: Boda-Boda riders and customers in the upper, mid, and low-income categories for the Kenya context, HHs connected to the nano grid and HHs not connected to the nano grids for the Madagascar context and HHs living in the dumpsite areas of Freetown and those living in the outskirt areas of the dumpsites for the Sierra Leone context.

The KII respondents were categorised in homogeneous strata similar across the three countries as representatives from; government ministries and parastatals related to energy and renewable energy, research institutes, small-scale RE companies, Community-Based Organisations (CBOs) implementing community RE projects/solutions, and Civil Society Organisations (CSOs) advocating for sustainable environmental practices and renewable energies.

The sample size for the survey was guided by the grant agreement which indicated a minimum of 300 respondents for each country's context. Partners responsible for the collection of data for this survey agreed to have a sample of between 340 – 380 respondents in the general population survey and fifteen respondents for the key informant interviews per country context. A total of 1,674 HH surveys were collected in Kenya, Madagascar and Sierra Leone After data cleaning and data sorting, the actual data that was analysed was 537 – in Kenya, 658 – in Madagascar and 479 – in Sierra Leone for the general population survey and 14 – Kenya, 8 – Madagascar and 14 – Sierra Leone for the key informant interviews, making a total of 1674 quantitative surveys and 36 qualitative surveys.

3.3. Research Design

A mixed methods approach was applied using a combination of qualitative (key informant interviews) and quantitative (general population questionnaire) tools to discern the participants' perceptions of the energy transition and the roles they see themselves having in this process. An analysis of the local social, cultural, and environmental contexts was conducted through a baseline evaluation of the community, market, and ecosystem in all the three countries: Kenya, Madagascar, and Sierra Leone.

3.4. Methods

All task partners (EACREEE and OPIBUS for the Kenya demonstrator, SACREEE, CLUB-ER, NANOÉ, for the Madagascar demonstrator, and ECREEE & FWT for the Sierra Leone demonstrator) supported the data collection activities at the local level hiring and conducting face-to-face interaction training for the enumerators, supporting the pilot study and supervision of the actual data collection exercise. With the help of local partners, KII respondents were identified through a mapping and verification process. Consented and recorded virtual interviews were conducted by HUD with the help of the local partners. The recordings were purely used in the data analysis process.

The research structure involved a desktop review of similar studies that were conducted in the study locations and other regions and especially in the global south to learn how best to structure the survey tools for quality findings. Collaboratively, all task partners engaged in developing the general survey tool and the key informant interview guide for the three contexts. Specifically, the local partners responsible for implementing the demonstrator solutions at the local level contributed to the context-specific sections of both the questionnaire and the guide. OPIBUS contributed to the Kenya context, FWT to the Sierra Leone context and Nanoé to the Madagascar context.

As a quantitative method of data collection, a questionnaire was developed in the English language with input from all the relevant contexts and local partners as collaborators and later translated into French for the Madagascar context. KOBO Toolbox[8] was used for data collection as it would enable enumerators to collect data both online and offline without limitations on network connectivity, and they could easily use their mobile phones.

[8] https://www.kobotoolbox.org/

The questionnaire tool developed for the general population survey consisted of nine sections:

- **Background information** - included age, education level, employment, and marital status of the respondent, as well as the context in which they live and HH population. This offered a general overview and perspective of people living in the area.
- **Energy access** - included an introductory section to the energy topic, to assess the accessibility, reliability, and sustainability of the energy sources currently available.
- **Awareness of energy and environment** - to learn about knowledge on RE & non-RE sources, and their differences, the observable effects of non-RE sources at their local context and need for more RE sources in their country.
- **Community life** - assessed the possibility of sustainability of a RE project through assessing their social structures, trust in themselves and their community, their ethical and integrity perception of the community towards implementing and participating in community projects amongst community members.
- **Support and acceptance of innovative technologies and services -** to evaluate the communities' willpower to participate and contribute to the RE projects and initiatives as well as introduce the thought of change from their current sources of energy to RE sources and their willingness to champion this change thought on RE projects to other community members.
- **Perceived risks and benefits -** this section sought to preempt the perceived risks and possible benefits of RE projects and initiatives. This would potentially help the ENERGICA project prepare well during implementation to tackle these risks through initiatives like; a participatory approach in implementing the projects, training, and civic education forums. Also, during the mid and end-term evaluation assessments of the project, an assessment of where the project met the communities' expectations would be conducted, as they were highlighted in the section.
- **Economic aspects -** to assess the expected or perceived economic impact the RE projects will have on the communities and especially in ending discrimination against marginalised groups.
- **Demonstrator-specific sections** - this comprised a Water and Food Nexus for the Madagascar context, Transport for the Kenya context and Waste and Chemical for the Sierra Leone context. These sections were linked to the energy challenges of the areas and the proposed specific demonstrator solutions.
- **Gender and energy** - An assessment of the correlation between gender, access & knowledge, and benefits of RE.
- **Final open section** - the respondent could offer additional information that would be relevant and beneficial to the community and the project.

For the qualitative research, the KII guide was developed collaboratively and included sections on:

- **Background information of the respondent** - their position and the institution they represented.
- **Awareness of energy and environment** - to share in-depth information on challenges, practical solutions, and motivation for acceptance of the solutions they suggest.
- **Community/social life -** a brief description of the characteristics of the community; **Economic aspects** - assessed the potential economic impact a RE project would have on the various groups and intersections of their communities.

- **Demonstrator-specific sections** - assessed the general energy challenge in the context, and factors influencing the challenges, practical solutions, potential risks, and potential usage of the RE demonstrator solution.
- **Gender and energy** - assessed the gender representation in the energy sectors in both their organisations and their communities, the factors influencing the statistics, measures in place to improve the disparities (for cases with disparities) and suggestions on best energy practices that would promote gender equity; and
- **Final open section** for the informant to share additional useful information that would be beneficial to both the community and the project.

A brief Partners training which entailed the data collection tool (KOBO Toolbox), ethical considerations, communication skills, and the survey questions was conducted. The training materials were shared with the partners for each context who used them during the training of the enumerators for the data collection exercise.

Gang and Kothari (2014), describe Information analysis as the modification of information to become information with meaning. This process involved correcting errors, editing, rectifying omissions, and joining the data taken together. Unprocessed information that was gathered from questionnaires underwent analysis by using descriptive statistics that involved means, percentages and frequencies by the study objectives. The data were analysed using Statistical Package for the Social Sciences (SPSS). Multiple regression, correlation and mean comparison analysis was utilized to clarify the impact of dependent variables on independent variables (Gast and Ledford, 2014).

3.5. Pilot test

A pre-test of the survey was conducted after programming the survey on KOBO Toolbox before it could be shared with the local partners for the pilot study. This was done in all contexts conducted including the respective target population in the implementation areas. The subjects of the pilot study and the enumerators were encouraged to give suggestions concerning the instructions, clarity of the questions, the sensitivity of the questions and the flow of the questionnaire. 148 respondents were reached and. The main findings of the pilot study where some respondents were unwilling to give out contact details citing the possibility of voter fraud, especially in the Central Business District of Nairobi, this is because the study was conducted during the campaign period in preparation for the presidential elections on August 9th, 2022. This was solved by emphasizing to the enumerators to inform the respondents that this information was not mandatory and was to be used purely for this study and other follow-up studies in this project in case they wanted to participate in future follow-up interviews. For Sierra Leone and Madagascar, the suggestion was to include other sources of energy that were not in the tool before, like outside electricity (for respondents who had access to electricity through other HHs in the neighbourhood), and HH electricity (where the physical electricity installation was done in the HH). These recommendations from the pilot study were adapted to the tool and other discussions to bring clarity to the enumerators were held before the actual data collection exercise began. The validity of the survey tool for the general population survey was evaluated to ensure that the questions were easily comprehensible, clear, used simple words familiar to all the respondents and that they conveyed only one thought at a time, as suggested by Kothari, (2004).

3.6. Ethics

The ethical considerations were guided by the project's grant agreement requirements. For the general population survey, informed consent was obtained from the respondents before data collection was conducted, and only those that agreed to participate were engaged in the survey. The researcher also informed the respondents about their confidentiality and the purpose of the data collection. For the KII, the interviewees received a copy of the consent information before the scheduled interview and their consent was recorded before the interviews could start. It was also communicated to both the KII respondents and the general population survey respondents that they could indicate if they wished to be reached out to during the midterm and end-term evaluation or to be informed about the project's progress and participate in building the solutions.

4. RESULTS

4.1. Kenya

4.1.1. Background Information

The background information in this study sought to understand the basic information about the respondents in Nairobi, and how these factors could influence their opinions, attitudes, or behaviours. This information helped to identify patterns and trends within the data and to ensure that the sample is representative of the population in Nairobi. From the study, 537 people were interviewed with 78.6% being male and 21.4% being female. Their average age 31 with a mean monthly HH income was $191.89[9] as shown in Table 1 below.

[9] 1 usd =121 Kenya shillings (xe.com - currency convertor Oct 8, 22)

Table 1: Socio-demographic characteristics – Kenya

Nationality: Kenya (N = 537)			
Variables	**Frequency**	**(%)**	**Mean**
Gender			
Female	115	21.4	
Male	422	78.6	
Age			31
Marital status			
Single	256	47.7	
Married	259	48.2	
Separated	15	2.8	
Divorced	5	0.9	
Widowed	2	0.4	
Education			
I prefer not to answer	80	14.9	
No formal education	3	0.6	
Primary (1-5 years of school)	20	3.7	
Intermediate (6-8 years of school)	58	10.8	
Secondary (9-12 years of school)	205	38.2	
Vocational training	22	4.1	
Tertiary (University)	148	27.6	
Locality			
Rural	0	0.0	
Intermediate density area	152	28.3	
Urban	385	71.7	
Occupation			
Student	86	16.0	
Unemployed	5	0.9	
Employed	59	11.0	
Self-employed	386	71.9	
Houseman/-wife	0	0.0	
Retired	1	0.2	
Monthly HH income			$191.89
Monthly HH expenditure on Energy			$105.48

4.1.2. Energy Access

Almost everyone (98.7%) had access to energy in their HH in form of electricity provided to them by (87.6%) Kenya Power Company. Most people (87.3%) said the energy was reliable and available for an average of 17-24 hours per day. The most common sources of energy for different purposes were petroleum gas for cooking, HH electricity for lighting and communication, and petrol for transportation. Firewood was not commonly used in the city. However, almost half (44.7%) of the people were not happy with their energy sources. On average, people spend about 55% of their monthly HH income on energy.

Is satisfaction with energy sources influenced by the energy provider and energy reliability in Kenya?

An ordinal logistic regression analysis (Agresti, A. 2010) was run as shown in Table 2 below to determine whether satisfaction with energy sources was influenced by the energy provider and energy reliability. The results found that people with unreliable energy were 3.8 times more likely to be unhappy with the energy sources than those with reliable energy. The HH energy provider also influenced satisfaction levels, with Kenya Power being associated with higher satisfaction levels than individual solar systems.

Table 2: Collinearity on the influence of energy provider on satisfaction with energy sources – Kenya

Coefficients[a]			
Model		Collinearity Statistics	
		Tolerance	VIF
1	Energy Reliability	0.998	1.002
	Kenya Power and Lighting Company	0.202	4.962
	Individual Solar Systems	0.202	4.959

a Dependent Variable: Satisfaction with energy source

4.1.3. Awareness of Energy and the Environment

81.4% of the respondents had heard of climate change, and 58.7% thought it would affect them in the future, through extreme weather events and food shortages. The majority (76.9%) had heard of RE, with solar energy being the most known. Additional sentiments on the impact of climate change were shared below. Key informants confirmed that climate change impacts the community already, for example the following was stated by a representative of the government:.

"The impacts of climate change are affecting the social fabric of our communities. For example, the farming community in western Kenya, especially Kitale, has been significantly impacted by the effects of climate change. Their planting calendar has been disrupted, leading to reduced yields and income. Additionally, climate change has disrupted the informal labour sector, as people are not aware of when to prepare for certain income-generating activities. This lack of awareness is causing significant economic challenges for many people in our community."

Reported a representative to a government ministry department.

Is there a relationship between knowledge of climate change and the knowledge of RE in Kenya?

A bivariate correlation analysis was conducted to examine if knowledge of RE is related to knowledge of climate change. The result indicated a strong and statistically significant relationship between people's knowledge of climate change and their knowledge of RE. In other words, if people know more about climate change, they are also more likely to know about RE as shown in Table 3 below.

Table 3: Relationship between knowledge of climate change and the knowledge of RE - Kenya

Correlations

		Do you know what climate change is 1	Have you heard of RE 1
Do you know what climate change is	Pearson Correlation	1	.375**
	Sig. (2-tailed)		.000
	N	535	533
Have you heard of RE	Pearson Correlation	.375**	1
	Sig. (2-tailed)	.000	
	N	533	534

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

Is there a relationship between awareness of RE and support for increasing its use in one's country?

A chi-square test of independence was used to determine whether people's awareness of RE is related to their willingness to support increasing its use. The test found a strong and significant relationship between the knowledge of RE and willingness to support its use amongst the people of Kenya as shown in Table 4 and Table 5 below. The findings show that people who are more aware of RE are more likely to support increasing its use.

Table 4: Relationship between awareness of RE and support for increasing its use – Kenya

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	531.414[a]	12	.000
Likelihood Ratio	568.716	12	.000
N of Valid Cases	537		

a12 cells (60.0%) have an expected count of less than 5. The minimum expected count is .01.

Table 5: Association between awareness of RE and support for increasing its use – Kenya

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	0.995	.000
	Cramer's V	0.574	.000
N of Valid Cases		537	

Is there a correlation between knowing what climate change is and the belief that it will affect individuals in the future?

The logistic regression analysis was used to find out if there is a link between knowing about climate change and the belief that it will affect individuals in the future. The results showed a strong relationship between the two variables, indicating that belief of the impact of climate change affecting people in the future is associated with knowledge of climate change. The model fits the data well, as shown by the statistical measures in Table 6, Table 7, *and* Table 8 below.

Table 6: Model fitting information on correlation between knowing what climate change is and the belief that it will affect individuals in the future – Kenya

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	525.206			
Final	.000	525.206	3	.000

Link function: Logit.

Table 7: Goodness of fit - showing correlation between knowing what climate change is and the belief that it will affect individuals in the future – Kenya

Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	.000	12	1.000
Deviance	.000	12	1.000

Link function: Logit.

Table 8: Pseudo R-square - correlation between knowing what climate change is and the belief that it will affect individuals in the future – Kenya

Pseudo R-Square

Cox and Snell	.624
Nagelkerke	.684
McFadden	.401

Link function: Logit.

4.1.4. Community Life

In Kenya, most respondents (70.8%) feel recognized and proud to be a part of their community, and nearly half of them (44.6%) trust their fellow community members. However, about one-third of the respondents (32.2%) do not trust their local authorities, and 37% have a neutral opinion about them. While respondents are comfortable asking for help from their neighbours, they are not actively involved in clubs or social groups (73.9%).

A Key Informant from an NGO highlighted the modes of engagement and communication as,

"In our community, people engage with each other through social groupings such as Chamas and Nyumba Kumi. They also engage administratively or officially through formal meetings and community barazas."

Is trust in local authorities positively correlated to participation in community organisations?

The Cochran-Armitage test of trend was used to check if there is a linear trend between trust in local authorities and participation in community organizations. The findings showed that trust in local authorities is associated with participation in community organizations. The results are presented in Table 9 below.

Table 9: Linear trend between trust in local authorities and participation in community organizations – Kenya

Variables not in the Equation

			Score	df	Sig.
Step 0	Variables	Do you trust local authorities in your neighbourhood	35.295	1	.000
	Overall Statistics		35.295	1	.000

Can a sense of community belonging positively impact the likelihood of asking for help from neighbours?

The study used Spearman's rank-order correlation test to see if there is a link between feeling a sense of community belonging and asking for help from neighbours. Table 10 below presents the results showing a weak positive relationship. This suggests that those who feel a sense of community belonging are more likely to ask for help from their neighbours.

Table 10: Relationship between feeling a sense of community belonging and the likelihood of asking for help from neighbours - Kenya

Correlations

			Do you feel recognised part in your neighbourhood	Would you ask neighbours for help
Spearman's rho	Do you feel recognised part in your neighbourhood	Correlation Coefficient	1	.113**
		Sig. (2-tailed)	.	
		N	529	
	Would you ask your neighbours for help	Correlation Coefficient	.113**	
		Sig. (2-tailed)	0.01	.
		N	521	

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

Are positive feelings about one's neighbourhood associated with possible future adoption of RE sources?

Spearman's rank-order correlation was conducted to investigate if positive feelings about one's neighbourhood is associated with the likelihood of greater adoption of RE sources if their neighbours do. The results Table 11 in showed that there is a moderate and meaningful connection between liking one's neighbourhood and being willing to use RE if most of the neighbours are doing so.

Table 11: Relationship between positive feelings about one's neighbourhood and the likelihood of adopting RE sources – Kenya

Correlations

			Are you proud to be part of your neighbourhood	Would you adopt RE if majority of neighbours are doing so
Spearman's rho	Are you proud to be part of your neighbourhood	Correlation Coefficient	1	.515**
		Sig. (2-tailed)	.	.000
		N	521	514
	Would you adopt RE if majority of neighbours are doing so	Correlation Coefficient	.515**	1
		Sig. (2-tailed)	.000	.
		N	514	521

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

One key informant from a research institution also echoed these findings, *"When it comes to our community's motivation, there are several factors at play. Money, family, and responsibilities are certainly important drivers. However, what really motivates people is the desire to create an impact, to be effective in their own lives and the lives of others. Additionally, there is a powerful sense of pride in the status quo of Nairobi in society and how the world and Africa perceive Nairobi. All of these factors contribute to our community's motivation."* They added, *"As for how this motivation can help boost renewable energy (RE) uptake, it is important to note that people are becoming increasingly aware of the need to shift towards sustainable energy sources. By highlighting RE's impact on the environment and the community, we can tap into this motivation and encourage more people to adopt RE. Additionally, by highlighting the financial benefits of RE, we can appeal to the money-driven motivations of some members of the community. Overall, our community's motivation can definitely play a role in boosting RE uptake." Reported by a research institution representative.*

4.1.5. Support and Acceptance of Innovative Technologies and Services

More than half of the people in the study (50.8%) were unhappy with their current energy system because it is too expensive. However, they said they would be happy to have a RE production plant in their neighborhood (80.1%) or on their property (63%). They are also willing to pay extra to get RE and help others in their community to do the same. In fact, they want to be involved in the RE project and learn more about it. Almost everyone in the study (95.2%) is interested in participating in RE. When asked whether people feel that the laws in the country support RE and their influence on uptake of RE solutions, a key informant had the following to share.

"People in our community do not feel that laws, regulations, and policies support renewable energy. This is due to a weakness in awareness creation, as many people are not aware of the benefits of renewable energy. Additionally, renewable energy is still being overseen at the top tier of the government and the information has not cascaded down to the community. Community engagement in the making of policies has not been done to some communities, particularly those that are hard to reach and where print media does not reach them. This creates challenges in getting the necessary information to these communities and involving them in the policymaking process and can also slow the uptake of renewables." Commented a Parastatal representative.

Are the people who are unhappy with the current energy system more inclined to support RE production plants in their community?

Correlation analysis was conducted to investigate people's level of happiness with the current energy system and their possible future support for a project in their community for more RE production. The results, shown in Table 12, suggest a positive relationship between the two variables. Indicating that unhappiness with the current energy system is associated with possible support RE production projects in their community.

Table 12: Relationship between people's level of happiness with the current energy system and their support for a project in their community for more RE production – Kenya

Correlations

			Are you happy with the current energy system	Would you support project in your community for mor RE
Kendall's tau_b	Are you happy with the current energy system	Correlation Coefficient	1	.251**
		Sig. (1-tailed)	.	0
		N	533	532
	Would you support a project in your community for more RE	Correlation Coefficient	.251**	1
		Sig. (1-tailed)	0	.
		N	532	535

** Correlation is significant at the 0.01 level (1-tailed).

Is income level negatively related to willingness to pay extra costs for RE, to obtain RE?

A correlation analysis test was used to assess whether income level is negatively related to willingness to pay extra costs for RE, to obtain RE. As illustrated in Table 13 below, the results showed that there was no significant correlation between income and willingness to pay extra for RE.

Table 13: Relationship between total monthly HH income and willingness to pay extra costs for RE – Kenya

Correlations

			Q7. Total monthly HH income (USD)	Would you pay extra cost to obtain RE
Spearman's rho	Q7. Total monthly HH income (USD)	Correlation Coefficient	1	-0.016
		Sig. (2-tailed)	.	0.725
		N	480	479
	Would you pay extra cost to obtain RE 1	Correlation Coefficient	-0.016	1
		Sig. (2-tailed)	0.725	.
		N	479	535

Is the willingness to pay extra costs for RE higher among people who are more concerned about the environment and climate change?

Spearman's rank correlation analysis examined how concern about climate change relates to willingness to pay extra for RE. The results in Table 14 indicated that there is a positive relationship between concern about climate change and willingness to pay extra for RE. This means that people who are more concerned about climate change are also more willing to pay extra to obtain RE.

Table 14: Relationship between willingness to pay extra costs for RE and concern about climate change – Kenya

Correlations

			Would you pay extra cost to obtain RE	Do you think climat change will affect y in the future
Spearman's rho	Would you pay extra cost to obtain RE	Correlation Coefficient	1	.132**
		Sig. (1-tailed)	.	0.003
		N	535	437
	Do you think climate change will affect you in the future	Correlation Coefficient	.132**	1
		Sig. (1-tailed)	0.003	.
		N	437	438

** Correlation is significant at the 0.01 level (1-tailed).

Does gender and availability of electricity in the HH have an influence on the likelihood of the participants playing an active role to support RE projects in their community?

A cumulative odds ordinal logistic regression with proportional odds was run to determine the effect of gender and availability of electricity in the HH on the likelihood of the participants playing an active role to support RE projects in their community. The odds of females playing an active role to support RE projects in their community was 0.116, 95% CI [0.073, 0.183] times that of males, a not statistically significant effect, $\chi^2(1) = 0.116$, $p = 0.000$. The odds of participants with no electricity in the HH playing an active role to support RE projects in their community was 0.705, 95% CI [0.077, 6.414] times that of participants with electricity in the HHs, a not statistically significant effect, Wald $\chi^2(1)$ =0 .096, p = 0.756. This implies that the odds of females playing an active role to support RE projects in their community were lower than that of males, but the effect was not statistically significant. Similarly, the odds of participants with no electricity in the HH playing an active role to support RE projects in their community were not statistically significant. Therefore, the study suggests that other factors may be more influential in determining the likelihood of community members supporting RE projects than gender.

4.1.6. Perceived Risks and Benefits

Sixty-two percent of the respondents foresee no risks or concerns about having an RE production plant in their neighbourhood for collective consumption with the local community. The major possible risk mentioned is transparency and fairness issues. Economic benefits were highlighted as an advantage of having RE.

The representative from the renewable energy company shared on some of the concerns of switching to RET as,

"One of the main concerns regarding switching to electric motorcycles in Nairobi is the lack of capacity for charging and swapping. Additionally, there is a lack of advertising and poor exposure to the public about e-mobility. Insurance companies do not cover e-vehicles, and there is a risk of fraudsters taking advantage of the public due to a lack of information, such as the misconception that e-vehicles have low horsepower because they do not have an engine. Another concern is the gap between what can be done now and the future, such as e-waste management. Furthermore, the high initial cost of e-vehicles makes people shy away from buying or selling them since not many financial institutions offer support. On the positive side, we have received feedback that e-vehicles are less

noisy, but we need to address these concerns and make sure the community is informed about the benefits and risks of switching to electric motorcycles."*

Are people with low income more likely to perceive risks associated with having a RE plant in their community?

Goodman and Kruskal's λ test were used to answer the question. The test as illustrated in Figure 1 below, indicates income levels can influence people's perception of risks related to RE production plants being built in their community for collective use. However, people in the low-income earning bracket were less likely to perceive risks or not. This was higher in the middle-income range.

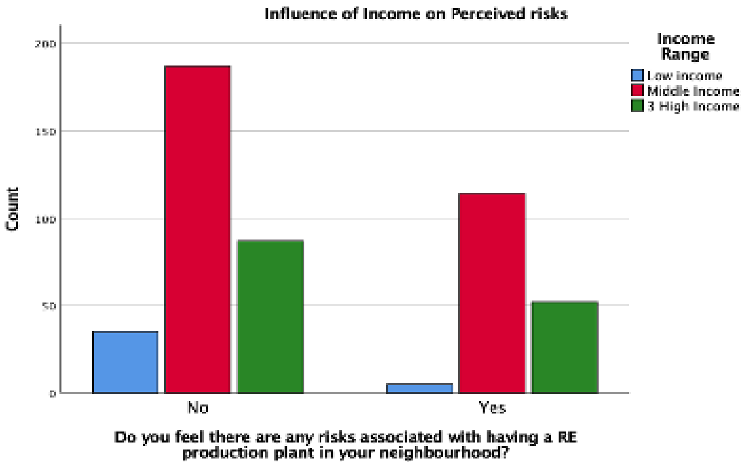

Figure 1: Relationship between perceived risks associated with having a RE production plant in the neighbourhood and the income levels - Kenya

Are the people with a lower level of trust in local authority more likely to perceive risks associated with having a RE production plant in their community?

The results of the Cochran-Armitage test of trend as shown in Table 15 below, indicates that as the level of trust in local authorities decreases, the perception of risks associated with having a RE production plant in the neighbourhood increases. This means that people who trust their local authorities less may be more concerned about the potential risks of having an RE production plant in their community.

Table 15: Linear trend between a lower level of trust in local authorities and the perception of risks associated with having a RE production plant in the neighbourhood – Kenya

Variables not in the Equation

			Score	df	Sig.
Step 0	Variables	Trust in local authorities	16.479	4	0.002
	Overall Statistics		16.479	4	0.002

Will people who think climate change will affect them in the future not feel any risks associated with having a RE production plant in their neighbourhood?

The study used a Cochran-Armitage test of the trend to examine whether there is a relationship between the likelihood of climate change affecting the future and the perception of risks associated with having a RE production plant in the neighbourhood. The results show that as the likelihood of climate change affecting the future increases, the proportion of respondents perceiving no risks associated with having a RE production plant in their neighbourhood also increases. This means that people who are more concerned about the impact of climate change are less likely to perceive risks associated with having a RE production plant in their neighbourhood. The statistical analysis showed that this relationship is significant as indicated in Table 16 below.

Table 16: Linear trend between a higher likelihood of climate change affecting the future and the perception of no risks associated with having a RE production plant in the neighbourhood – Kenya

Variables not in the Equation

			Score	df	Sig.
Step 0	Variables	Will climate change affect you in the future	19.004	5	0.002
	Overall Statistics		19.004	5	0.002

4.1.7. Economic Aspects

RE is viewed by Kenyans as a possibility to reduce energy costs in the future by 84.1% of the respondents with the ability to create employment and reduce the social and economic gap between low-income earners v/s wealthy, and men v/s women.

When asked about the economic impact of RET to diverse community groups, one representative from a research institution stated,
"Renewable energy technologies could have different economic impacts on various groups in the community. Women could benefit from clean cooking technologies, and three-wheeler powered vehicles could promote opportunities in the service industry through swift and affordable delivery of goods."
"Renewable energy technologies should also be considered in terms of their impact on the health of people with disabilities or those who are physically challenged. Furthermore, it is important to ensure that these technologies empower people across different socioeconomic backgrounds and do not benefit only the rich. The impact on different ethnicities and the literacy level of different groups should also be considered to ensure that renewable energy technologies benefit everyone."

Do individuals with higher levels of education tend to have more positive perceptions about the potential employment opportunities created by a RE production plant in their community?

The Chi-square test was used to investigate whether individuals with higher levels of education tend to have more positive perceptions about the potential employment opportunities created by a RE production plant in their community. The results shown in *Table 17* below, indicate a significant relationship between education level and perception of employment opportunities, meaning that people with different levels of education may have different perceptions of the potential for employment opportunities created by a RE production plant. Those with higher education levels have a more positive perception of potential employment opportunities from RE production plant in the community.

Table 17: Relationship between education level and perception of potential employment opportunities created by a RE production plant in the community – Kenya

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	86.131a	28	.000
Likelihood Ratio	79.861	28	.000
N of Valid Cases	537		

a 27 cells (67.5%) have expected count less than 5. The minimum expected count is .00.

Does occupation affect respondents' beliefs about which groups of the community will benefit the most from RETs?

Two directional measures of association were conducted using Goodman and Kruskal's λ test to examine whether occupation affects respondents' beliefs about which groups of the community will benefit the most from RETs. The results as illustrated in Figure 2, reveal that employed people, students, and self-employed people are more likely to believe that specific groups of the community will benefit from RETs (p value <0.05).

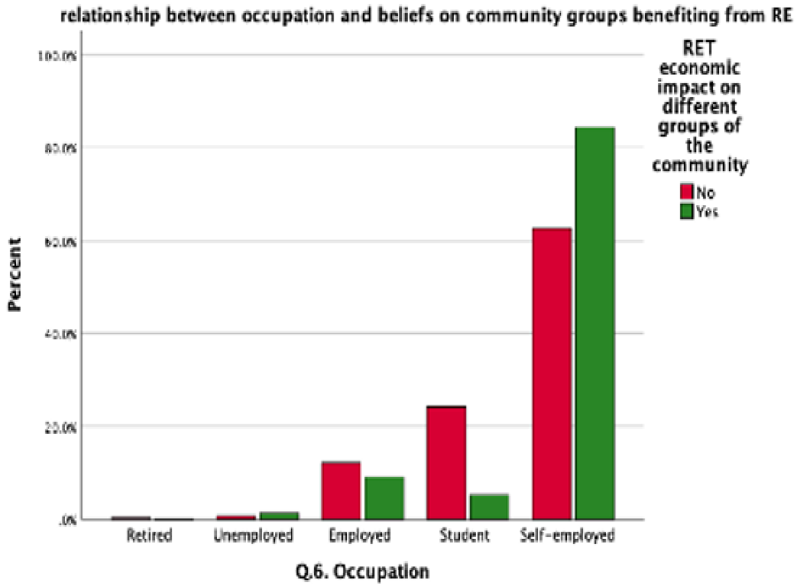

Figure 2: Relationship between occupation and beliefs about diverse groups of the community will benefit the most from RET - Kenya

Do people with no electricity at home think that using RE technologies can reduce energy costs in the future?

A chi-square test was conducted to examine whether the lack of electricity in a HH influenced the belief that RETs can reduce energy costs in the future. The results (p value >0.05) as illustrated in **Error! Reference source not found.** below, indicated that the availability of electricity in a HH had a higher influence on the belief that RET can help reduce energy costs in the future than the unavailability of electricity in the HH.

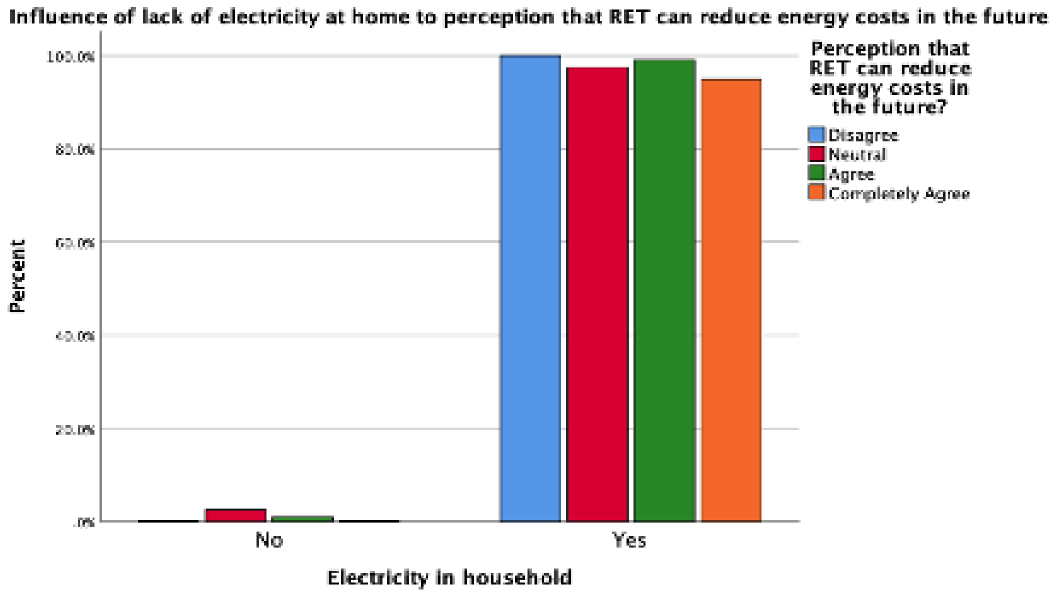

Figure 3: Association between lack of electricity in the HH and its influence on the belief that RET can reduce energy costs in the future - Kenya

4.1.8. Transport - Kenya-Specific Section

The average distance covered per day by boda-boda riders was 124.08KM and a maximum of 550 km. On average, $5.49 was spent on boda-boda fuel every day with an average daily net income of $12.19. Half of the sample (49.3%) know about the existence of electric motorcycles, with 45.3% having used them before.

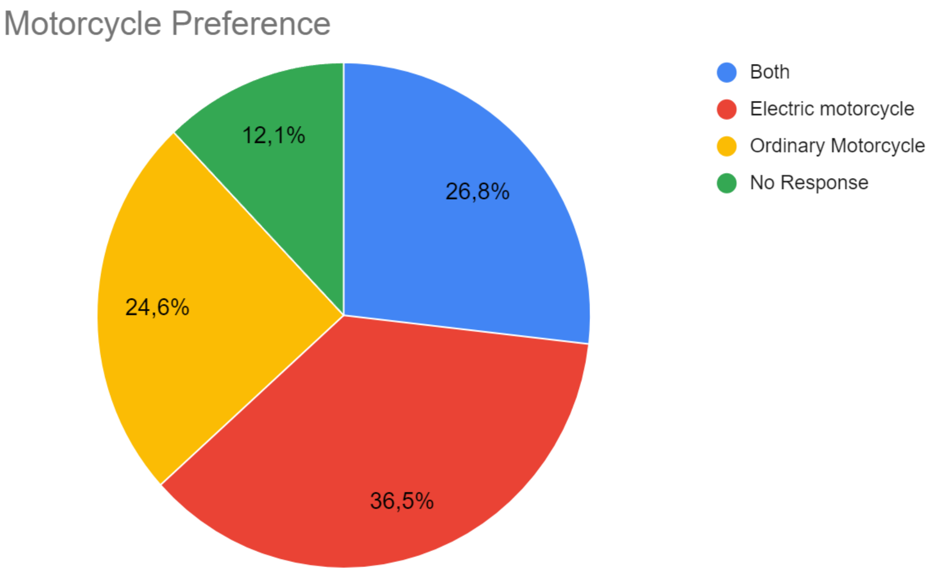

Figure 4: Motorcycle preference

When comparing boda-boda and e-bikes, respondents mentioned that there are fuel stations everywhere and along the roads compared to charging stations, and e-bikes have less horsepower

than 150cc boda-bodas. Nevertheless, if the daily income would increase, it is an option for the boda-boda riders to switch to e-bikes. The main concerns about switching to e-bikes were charging duration, purchase cost, resale value and speed. Figure 4 illustrates motorcycle preference.
It was striking that 100% of the respondents did not share their thoughts on how the concerns could be addressed and their reasons for the choice of motorbikes to be ridden on.

A representative from a parastatal commented on the e/mobility sector in the country as,

"In Nairobi, the transportation situation concerning renewable energy is currently at the breakthrough stage in e-mobility. Over the past 5 years, there has been a focus on planning and product development, taking into consideration the unique context of Nairobi compared to other regions like Asia. Fortunately, we now have viable products that can operate in this context, such as 2 and 3-wheeler vehicles and mass transit systems like matatus. In fact, KPLC is currently working on replacing its 2 wheelers with electric ones. This is a positive step towards achieving sustainable transportation in Nairobi through the use of renewable energy."

Are the respondents who have used or ridden electric motorcycles before more likely to choose them over traditional motorcycles?

A chi-square test of independence was conducted to examine whether people who have used or ridden electric motorcycles before are more likely to prefer them over traditional motorcycles. The results shown Table 18, and Table 19 indicate that among those who had experience with electric motorcycles, almost all of them preferred electric or both electric and traditional motorcycles, whereas, among those without experience with electric motorcycles, very few of them preferred electric motorcycles. The statistical analysis showed a strong association between the two variables, indicating that those who have experience with electric motorcycles are more likely to prefer them over traditional motorcycles.

Table 18: Relationship between respondents who have used or ridden electric motorcycles before are more likely to choose them over traditional motorcycles

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	454.355a	6	.000
Likelihood Ratio	308.189	6	.000
N of Valid Cases	537		

a 1 cells (8.3%) have expected count less than 5. The minimum expected count is 4.12.

Table 19: Association between respondents who have used or ridden electric motorcycles before are more likely to choose them over traditional motorcycles

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	0.92	.000
	Cramer's V	0.65	.000
N of Valid Cases		537	

Is experience using electric motorcycles positively correlated with the age of the respondent?

A Chi-square test of independence test to examine whether experience using electric motorcycles positively correlated with the age of the respondent was conducted. The test found that there was a significant association between age and electric motorcycle usage, with participants aged 31-40 being more likely to have used electric motorcycles before than those aged 20-30. On the other hand, participants in the age range of 20-30 were less likely to have used electric motorcycles than expected. Participants in the age range of 41-50 showed no significant difference in electric motorcycle usage. The results as shown in Table 20, and Table 21 also found that although the effect size for this relationship was small, age may be a factor in determining whether individuals have used electric motorcycles before. Overall, the results suggest that the age range of 31-40 is the group most likely to have used electric motorcycles before.

Table 20: Relationship between age and experience using an electric motorcycle

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	18.742a	6	0.005
Likelihood Ratio	19.167	6	0.004
N of Valid Cases	537		

a 4 cells (33.3%) have expected count less than 5. The minimum expected count is .03.

Table 21: Association between age and experience using an electric motorcycle

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	0.187	0.005
	Cramer's V	0.132	0.005
N of Valid Cases		537	

Is the average distance covered per day positively correlated with the amount of money made per day from the boda-boda business?

A Chi-Square test to examine how the average distance covered per day by boda-boda riders relates to their daily net income was conducted. The analysis found that there is a strong and statistically significant association between the two variables, based on the Pearson Chi-Square test, Phi coefficient, Linear-by-Linear Association test, and Cramer's V coefficient as shown in Table 22 and Table 23 below. Specifically, the results suggest that as the average distance covered per day by boda-boda riders increases, their daily net income also tends to increase.

Table 22: Relationship between the average distance covered per day and daily net income

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2185.795a	1215	.000
Likelihood Ratio	700.048	1215	1.000
Linear-by-Linear Association	43.199	1	.000
N of Valid Cases	432		

a 1275 cells (99.0%) have expected count less than 5. The minimum expected count is .00.

Table 23: Association between the average distance covered per day and daily net income

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	2.249	.000
	Cramer's V	0.433	000
N of Valid Cases		432	

4.1.9 Gender and Energy

The study found that while most HHs did not have distinct roles for men and women, HH chores were mostly reserved for women. Women also had limited participation in RE-related projects due to inadequate information and availability of the RE projects. The solutions suggested to promote women's participation in RE projects included awareness creation, deliberate inclusion of more women in projects, RE campaigns, equitable distribution of resources by the government, and financial support from organizations. Engaging in RE business activities was seen as a factor to potentially promote women's decision-making power, access to education and financial resources, and safety. However, there was uncertainty about women's willingness to learn and participate in RE projects.

In relation to gender and energy, a parastatal representative had the below information stating,

"We have made deliberate efforts to mainstream the labour force in the engineering sector by encouraging women to get on board. As a result, we have seen great positive progress, with more women joining the technical departments. In terms of addressing the challenges of renewable energy and women's participation, we are proud to report that the entire national grid is up to 92% green energy, and this will increase to 95% with the current plant from Ethiopia. This will provide great avenues for energy prosumption, especially to women. Going forward, we will continue to put more deliberate efforts in place to support this initiative."

Do HHs with no gender-specific roles have higher education levels (i.e., Secondary level and above)?

A chi-square test of independence to investigate whether HHs with no gender-specific roles have higher education levels was conducted. The association is significant, as confirmed by both the Phi (ϕ = .389) and Cramer's V (V = .275) coefficients as shown in Table 24 below. The results indicate a moderate association between the variables, which means that there is a relationship between the absence of gender-specific roles in HHs and higher education levels.

Table 24: Association between HHs with no gender-specific roles have higher education levels – Kenya

Symmetric Measures

		Value	Approx. Significance
Nominal by Nominal	Phi	0.389	.000
	Cramer's V	0.275	.000
N of Valid Cases		537	

Are men more likely than women to be responsible for making choices around energy use in the HH?

A chi-square test of independence was conducted to examine whether men are more likely than women to be responsible for making choices around energy use in the HH. The study found that men are more likely than women to be responsible for making choices about energy use in the HH. Indicating a significant association between gender and responsibility for making energy use choices, with a moderate positive relationship between the two as shown in Table 25 below. Men were found to be more responsible than women or both partners combined for making energy choices in the HH.

Table 25: Association between gender and responsibility for making choices around energy use in the HH – Kenya

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	0.592	.000
	Cramer's V	0.592	.000
N of Valid Cases		537	

A representative from a government ministry had a similar opinion as those expressed by the public, stating,

"The gender representation in the renewable energy sector in our community is quite balanced. From my experience interacting with the communities, I would say it is 50/50. However, there are factors that cause some gender disparities. Traditionally, the husband is considered the owner of the home and everything in it, including any renewable energy installations. For instance, when a biogas plant is installed in a home, the wife may say it belongs to the husband, but she is usually the one who feeds the plant. Also, when it comes to procurement in a couple's home, the husband usually provides the finances. But in the case of cookstoves, it's often the initiative of the women who either ask for money from the husband or use their own or loans to acquire them."

4.2. Madagascar

4.2.1. Background Information

The background information in this study sought to understand the basic information about the respondents in Diana, and how these factors could influence their opinions, attitudes, or behaviours. A survey was conducted with 658 respondents, of which 55.5% were male, 44.4% were female, and 0.1% represented other genders. The average age of respondents was 41 years, and a mean monthly HH income of $58.81[10]

[10] 1 usd =4228 Malagasy Ariary (xe.com - currency convertor Oct 8, 22)

Table 26: Socio-demographic characteristics - Madagascar

Nationality: Madagascar (N = 658)			
Variables	**Frequency**	**(%)**	**Mean**
Gender			
Female	292	44.4	
Male	365	55.5	
Other gender	1	0.2	
Age			42
Marital status			
Single	83	12.6	
Married (Living together)	501	76.1	
Separated	62	9.4	
Divorced	1	0.2	
Widowed	11	1.7	
Education			
I prefer not to answer	6	0.9	
No formal education	85	12.9	
Primary (1-5 years of school)	184	28.0	
Intermediate (6-8 years of school)	230	35.0	
Secondary (9-12 years of school)	133	20.2	
Vocational training	6	0.9	
Tertiary (University)	14	2.1	
Locality			
Rural (thinly populated area)	599	91.0	
Intermediate density area	58	8.8	
Urban (densely populated area)	1	0.2	
Occupation			
Student	1	0.2	
Unemployed	32	4.9	
Employed	77	11.7	
Self-employed	525	79.8	
Houseman/-wife	11	1.7	
Retired	12	1.8	
Monthly HH income			$58.81
Monthly HH expenditure on Energy			$9.15

4.2.2. Energy Access

It should be noted that the study respondents in the Diana region mostly had electricity access via nano grids and generators and may not represent energy access for all of Madagascar. Around 31.6% of respondents had no HH energy access, while 68.4% had access to nano grids and petrol/diesel generators. The main energy service provider was Solar Home Systems according to 48.2% of respondents. Firewood and charcoal were commonly used for cooking, Solar Home Systems for lighting, and animal and hydro energy for agriculture. Solar power was the primary source of energy for communication. Almost 40.2% of the respondents were dissatisfied with their current energy sources. Fathers, sons, and children were responsible for firewood collection spending less than 10 hours per day and 5 days per month on the activity. On average, people spend about 16% of their monthly HH income on energy.

When asked about the challenging things in the community, a government department representative stated,

"There are several challenging things in our community related to energy access. Firstly, it is challenging to do business in the renewable energy sector, as some companies have reported losses for up to 5 years. Additionally, establishing renewable energy companies requires public financing. Secondly, the rising prices of diesel fuel have affected the distribution of energy to rural areas, resulting in financial losses."

Is satisfaction with energy sources influenced by the energy provider and energy reliability in Madagascar?

A cumulative odds ordinal logistic regression with proportional odds was run to determine whether satisfaction with energy sources was influenced by the energy provider and energy reliability. The assumption of proportional odds was met, $\chi^2(45) = 98.178$, $p = .000$. Table 27 illustrates, $\chi^2(61) = 41.379$, $p = .974$, demonstrating that energy reliability was the most important factor influencing satisfaction with energy, not the type of energy source. Hence, energy reliability is the communities' priority to increase satisfaction with energy sources

Table 27: Influence of energy provider on Satisfaction with energy sources – Madagascar

Goodness-of-Fit			
	Chi-Square	df	Sig.
Pearson	51.248	61	0.809
Deviance	41.379	61	0.974

Link function: Logit.

4.2.3. Awareness of Energy and the Environment

People in Diana are aware of climate change (82.7%) and acknowledge its likelihood to affect them in the future 74.9%. The impact of climate change is expected to be significant on food and water shortages as well as increased fuel costs. Almost half of the respondents (47.4%) have heard of RE sources, with solar energy being the most common. Additionally, 42.2% of the respondents believe that their country needs more RE sources.

A representative from an NGO had similar opinions on the impact of climate change as shared by the public. They shared,

"In South Madagascar, we are experiencing severe effects of drought, while in the Highlands and central region, heavy rains and floods are causing a lot of damage. The West Coast is also experiencing erosion on the seashore due to rising water levels. Unfortunately, these effects of climate change are leading to a heavier burden on the daily lives of women and girls in our community. Additionally, we have a heavy culture of deforestation, which is leading to low levels of education and poverty, as there are fewer resources to use. We had 120 active fires in the country just two weeks ago, and non-sustainable agriculture activities are also contributing to these issues. To address these problems, we need to educate people on the consequences of their community actions and offer alternative sustainable ways of surviving and adapting to the local community's

culture. Additionally, we need solutions engineering in partnership with the community to help us develop lasting solutions."

Is there a relationship between knowledge of climate change and the knowledge of RE?

A bivariate Pearson correlation coefficient analysis was conducted to examine the relationship between knowledge of climate change and knowledge of RE. The results as shown in Table 28 below indicated a significant positive correlation ($r=.333$, $p<.001$, $N=656$) between the two variables, suggesting that individuals who are more knowledgeable about climate change are more likely to have heard of RE.

Table 28: Relationship between knowledge of climate change and the knowledge of RE – Madagascar

Correlations

		Do you know what climate change is	Have you heard of RE
Do you know what climate change is	Pearson Correlation	1	.333**
	Sig. (2-tailed)		.000
	N	656	656
Have you heard of RE	Pearson Correlation	.333**	1
	Sig. (2-tailed)	.000	
	N	656	656

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

Is there a relationship between awareness of RE and support for increasing its use in one's country?

A chi-square test of independence was conducted to investigate the relationship between awareness of RE and support for increasing its use in the country. The results as in Table 29 and Table 30 showed a strong association between these two variables, and the likelihood ratio test was also significant. These findings suggest that awareness of RE strongly influences the attitude to and support for increasing its use in the country.

Table 29: Relationship between awareness of RE and support for increasing its use – Madagascar

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	654.001a	12	.000
Likelihood Ratio	896.728	12	.000
N of Valid Cases	658		

a 11 cells (55.0%) have expected count less than 5. The minimum expected count is .01.

Table 30: Association between awareness of RE and support for increasing its use – Madagascar

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	0.997	.000
	Cramer's V	0.576	.000
N of Valid Cases		658	

Is there a correlation between knowing what climate change is and the belief that it will affect individuals in the future?

Logistic regression analysis was conducted to assess whether there is a correlation between knowing what climate change is and the belief that it will affect individuals in the future. The analysis as shown in Table 31, Table 32, and Table 33 below, revealed a strong association between knowing what climate change is and the belief that it will affect individuals in the future. This hints that individuals who are aware of climate change are more likely to believe it will affect them in the future.

Table 31: Model fitting information on the correlation between knowing what climate change is and the belief that it will affect individuals in the future – Madagascar

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	598.726			
Final	19.946	578.78	3 0	

Link function: Logit.

Table 32: Goodness of fit - correlation between knowing what climate change is and the belief that it will affect individuals in the future – Madagascar

Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	.000	12	1.000
Deviance	.000	12	1.000

Link function: Logit.

Table 33: Pseudo R-square - correlation between knowing what climate change is and the belief that it will affect individuals in the future – Madagascar

Pseudo R-Square

Cox and Snell	0.585
Nagelkerke	0.685
McFadden	0.458

Link function: Logit.

When asked about the possible solutions to the effects of climate change being experienced, a representative of a research institution responded,

"As we are already experiencing severe effects of climate change, it is essential that we take immediate action to mitigate these effects. The government is promoting reforestation, which is a great initiative. However, more support is required to curb the current deforestation activities. In this regard, I propose the following solutions: Firstly, we need to improve our strategies for cooking. Clean cooking methods, such as the use of biogas, should be promoted. Secondly, we need a mix of energy solutions instead of a complete transition to renewable energy. The latter is too large and may not be feasible in the short term. Thirdly, waste management is a critical issue. With a large population, there is a significant amount of waste generated. Therefore, it is essential to have a policy on waste management. Fourthly, people who live in poverty are more concerned about their immediate needs rather than the effects of their actions on the environment. Therefore, capacity building and awareness creation on the productive use of resources is vital. Lastly, success stories of

renewable energy projects should be highlighted to motivate the people. It is also crucial to disseminate information to the public on the best practices and the need to shift to renewable energy. If we can implement these solutions effectively, we can mitigate the effects of climate change and create a more sustainable future for all."

4.2.4. Community Life

Most of the participants (89.7%) report feeling recognized and proud (91.5%) to be part of their community. They also indicate high levels of trust in their local authorities (90.1%) and neighbourhood (92.4%) and are comfortable asking their neighbours for help (96.6%). In addition, more than half of the respondents (56.1%) reported being members of a social group. Interesting findings from one Key informant worth noting were also recorded.

A representative from a CBO and an NGO had the following sentiments on the challenges the community faces.

"There are several challenges in our community that we face, including fragile contexts such as the ongoing humanitarian crisis in the south, seasonal farming challenges, migration by communities critical to the implementation of sustainable projects, challenging opportunities to make a living, and challenges in accessing social amenities such as schools and hospitals. To address these challenges, we engage with each other in various ways. For instance, fishermen have formal and informal cooperatives to attract funding from donors. We also link with external parties and use cooperative leaders to mobilize. Mayors and governors of the region can conduct engagements, and we work with the central level, including the Ministry of Energy and Hydrocarbons, ADER, Rural Electrification Agency, and ORE (the regulator) for energy projects. Our motivation comes from our traditional society, in this regard, electricity is not well-regarded for cultural reasons, and we do not deploy mini grids where there are tombs. Moreover, technology may not be well-regarded, especially in Muslim communities in the North."

Is trust in local authorities positively correlated to participation in community organisations?

A Cochran-Armitage test of trend was run to determine whether a linear trend exists between trust in local authorities and participation in community organizations. As demonstrated in Table 34 below, there is a statistically significant linear trend between trust in local authorities and participation in community organizations. This suggests that as trust in local authorities increases, so does participation in community organizations

Table 34: Linear trend between trust in local authorities and participation in community organizations - Madagascar

Variables not in the Equation

			Score	df	Sig.
Step 0	Variables	Do you trust local authorities in your neighbourhood	4.828	1	0.028
	Overall Statistics		4.828	1	0.028

Can a sense of community belonging positively impact the likelihood of asking for help from neighbours?

A Spearman's rank-order correlation was run to assess the relationship between feeling a sense of community belonging and the likelihood of asking for help from neighbours. The analysis showed a statistically significant positive correlation between feeling recognized as part of one's neighbourhood and being willing to ask neighbours for help as illustrated in Table 35 below. To conclude, those who feel recognized as part of their neighbourhood are more likely to be willing to ask their neighbours for help.

Table 35: Relationship between feeling a sense of community belonging and the likelihood of asking for help from neighbours – Madagascar

Correlations

			Do you feel recognised part of your neighbourhood	Would you ask your neighbours for help
Spearman's rho	Do you feel recognised as part in your neighbourhood	Correlation Coefficient	1	.259**
		Sig. (2-tailed)	.	.000
		N	653	647
	Would you ask your neighbours for help	Correlation Coefficient	.259**	1
		Sig. (2-tailed)	.000	.
		N	647	649

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

Can positive feelings about one's neighborhood lead to greater adoption of RE sources?

A Spearman's rank-order correlation test was used to examine the relationship between positive feelings about one's neighbourhood and the likelihood of adopting RE sources. The results indicated a significant positive correlation between positive feelings about one's neighbourhood and the likelihood of adopting RE sources. As illustrated in Table 36 below, people who have a positive feeling about their neighbourhood are more likely to adopt RE sources

Table 36: Relationship between positive feelings about one's neighbourhood and the likelihood of adopting RE sources – Madagascar

Correlations

			Are you proud to be part of your neighbourhood	Would you adopt RE if majority of neighbours are doing so
Spearman's rho	Are you proud to be part of your neighbourhood	Correlation Coefficient	1	.157**
		Sig. (2-tailed)	.	.000
		N	649	646
	Would you adopt RE if majority of neighbours are doing so	Correlation Coefficient	.157**	1
		Sig. (2-tailed)	.000	.
		N	646	651

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

4.2.5. Support and Acceptance of Innovative Technologies and Services

34.5% of people are not satisfied with their current energy system due to issues like battery size, lifespan, subscription fees, and limited services supported by their energy systems. However, they are willing to support RE by having a RE production plant on their property (73.3%) or neighbourhood (93.4%). 90.4% are willing to pay extra to get RE and support their community members. They are also interested in actively participating in RE projects and paying extra costs for themselves and their less financially stable neighbours to access RE.

Are the people who are unhappy with the current energy system more likely to support RE production plants in their community?

A correlation analysis test was run to assess whether people who are unhappy with the current energy system are more likely to support a project for more RE production in their community. The correlation analysis showed a weak and negative relationship *(*Table 37*)*, which means that the negative feelings about the current energy system do not influence people's willingness to support a community project for more RE, hence, not a barrier to community support for RE projects.

Table 37: Relationship between people's level of happiness with the current energy system and their support for a project in their community for more RE production – Madagascar

Correlations

			Are you happy with the current energy system 1	Would you support a project in your community for more RE
Kendall's tau_b	Are you happy with the current energy system 1	Correlation Coefficient	1	-0.016
		Sig. (1-tailed)	.	0.337
		N	654	653
	Would you support a project in your community for more RE	Correlation Coefficient	-0.016	1
		Sig. (1-tailed)	0.337	.
		N	653	655

Is income level negatively related to willingness to pay extra costs, to obtain RE?

A correlation analysis - Spearman's rho test - was conducted to determine the relationship between total monthly HH income and willingness to pay extra costs for RE. The results *(*Table 38 *below)* showed a weak negative correlation between the two variables. The findings suggest that income level does not play a significant role in predicting the willingness to pay extra costs for RE.

Table 38: Relationship between total monthly HH income and willingness to pay extra costs for RE – Madagascar

Correlations

			Total monthly HH income (USD)	Would you pay extra cost to obtain RE
Spearman's rho	Total monthly HH income (USD)	Correlation Coefficient	1	-0.078
		Sig. (2-tailed)	.	0.072
		N	535	532
	Would you pay extra cost to obtain RE	Correlation Coefficient	-0.078	1
		Sig. (2-tailed)	0.072	.
		N	532	655

Is the willingness to pay extra costs for RE higher among people who are more concerned about the environment and climate change?

Spearman's rho correlation analysis was conducted to examine the relationship between willingness to pay extra costs for RE and concern about climate change. The results as highlighted in Table 39 indicate that there is no relationship between the individuals who are more concerned about climate change and their willingness to pay extra costs to obtain RE. For these results, concerns about climate change do not impact willingness to pay extra costs to obtain RE.

Table 39: Relationship between willingness to pay extra costs for RE and concern about climate change – Madagascar

Correlations

			Would you pay extra cost to obtain RE	Climate change will affect you in future
Spearman's rho	Would you pay extra cost to obtain RE 1	Correlation Coefficient	1.000	0.013
		Sig. (1-tailed)	.	0.385
		N	655	540
	Climate change will affect you in the future	Correlation Coefficient	0.013	1.000
		Sig. (1-tailed)	0.385	.
		N	540	541

Asked whether community challenges could influence the uptake of RE, an energy entrepreneur responded,

"I believe that different groups in the community could benefit economically from renewable energy, such as households and small businesses. However, there are still some challenges to the uptake of renewable energy in the community. Laws, regulations, and policies to support renewable energy are not being implemented effectively, which makes it difficult for consumers to understand the benefits of renewable energy. Building incentives for consumers are not highly considered. Another issue is that banks do not offer loan facilities to finance renewable energy projects at the household level. This is a major challenge because financing is critical for the success of renewable energy projects. If policies and regulations could be put in place to support renewable energy, such as providing incentives for consumers and financing for renewable energy projects, the uptake of renewable energy could increase in the community."

Does gender and availability of electricity in the HH have an influence on the likelihood of the participants playing an active role to support RE projects in their community?

The study examined the effect of gender and availability of electricity on the likelihood of people supporting RE projects in their community using a cumulative odds ordinal logistic regression. The final model statistically significantly predicted the dependent variable over and above the intercept-only model, $\chi^2(3) = 5.518$, $p = .138$. The odds of females playing an active role to support RE projects in their community was 2.296E-9, 95% CI [.000.] times that of males, not statistically significant effect, $\chi^2(1) = .000$, $p = 1.000$. The odds of participants with no electricity in the HH playing an active role to support RE projects in their community was .805, 95% CI [.504, 1.286] times that of participants with electricity in the HHs, not statistically significant effect, Wald $\chi^2(1) = .825$, $p = .364$. The model was a good fit for the observed data (, $\chi^2(13) = 9.601$, $p = .726$.). These results showed that females were slightly more likely to play active roles in RE projects than males. Participants without electricity in their HHs were slightly more likely to support RE projects than those with electricity. Hence gender and access to electricity in the HH had an influence on whether people would play active roles in RE projects.

4.2.6. Perceived Risks and Benefits

According to the survey, 47.9% of respondents have apprehensions about having a RE production facility in their locality for collective consumption with the local community. The primary concern among them is safety issues. On the other hand, the respondents also identified several benefits of having a RE production plant in the neighborhood. These include environmental benefits, more dependable power supply, and social benefits such as increased local employment opportunities and community engagement.

Are people with low incomes more likely to perceive risks associated with having a RE plant in their community?

Goodman and Kruskal's λ was conducted to examine how income levels (low, middle, or high) of respondents relate to their perceived risks of having a RE production plant in their neighbourhood. The results as shown in Figure 5 indicate a weak and positive relationship between income range (low income) and risk perception ($\lambda = 0.001$, $p < .002$), which means that other factors beyond income level may have a more significant impact on risk perception.

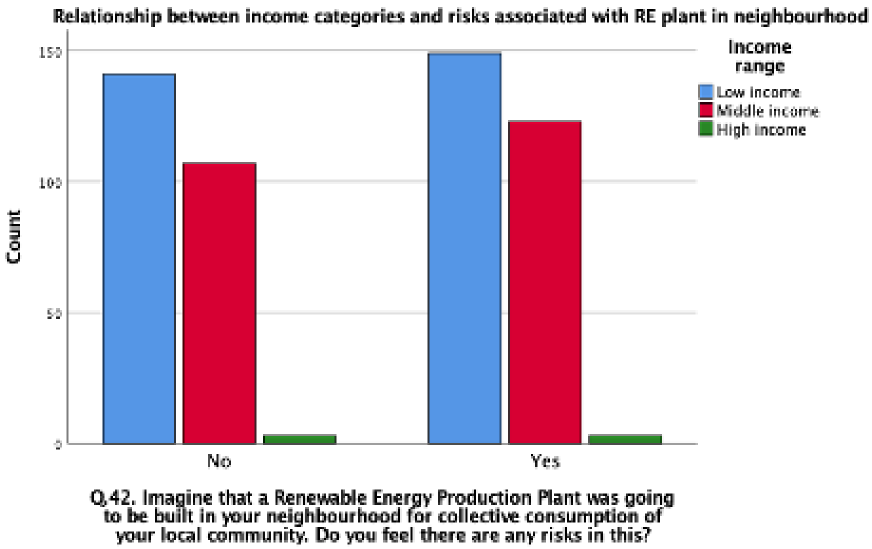

Figure 5: Relationship between perceived risks associated with having a RE production plant in the neighbourhood and the income levels - Madagascar

Are the people with a lower level of trust in local authority more likely to perceive risks associated with RE production plant in their community?

A Cochran-Armitage test of trend was run to determine whether a linear trend exists between a lower level of trust in local authorities and the perception of risks associated with having a RE production plant in the neighbourhood. The results showed that there is no significant relationship between trust in local authorities and perceived risks (Table 40). This indicates that trust in local authorities does not have a significant impact on the perceived risks of having a RE production plant in the community.

Table 40: Linear trend between a lower level of trust in local authorities and the perception of risks associated with having a RE production plant in the neighbourhood – Madagascar

Variables not in the Equation

			Score	df	Sig.
Step 0	Variables	Do you trust the local authorities of your neighbourhood	2.026	4	0.731
	Overall Statistics		2.026	4	0.731

Will people who think climate change will affect them in the future not feel any risks associated with having a RE production plant in their neighbourhood?

A Cochran-Armitage test of trend was run to determine whether a linear trend exists between a higher likelihood of climate change affecting the future and the perception of no risks associated with having a RE production plant in the neighbourhood. The results (Table 41) show that the likelihood of climate change affecting them in the future significantly predicted the perceived risks of having an RE plant in the community. The study found that a higher perception of no risks in having an RE production plant in the neighbourhood was associated with the likelihood of climate change affecting the future.

Table 41: Linear trend between a higher likelihood of climate change affecting the future and the perception of no risks associated with having a RE production plant in the neighbourhood – Madagascar

Variables not in the Equation

			Score	df	Sig.
Step 0	Variables	Do you think climate change will affect you in the future	69.699	5	.000
	Overall Statistics		69.699	5	.000

4.2.7. Economic Aspects

According to the survey, 87.5% of respondents believe that RETs could potentially reduce energy costs in the future. Additionally, 78.3% of respondents think that RET has the potential to create employment opportunities and reduce social and economic inequality between genders. Furthermore, 59.3% of respondents believe that RET could reduce the gap between physically abled people and those with disabilities, while 57.1% of respondents think that RET could reduce the income gap between low-income earners and the wealthy.

A representative from a parastatal was asked to share their thoughts on how RET could impact diverse groups in the community. They shared,

"In rural and peri-urban areas, renewable energy can benefit different groups in the community in various ways. Men in their subsistence activity could use renewable energy to meet the basic needs of their families and increase their income. Women, on the other hand, spend more time on domestic activities and could benefit from improved working conditions that would allow them to participate in subsistence activities, have leisure time for their personal development, and preserve their health. For instance, the use of energy at the service of water could provide access to a standpipe instead of

going to draw water from a river, among other things. However, the benefits of renewable energy may not be immediately apparent to everyone in the community, especially those from different ethnicities, cultures, and beliefs. For some, the existence of a standpipe could limit the time to socialize and share with friends, while others may see it as a time-saver for the long drive-in search of water. Low-income people and wealthy people could both benefit from renewable energy by improving their incomes and opting for new activities, such as the extension of opening hours for shops. Additionally, renewable energy could benefit semi-literate people by providing additional time for studies through evening classes. Finally, people in powerful political office and those not in powerful political office could benefit from renewable energy by lengthening the time available for carrying out their responsibilities."

Do individuals with higher levels of education tend to have more positive perceptions about the potential employment opportunities created by a RE production plant in their community?

A Chi-square test of independence was conducted to examine the relationship between education level and perception of potential employment opportunities created by a RE production plant in the community. As demonstrated in Table 42 below, the results suggest that education level influences respondents' views on the potential employment opportunities created by RE production plants in the community.

Table 42: Relationship between education level and perception of potential employment opportunities created by a RE production plant in the community – Madagascar

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	80.564a	24	.000
Likelihood Ratio	45.952	24	0.004
N of Valid Cases	658		

a 23 cells (65.7%) have expected count less than 5. The minimum expected count is .005.

Does occupation affect respondents' beliefs about which groups of the community will benefit the most from RETs?

Goodman and Kruskal's λ was conducted to examine the association relationship between occupation and beliefs about which groups of the community will benefit the most from RETs. The results as illustrated in Figure 6, show a significant relationship between occupation and beliefs about which groups of the community will benefit the most from RETs ($p < .001$). Specifically, people who were self-employed believed that RETs would have the most economic impact on diverse groups in the community than other occupations.

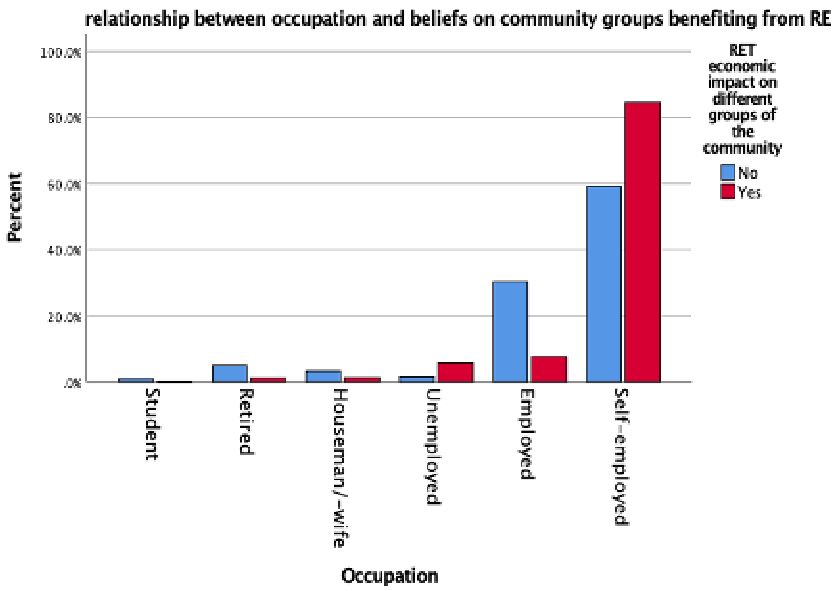

Figure 6: Relationship between occupation and beliefs about diverse groups of the community will benefit the most from RET - Madagascar

Do people with no electricity at home think that using RE technologies can reduce energy costs in the future?

A chi-square test was conducted to explore the association between lack of electricity in the HH and its influence on the belief that RET can reduce energy costs in the future. Pearson chi-square revealed a significant association between access to electricity and the belief in RET to reduce energy costs in the future ($\chi2(4) = 12.013$, $p = .017$) as illustrated in Figure 7. The results showed that most people who had electricity in the HH agreed that RET could reduce energy costs in the future, but only a few people who did not have electricity agreed. This means that having access to electricity in the HH has a slightly higher influence on people's belief in RET reducing energy costs in the future than in those without access to electricity in the HH.

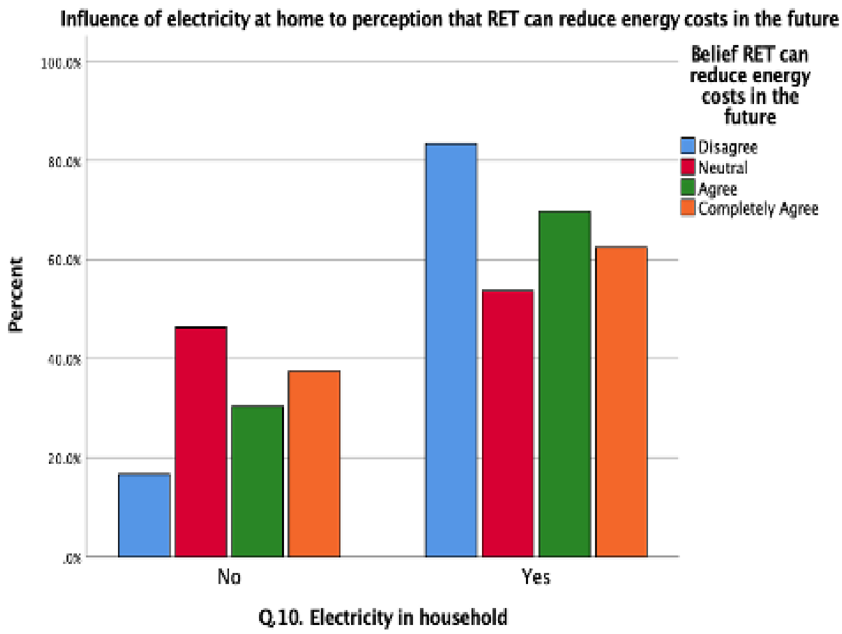

Figure 7: Association between lack of electricity in the HH and its influence on the belief that RET can reduce energy costs in the future - Madagascar

4.2.8. Water Energy and Food Nexus - Madagascar-Specific Section

Most respondents (71.7%) have access to clean water in their neighbourhood, with sources of water as illustrated in Figure 8. Clean water is used for cleaning and cooking. Most respondents did not provide information on their monthly expenditure for water and are not very willing to pay for access to clean water in their neighbourhood or HH. The maximum amount they are willing to pay is $14.19 to access clean water.

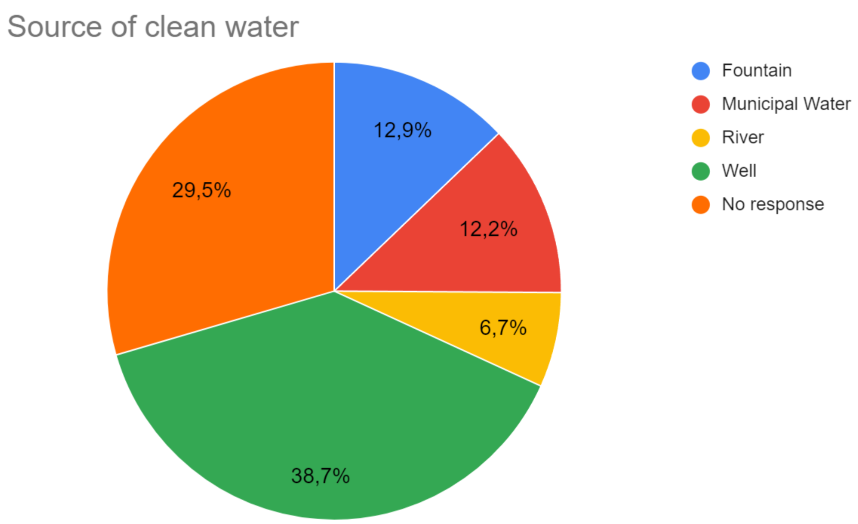

Figure 8: Source of water

Over two-thirds of the respondents surveyed lack access to cooling and freezing services but are willing to pay for access both in their HHs and neighbourhoods. The services will be used for making ice blocks, cooling beverages, and preserving meat and fish, and the maximum amount the respondents are willing to pay is $94.61. More than half of the respondents have access to agricultural machines in their neighbourhood, with local entrepreneurs being the primary source for the services. Most respondents are not willing to pay for access to agricultural machines, and those willing to pay could spend up to $118.26 per month to access the services. The most useful agricultural machine for them is for husking rice.

Is the cost of cooling and freezing services per month positively correlated with the choice of service provider?

A Kruskal-Wallis H test was conducted to determine if there were differences in the monthly cost of using cooling and freezing services between different service providers. The median monthly costs for the different providers were reported, but the differences were not statistically significant, as recorded in Table 43 confirming that cost would not be a factor to consider when people are making decisions on their choice of service providers for cooling and freezing services.

Table 43: Differences in the monthly cost of using cooling and freezing services between different service providers

Ranks

	Where do you get your cooling and freezing services for food and beverage	N	Mean Rank
How much per month do you spend on cooling or freezing (USD)	Personal petrol or gas fridge	3	$37.83
	Personal electric fridge	1	$22.00
	Ice blocks	44	$24.88
	Local shops with refrigerator or freezer	3	$34.33
	Other (Manually specify)	2	$49.00
	Total	53	

Is the cost of using stationary agricultural machines per month positively correlated with the distance to the machine provider?

A Kruskal-Wallis H test was conducted to determine if there were differences in the monthly cost of using stationary agricultural machines between different locations. The median monthly costs for using the machines were reported for four separate locations, as recorded in Table 44 and the differences were statistically significant, confirming that cost is a factor considered when people are making decisions on their choice of service providers and locations for access to stationary agricultural machines.

Table 44: Differences in the monthly cost of using stationary agricultural machines between different agricultural machines locations

Ranks

	How far is your access to stationary agricultural machines	N	Mean Rank
How much per month do you spend on the use of agricultural machines (USD)	At home	48	$110.81
	In the neighbourhood (Less than 100 Meters)	205	$174.28
	In the village (Less than 1 KM)	39	$169.65
	Further away (More than 1 KM)	27	$125.11
	Total	319	

Is the cost of clean water per month positively correlated with the distance to the water source?

A Kruskal-Wallis H test was conducted to determine if there were differences in the monthly cost of access to clean water. The median monthly costs for using access to clean water were reported for four separate locations, and the differences were statistically significant ($p<0.05$) as recorded in Table 45 confirming that cost is one of the factors considered when people are making decisions on their choice of areas to access clean water.

Table 45: Differences in the monthly cost of access to clean water at the different water source's locations

Ranks

	Where do you get your clean water from	N	Mean Rank
What is your household cost for water per month (USD)	At home	5	$31.00
	In the neighbourhood (Less than 100 Meters)	39	$32.62
	In the village (Less than 1 KM)	19	$31.00
	Further away (More than 1 KM)	1	$64.00
	Total	64	

Are individuals who are willing to pay for access to clean water, cooling and freezing services, and stationary agricultural machines in their neighbourhood more likely to have higher income levels?

The study investigated whether individuals with higher income levels are more willing to pay for access to clean water, cooling and freezing services, and stationary agricultural machines. A Kruskal-Wallis H test was conducted, and the results as recorded in Table 46 below were not statistically significant. Therefore, the willingness to pay for access to clean water, cooling and freezing services and the stationary agricultural machine is not influenced by the level of income.

Table 46: Correlation between individuals who are willing to pay for access to clean water, cooling and freezing services and stationary agricultural machines in their neighbourhood are more likely to have higher income levels

Ranks

	Income range	N	Mean Rank
Would you pay to have access to clean water in your neighbourhood	Low Income	66	$49.02
	Middle Income	28	$45.32
	High Income	1	$55.50
	Total	95	
Would you pay to have access to cooling or freezing in your neighbourhood	Low Income	185	$175.91
	Middle Income	144	$156.35
	High Income	4	$138.50
	Total	333	
Would you pay to have access to a stationary agricultural machine in the neighbourhood	Low Income	34	$49.15
	Middle Income	55	$45.64
	High Income	3	$32.33
	Total	92	

When asked what the overall benefits of a RE solutions would be to the communities in Diana, and the best RE source, a representative from an NGO suggested,

"For the farming communities of the Diana region, we recommend the use of solar panels for cooking food, as currently coal and wood are commonly used. Additionally, solar energy can be utilized in the production of rice to remove the husks. We also recommend the use of batteries for fridges to cool milk and make yoghurt, which would be a great alternative to the current methods that are being used. By adopting these renewable energy sources, not only will we reduce our carbon footprint, but we will also be able to provide sustainable solutions for the farming communities of the Diana region."

4.2.9. Gender and Energy

The study found that in HHs, women had traditional roles of taking care of children and HH chores, with very few engaging in income-generating activities. Both men and women were responsible for making energy choices, but men were more likely to have the role. Women were reported to participate in RE projects, but lack of education was a barrier. Training was suggested as a solution, and engaging in RE business activities was seen to promote women's self-worth and decision-making power while improving living standards and reducing violence. The respondents believed that women in their HHs were willing to learn and participate in RE projects, and most were open to learning more about them.

Do HHs with no gender-specific roles have higher education levels (Secondary level and above)?

A chi-square test of independence was conducted to examine whether HHs with no gender-specific roles have higher education levels. Participants who preferred not to answer had primary education, while those who answered "No" had achieved secondary and intermediate education. Those who answered "Yes" had achieved primarily tertiary and secondary education. The study found a statistically significant relationship (as demonstrated in Table 47 below) between the two variables, indicating that HHs with no gender-specific roles have higher education levels.

Table 47: Association between HHs with no gender-specific roles have higher education levels – Madagascar

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	0.226	0.001
	Cramer's V	0.16	0.001
N of Valid Cases		658	

Are men more likely than women to be responsible for making choices around energy use in the HH?

A chi-square test of independence was conducted to examine whether men are more likely than women to be responsible for making choices around energy use in HH in Madagascar. The test revealed a statistically significant relationship between gender and the person responsible for energy use choices as shown in Table 48 below. The results showed that 51.4% of females reported being responsible for energy use choices compared to 42.7% of males. The study found that women and both genders are more likely than men to be responsible for making choices around energy use in the HH

Table 48: Association between gender and responsibility for making choices around energy use in the HH – Madagascar

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	0.287	.000
	Cramer's V	0.203	.000
N of Valid Cases		658	

Some final remarks on gender from a representative from an NGO

"Promoting gender equality in Madagascar is proving to be a significant challenge for us. The country's social hierarchy and high levels of illiteracy among women are significant barriers that we are trying to overcome. Additionally, we have encountered resistance due to the lack of support from other women. However, we remain committed to this cause, and we are taking steps to address these issues. We are working to educate both men and women in the community on the importance of gender equality and how it benefits society. We are also working on increasing access to education for women, which we believe is crucial for empowering them and creating a more equitable society. It will not be an easy task, but we are determined to continue our efforts towards promoting gender equality in Madagascar."

4.3. Sierra Leone

4.3.1. Background information

The study surveyed 487 individuals with a nearly equal distribution of male and female respondents. The average age of the participants was 40 years. The mean monthly HH income reported by the participants was $97.84[11]

Table 49: Socio-demographic characteristics - Sierra Leone

Nationality: Sierra Leone (N = 479)			
Variables	**Frequency**	**(%)**	**Mean**
Gender			
Female	237	49.5	
Male	242	50.5	
Age			40
Marital status			
Single	92	19.2	
Married (Living together)	315	65.8	
Separated	37	7.7	
Divorced	7	1.5	
Widowed	28	5.8	
Education			
I prefer not to answer	39	8.1	
No formal education	122	25.5	
Primary (1-5 years of school)	42	8.8	
Intermediate (6-8 years of school)	71	14.8	
Secondary (9-12 years of school)	150	31.3	
Vocational training	18	3.8	
Tertiary (University)	37	7.7	
Locality			
Rural (thinly populated area)	21	4.4	
Intermediate density area	457	95.4	
Urban (densely populated area)	1	0.2	
Occupation			
Student	13	2.7	
Unemployed	39	8.1	
Employed	47	9.8	
Self-employed	305	63.7	
Houseman/-wife	64	13.4	
Retired	11	2.3	
Monthly HH income			$97.84
Monthly HH expenditure on Energy			$17.70

[11] 1 usd = 16,250 Leone (xe.com - currency convertor Oct 8, 22)

4.3.2. Energy Access

Most respondents (64.7%) do not have access to energy in their HHs. Solar home systems are the most common energy service provider (21.71%), followed by EDSA and diesel generators. The most common energy source for cooking is charcoal (90%), and batteries (49.7%) for lighting. mothers accounted for 8.8% of the people in the HH responsible for sourcing firewood spending 10 days per month and less than 10 hours a day on the activity. Most respondents (44.7%) expressed dissatisfaction with their current energy sources. HHs spend 18% of their HH income on energy access.

Is satisfaction with energy sources influenced by the energy provider and energy reliability in Sierra Leone?

A cumulative odds ordinal logistic regression with proportional odds was run to determine whether satisfaction with energy sources was influenced by the energy provider and energy reliability. The assumption of proportional odds was met, $\chi^2(63) = 177.479$, $p = .000$. Table 50 illustrates, $\chi^2(107) = 113.832$, $p = .308$ demonstrating that energy reliability was the most important factor influencing satisfaction with energy. The only energy provider with a statistically significant effect on satisfaction with energy sources was "other sources of energy," hence energy reliability had more impact on the satisfaction levels with energy.

Table 50: Influence of energy provider on Satisfaction with energy sources - Sierra Leone

Goodness-of-Fit			
	Chi-Square	df	Sig.
Pearson	244.263	107	0
Deviance	113.832	107	0.308

Link function: Logit.

4.3.3. Awareness of Energy and the Environment

Most respondents are aware of climate change, and almost half of them believe it will affect them in the future, particularly through extreme weather events and resource shortages. Additionally, many respondents have heard of RE, with solar being the most known type.

When asked what some of the effects of climate change the people in Freetown are currently experiencing, a Private Sector Energy Institution Representatives stated:

"As a community, we are already experiencing some of the effects of climate change. With a population of seven million people and 410 km^2 of coastline, we are particularly vulnerable to its impact. One of the most significant effects is severe flooding and severe weather conditions that occur frequently in our community. This has led to the loss of lives and property and the disruption of economic activities. We are also experiencing landslides due to deforestation and encroachment into the forested areas, which is a result of human activities. This is causing massive erosion, soil degradation, and loss of biodiversity. Another effect of climate change is the rising seawater levels due to the falling off mangroves for smoking fish, and the disappearance of islands. This is a significant concern for our community, which relies heavily on fishing and other coastal activities. Finally, heavy precipitation is also a concern, with an average of 3000mm of rainfall per year between April and November. This is leading to soil erosion and making it difficult for farmers to grow crops. Overall, these are some of the effects of climate change that we are already experiencing in our community. We need to take urgent action to address these challenges and build resilience to the impacts of climate change."

Is there a relationship between knowledge of climate change and the knowledge of RE?

A bivariate Pearson correlation coefficient analysis was conducted to examine the relationship between knowledge of climate change and knowledge of RE. The test results in Table 51 below show a significant positive correlation between knowledge of climate change and knowledge of RE, indicating that as knowledge of climate change increases, the likelihood of having heard about RE also increases.

Table 51: Relationship between knowledge of climate change and the knowledge of RE - Sierra Leone

Correlations

		Do you know what climate change is	Have you heard of RE
Do you know what climate change is	Pearson Correlation	1	.608**
	Sig. (2-tailed)		.000
	N	477	475
Have you heard of RE	Pearson Correlation	.608**	1
	Sig. (2-tailed)	.000	
	N	475	477

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

Is there a relationship between awareness of RE and support for increasing its use in one's country?

A chi-square test of independence was conducted to examine the association between the relationship between awareness of RE and support for increasing its use in one's country. The results as demonstrated in Table 52 and Table 53 below, show that there is a relationship between these two variables - people who are aware of RE are more likely to support increasing its use in their country, and vice versa.

Table 52: Relationship between awareness of RE and support for increasing its use - Sierra Leone

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	654.001a	12	.000
Likelihood Ratio	896.728	12	.000
N of Valid Cases	658		

a 11 cells (55.0%) have expected count less than 5. The minimum expected count is .01.

Table 53: Association between awareness of RE and support for increasing its use - Sierra Leone

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	0.997	.000
	Cramer's V	0.576	.000
N of Valid Cases		658	

Is there a correlation between knowing what climate change is and the belief that it will affect individuals in the future?

Logistic regression analysis was conducted to evaluate whether there is a correlation between knowing what climate change is and the belief that it will affect individuals in the future. The results as presented in Table 54, Table 55, and Table 56 below explain that the belief that climate change will affect individuals in the future is strongly associated with knowing what climate change is.

Table 54: Model fitting information on correlation between knowing what climate change is and the belief that it will affect individuals in the future - Sierra Leone

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	558.85			
Final	.000	558.85	3	.000

Link function: Logit.

Table 55: Goodness of fit - correlation between knowing what climate change is and the belief that it will affect individuals in the future - Sierra Leone

Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	.000	12	1.000
Deviance	.000	12	1.000

Link function: Logit.

Table 56: Pseudo R-square - correlation between knowing what climate change is and the belief that it will affect individuals in the future - Sierra Leone

Pseudo R-Square

Cox and Snell	0.689
Nagelkerke	0.759
McFadden	0.490

Link function: Logit.

When asked about the possible solutions they are currently implementing to address the adverse effects of climate change, a representative from a government department of sanitation stated:

"The first step to address the effects of climate change in our community is to conduct a thorough assessment to understand the situation. We also need to learn from other cities that have successfully implemented mitigation and adaptation strategies. One of our main solutions is to develop a climate action plan that identifies the major drivers of emissions in the city, with transport being the highest priority. To combat deforestation and promote carbon sequestration, we plan to plant a million trees in different parts of the community such as hillsides, coastal lines, and water catchment areas. We are also working with communities to become planets and growers, and they will be provided with incentives for that. Additionally, we aim to convert empty spaces into forest areas. In the urban planning sector, we plan to introduce cable cars to help reduce the use of cars and fossil fuels while reducing congestion and providing transportation to the majority. We are also working on constructing a new dump field as the current one is full of methane. To improve waste management, we will work with youth groups to increase waste collection and transportation. We

have no mandate on the energy sector, but we work closely with the Ministry of Energy and the EU to install solar lamps that communities can rely on instead of the national grid. We also have clean cooking programs to promote the use of clean energy sources."

4.3.4. Community Life

Many respondents (89.1%) reported feeling recognized and proud to be part of their community. Additionally, more than half of the respondents (61.8%) reported trusting members of their community. Most of the respondents (67.7%) reported having trust in their local authorities and expressed confidence in asking their neighbors for help. However, most respondents (73.1%) indicated that they were not members of any club or social grouping.

When asked what challenges the communities are facing, a CBO Representative shared:

"There are several challenging things that we face in our community. Firstly, access to proper electricity is a major issue. This makes it difficult for us to carry out our day-to-day activities and affects our productivity. Education and healthcare are also major concerns. Many people in our community do not have access to quality education or healthcare, which hinders our progress and development. During the rainy season, our communities on the islands face a rise in water levels, and we are forced to relocate to higher areas. This makes it difficult to manage energy and waste services. We also lack proper markets for economic activities, which affects our ability to generate income and sustain our livelihoods. Additionally, we have low employment rates, which makes it difficult for people to provide for themselves and their families. There are also political issues that affect our community, including gender-based violence, land grabbing, and child labour in the sand mining industry and waste collection. Overall, these are some of the most challenging things that we face in our community. We need support from the government and other stakeholders to address these issues and create a more sustainable and equitable community for all."

Is trust in local authorities positively correlated to participation in community organisations?

A Cochran-Armitage test of trend was run to determine whether a linear trend exists between trust in local authorities and participation in community organizations. The results as shown in Table 57 below, indicate that there is no statistically significant relationship between the predictor variable (trust in local authorities) and the outcome variable (participation in community organizations). Therefore, the study suggests that trust in local authorities does not influence the community's participation in organizations

Table 57: Linear trend between trust in local authorities and participation in community organizations - Sierra Leone

Variables not in the Equation

			Score	df	Sig.
Step 0	Variables	Do you trust local authorities in your neighbourhood 1	0.261	1	0.609
	Overall Statistics		0.261	1	0.609

Can a sense of community belonging positively impact the likelihood of asking for help from neighbours?

The study used Spearman's rank-order correlation analysis to investigate the relationship between feeling a sense of community belonging and the likelihood of asking for help from neighbours. The analysis as illustrated in Table 58 below, revealed a significant positive correlation between the two variables (r = .286, p < .01), indicating that participants who reported feeling recognized in their neighborhood were more likely to ask their neighbors for help.

Table 58: Relationship between feeling a sense of community belonging and the likelihood of asking for help from neighbours - Sierra Leone

Correlations

			Do you feel recognised part in your neighbourhood	Would you ask your neighbours for help
Spearman's rho	Do you feel recognised part in your neighbourhood	Correlation Coefficient	1.000	.286**
		Sig. (2-tailed)	.	.000
		N	444	441
	Would you ask your neighbours for help	Correlation Coefficient	.286**	1
		Sig. (2-tailed)	.000	.
		N	441	443

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

Can positive feelings about one's neighborhood lead to greater adoption of RE sources?

The study conducted a Spearman's rank-order correlation test to examine the relationship between positive feelings about one's neighbourhood and the likelihood of adopting RE sources. The results showed a significant and perfect positive correlation (r = .544, p < .01) between the two variables, indicating that participants who felt proud to be part of their neighbourhood were more likely to adopt RE sources if most of their neighbours were doing so. These findings, as shown in Table 59 below suggest that a sense of pride in one's neighborhood may be a principal factor in promoting the adoption of RETs.

Table 59: Relationship between positive feelings about one's neighbourhood and the likelihood of adopting RE sources - Sierra Leone

Correlations

			Are you proud to be part of your neighbourhood	Would you adopt RE if majority of neighbours are doing so
Spearman's rho	Are you proud to be part of your neighbourhood	Correlation Coefficient	1	.544**
		Sig. (2-tailed)	.	0
		N	440	439
	Would you adopt RE if majority of neighbours are doing so	Correlation Coefficient	.544**	1
		Sig. (2-tailed)	0	.
		N	439	444

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

4.3.5. Support and Acceptance of Innovative Technologies and Services

Most respondents (90.2%) are dissatisfied with their current energy system due to a lack of electricity and irregular availability. However, they are willing to support the production of RE in their community, with 77.7% willing to have an RE plant on their property and 99.4% in their neighbourhood. Respondents are also willing to pay extra for RE, support others in their community to acquire RE and take an active role in RE projects. Additionally, 85.2% are willing to learn and participate in RE.

When asked about what would make the community make a choice in favour of RE, a representative of a research institution responded,

"In order for my community to make a choice in favour of renewable sources of energy, we need to bridge the knowledge gap surrounding clean energy. Capacity building is crucial in educating individuals on the usage, cost, and advantages of clean energy solutions. However, we must also consider the poverty level of our community. Income level plays a significant role in whether people can afford innovative solutions. So, the pricing of these goods must be reasonable and affordable. The efficiency and ease of use of these solutions must also be considered to ensure accessibility to all members of our community. By addressing these factors, we can work towards a more sustainable future with renewable sources of energy. We must empower individuals and provide them with the necessary tools and knowledge to make informed decisions in favor of clean energy solutions."

Are the people who are unhappy with the current energy system more likely to support RE production plants in their community?

The study examined whether people who are dissatisfied with the current energy system are more likely to support a project for more RE production in their community. The results Table 60 of the correlation analysis test showed that there is a negligible correlation (tau_b = .018) between these two variables, and the p-value (p = .344) was greater than the conventional level of significance (α = .05). This indicates that participants' level of dissatisfaction with the current energy system does not significantly affect their willingness to support a project for more RE in their community.

Table 60: Relationship between people's level of happiness with the current energy system and their support for a project in their community for more RE production - Sierra Leone

Correlations

			Are you happy with the current energy system	Would you support a project in your community for more RE
Kendall's tau_b	Are you happy with the current energy system	Correlation Coefficient	1.000	0.018
		Sig. (1-tailed)	.	0.344
		N	479	479
	Would you support a project in your community for more RE	Correlation Coefficient	0.018	1.000
		Sig. (1-tailed)	0.344	.
		N	479	479

Is income level negatively related to willingness to pay extra costs for RE, to obtain RE?

A correlation analysis - Spearman's rho test - was conducted to examine the relationship between participants' total monthly HH income in USD and their willingness to pay extra costs to obtain RE. The analysis as shown in Table 61 below, indicating a weak negative correlation was found between the two variables. The correlation coefficient was small, and the p-value was marginally significant, indicating that income level is not a significant predictor of the willingness to pay extra costs for RE.

Table 61: Relationship between total monthly HH income and willingness to pay extra costs for RE - Sierra Leone

Correlations

			Total HH (USD)	monthly income	Would you pay extra cost to obtain RE
Spearman's rho	Total monthly HH income (USD)	Correlation Coefficient		1.000	-0.088
		Sig. (2-tailed)		.	0.055
		N		479	479
	Would you pay extra cost to obtain RE	Correlation Coefficient		-0.088	1.000
		Sig. (2-tailed)		0.055	.
		N		479	479

Is the willingness to pay extra costs for RE higher among people who are more concerned about the environment and climate change?

The study analyzed the correlation between participants' willingness to pay extra costs for RE and their belief that climate change will affect them in the future. The results showed that there was no significant correlation between these two variables, indicating that the belief about climate change does not impact the willingness to pay extra costs for RE. The results are as tabulated in Table 62 below.

Table 62: Relationship between willingness to pay extra costs for RE and concern about climate change - Sierra Leone

Correlations

			Would you pay extra cost to obtain RE	Climate change will affect you in future
Spearman's rho	Would you pay extra cost to obtain RE	Correlation Coefficient	1.000	-0.026
		Sig. (2-tailed)	.	0.621
		N	479	357
	Climate change will affect you in future	Correlation Coefficient	-0.026	1.000
		Sig. (2-tailed)	0.621	.
		N	357	357

Does gender and availability of electricity in the HH have an influence on the likelihood of the participants playing an active role to support RE projects in their community?

A cumulative odds ordinal logistic regression with proportional odds was run to determine the effect of gender and availability of electricity in the HH on the likelihood of the participants playing an active role to support RE projects in their community. The assumption of proportional odds was met at, $\chi^2(8) = 9.011$, $p = .061$. The odds of participants with no electricity in the HH playing an active role to support RE projects in their community was 4.439, 95% CI [.418, .969] times that of participants with electricity in the HHs, not statistically significant effect, Wald $\chi^2(1) = 4.439$, $p = .035$. These results found no significant effect of gender on participants playing an active role to support RE projects in their community, also people without electricity in their homes were less likely to play active role to support RE projects in their community compared to those with electricity.

4.3.6. Perceived Risks and Benefits

The majority (72.7%) of people have no concerns about having a RE production plant in their neighbourhood for collective consumption with the local community. The main potential risks are related to grid connection, transparency, and fairness. However, people also see social, environmental, and economic benefits such as increased local employment, community engagement, reduced emissions, and more qualified green jobs.

Are people with low incomes more likely to perceive risks associated with having a RE plant in their community

A Goodman and Kruskal's λ test were conducted to examine the relationship between income levels (low-income, middle-income, and high-income) and perceived risks of having a RE production plant in the neighborhood. The statistical analysis revealed a weak to moderate positive relationship between income range and perceived risks, with a small effect size (τ = .032) and moderate effect size (τ = .116), respectively. These results indicate that income level may play a role in shaping people's perception of risks associated with RE production plants as illustrated in Figure 9.

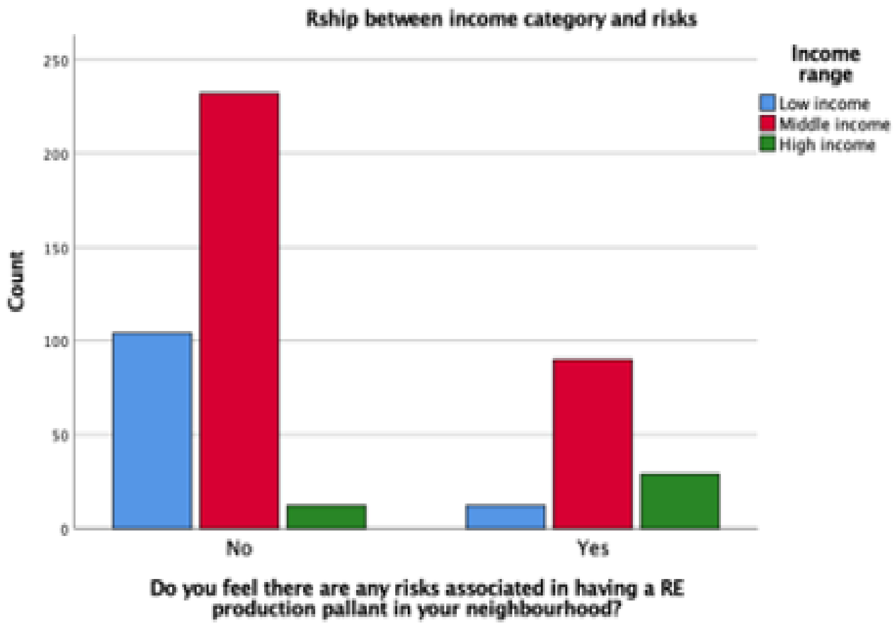

Figure 9: Relationship between perceived risks associated with having a RE production plant in the neighbourhood and the income levels - Sierra Leone

Are the people with a lower level of trust in local authority more likely to perceive risks associated with RE production plant in their community?

The analysis found that people who had lower levels of trust in local authorities were more likely to perceive risks associated with having a RE production plant in their neighborhood. The results (Table 63) suggest that trust plays a vital role in shaping people's perception of risks related to RE production plants

Table 63: Linear trend between a lower level of trust in local authorities and the perception of risks associated with having a RE production plant in the neighbourhood - Sierra Leone

Variables not in the Equation

			Score	df	Sig.
Step 0	Variables	Do you trust the local authorities of your neighbourhood?	32.608	4	.000
	Overall Statistics		32.608	4	.000

Will people who think climate change will affect them in the future not feel any risks associated with having a RE production plant in their neighbourhood?

A Cochran-Armitage test of trend was run to determine whether a linear trend exists between a higher likelihood of climate change affecting the future and the perception of no risks associated with having a RE production plant in the neighbourhood. The results (Table 64) found that there is a statistically significant linear trend, indicating that people who are more likely to believe that climate change will affect the future are less likely to perceive risks associated with having a RE production plant in their neighbourhood.

Table 64: Linear trend between a higher likelihood of climate change affecting the future and the perception of no risks associated with having a RE production plant in the neighbourhood - Sierra Leone

Variables not in the Equation

			Score	df	Sig.
Step 0	Variables	Q.21. Do you think climate change will affect you in the future?	52.284	5	.000
	Overall Statistics		52.284	5	.000

4.3.7. Economic Aspects

98.1% of respondents believe that RET can lower energy costs in the future. They also believe that RET can create job opportunities and reduce social and economic disparities between diverse groups of people, such as men and women, low-income earners and the wealthy, and people in positions of power versus those who are not.

When asked how RE will impact the economic sector of the community a Waste Management Company Representative stated:

"Renewable energy (RE) has the potential to bring significant economic benefits to our community. It is a catalyst for development for all social groups in our community. One of the key areas that will benefit from RE is the health sector. Hospitals and clinics rely heavily on electricity to operate essential medical equipment and provide quality healthcare. With RE, these facilities can run uninterrupted and provide critical healthcare services to the community. In addition, RE will improve communication in the community. Access to reliable and affordable electricity is essential for communication, and with RE, we can bridge the digital divide and bring communication services to all members of the community. Overall, the impact of RE on the economic sector of our community is significant. It will create jobs, promote economic growth, and improve the quality of life for everyone.

As a waste management company, we are committed to promoting sustainable practices that will benefit our community and the environment."

Do individuals with higher levels of education tend to have more positive perceptions about the potential employment opportunities created by a RE production plant in their community?

A Chi-square test of independence was conducted to investigate the relationship between education level and perception of potential employment opportunities created by a RE production plant in the community. The study results as tabulated in Table 65 below, found a significant association between the highest education level and beliefs about RE plant employment opportunities which suggests that education level may influence views on the potential employer that RE production plants can create in the community.

Table 65: Relationship between education level and perception of potential employment opportunities created by a RE production plant in the community - Sierra Leone

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	32.803a	18	0.018
Likelihood Ratio	36.3	18	0.006
N of Valid Cases	479		

a 14 cells (50.0%) have expected count less than 5. The minimum expected count is .15.

Does occupation affect respondents' beliefs about which groups of the community will benefit the most from RETs?

Goodman and Kruskal's λ was conducted to examine the association and relationship between occupation and beliefs about which groups of the community will benefit the most from RETs. The Pearson Chi-Square test revealed a significant association between occupation and beliefs about RET's impact as illustrated in **Error! Reference source not found.**. The results suggest that occupation may play a role in shaping beliefs about the benefits of RET to diverse groups in the community.

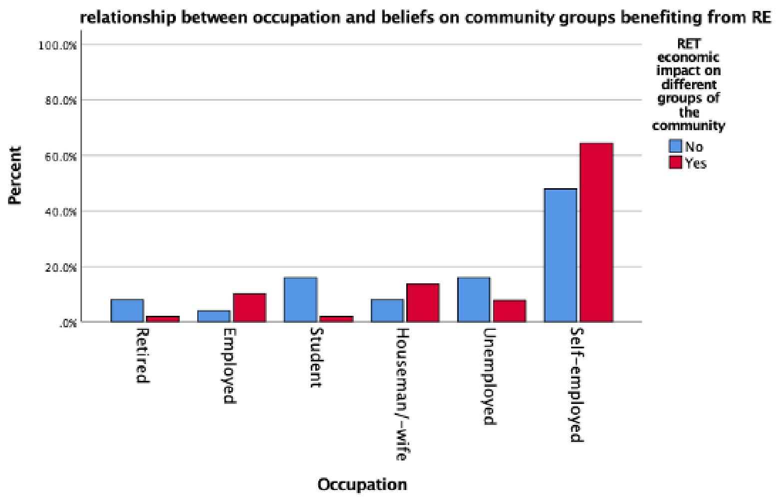

Figure 10: Relationship between occupation and beliefs about diverse groups of the community will benefit the most from RET - Sierra Leone

Do people with no electricity at home think that using RE technologies can reduce energy costs in the future?

A chi-square test was conducted to explore the association between the lack of electricity in the HH and its influence on the belief that RET can reduce energy costs in the future. Results showed a significant association exists between the two indicating that lack of access to electricity has an influence on the belief that RET can reduce energy costs in the future as demonstrated in **Error! Reference source not found.**.

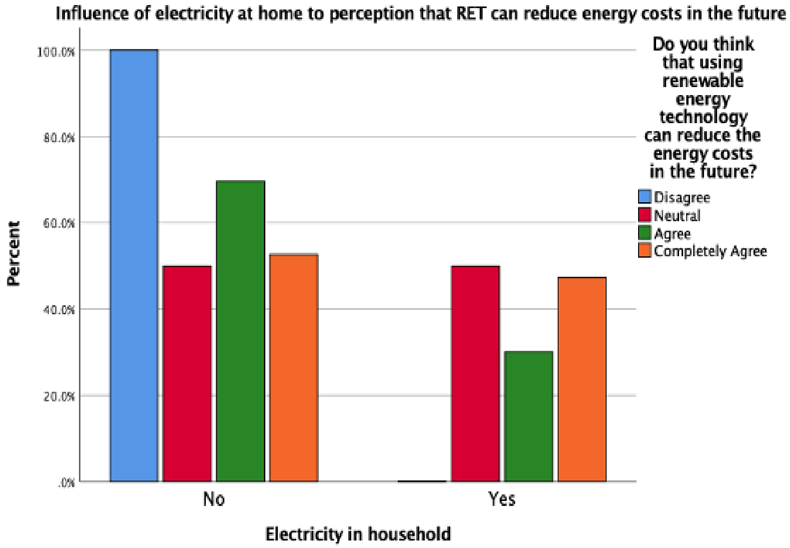

Figure 11: Association between lack of electricity in the HH and its influence on the belief that RET can reduce energy costs in the future - Sierra Leone

4.3.8. Waste and Chemicals - Sierra Leone – Specific Section

The communities dispose of their waste in various ways, as illustrated in Figure 12 including nearby forests, banana plantations, behind their compounds/backyards where they sometimes burn it during the dry season, in the river/ocean/swamp, paying boys/tricycles for collection and dumping at the waterloo dumping site or asking their children to dump it for them when they did not have money for dumping services. The respondents implied willingness to pay for the collection, disposal, and recycling of their waste (81.8%) and support having a waste recycling plant in their neighbourhood (97.2%). 90.6% of the respondents are willing to use fertilizer from recycled waste if it were cheaper than the fertilizer they currently use.

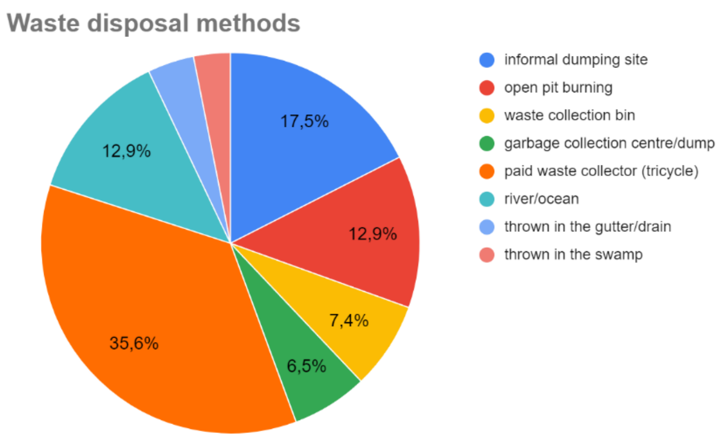

Figure 12: Waste disposal methods

When asked what the possible use of recycled products from waste a CSO Representative would be stated:

"When it comes to the possible use of recycled waste products in the communities of Freetown, there are several suggestions we can make. Firstly, we need to focus on technology transfer and create more opportunities for recycling. This will not only help to reduce waste in our communities but also create employment opportunities for those who are involved in the recycling process. Properly

managed dump and recycling sites are crucial for the success of any recycling program. We need to have proper waste management structures and vehicles to transport waste to these sites. Additionally, capacity-building mechanisms should be put in place to educate the community on the importance of recycling and how to properly dispose of waste. Protective gear is also essential for those involved in the recycling process to ensure their safety. Partners' and stakeholders' support is necessary to ensure the success of any recycling program. Funding should be made available to support the initiative. We also need to encourage proper waste management at the household level by setting up mini-recycling structures. The recruitment of manpower is also crucial for the success of any recycling program. I conclude by putting emphasis on technology transfer, proper waste management structures, capacity building mechanisms, and the recruitment of manpower, we can create a more sustainable and environmentally friendly community in Freetown."

Are respondents with higher income levels more likely to dispose of their waste in an environmentally responsible way?

A cumulative odds ordinal logistic regression with proportional odds was run to determine whether respondents with higher income levels were more likely to dispose of their waste in an environmentally responsible way. The high-income level parameter was set to zero as it was redundant, while the low income had a statistically significant effect with a 0.192 (95% CI, .093 to .397) and middle income had a 0.425 (95% CI, .222 to .814) statistically significant effect. The results show that income has significant influence in determining where respondents will dispose of their waste, especially for people in the low and middle-income categories.

The respondents were curious if ENERGICA project implementers were willing to buy waste from them and able to provide reliable and cheaper energy for the community to address the waste menace and the lack of electricity.

Do higher education levels influence the attitude towards support to waste recycling initiatives in the neighbourhoods?

A cumulative odds ordinal logistic regression with proportional odds was run to determine whether higher education levels were more likely to influence the attitude towards support to waste recycling initiatives in the neighbourhoods. The assumption of proportional odds was met, as assessed by a full likelihood ratio test comparing the fit of the proportional odds location model to a model with varying location parameters, $\chi^2(5) = 9.789$, $p = 0.081$. The results showed that education was not a noteworthy influence in determining attitudes towards support for waste recycling initiatives in the neighbourhoods. However, the study found that higher education levels could influence attitudes towards support for waste recycling initiatives in the neighbourhoods, as tertiary (university) education level was the highest education level with a statistically significant effect on the attitude towards support for waste recycling initiatives in the neighbourhoods.

4.3.9. Gender and Energy

Most of the respondents believed in distinct roles for men and women in their HHs, with women primarily responsible for HH chores, farming, and taking care of children. Men were perceived to make choices around energy in the HH. The study found that lack of education on RE, limited access to financial resources, unaffordable installation costs, cultural and social norms, and stereotypes were the main reasons for women not participating in RE projects. To overcome these challenges, female empowerment and self-reliance, access to finance, and awareness creation on RE were suggested. The study also found that RE could promote women's decision-making power and access to resources, improve living standards, and promote safety. However, 56.2% of the respondents were uncertain about the willingness of women in their HHs to learn and participate in RE projects.

Do HHs with no gender specific roles have higher education levels (Secondary level and above)?

A chi-square test of independence was conducted to examine whether HHs with no gender-specific roles have higher education levels. The results revealed a weak and non-significant association between education level and gender roles in HHs as illustrated in Table 66 below, indicating that gender roles still exist regardless of education level.

Table 66: Association between HHs with no gender-specific roles have higher education levels - Sierra Leone

Symmetric Measures

		Value	Approximate Significance
Nominal by nominal	Phi	0.129	0.24
	Cramer's V	0.129	0.24
N of Valid Cases		479	

Are men more likely than women to be responsible for making choices around energy use in the HH?

A chi-square test of independence was conducted to examine whether men are more likely than women to be responsible for making choices around energy use (Table 67). A significant association was found between gender and the person responsible for making choices around energy use, suggesting that gender differences still exist in energy decision-making. The analysis showed that men were more likely than women to assume decisions around energy choices in their HHs.

Table 67: Association between gender and responsibility for making choices around energy use in the HH - Sierra Leone

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	0.196	.000
	Cramer's V	0.196	.000
N of Valid Cases		479	

A representative from a Research Institution had the below thoughts on gender and energy,

"In our community, the gender representation in the renewable energy sector is currently quite low. Women are often hindered by cultural and patriarchal factors, making it difficult for them to participate in meetings and activities related to renewable energy. Women-to-women meetings are easier for them, but the larger patriarchal society can still be a barrier. Cultural factors also tie women to household chores and activities that are seen as traditionally male-dominated. However, we are seeing progress in this area. Organizations like UNOPs are setting up local grids and providing capacity-building programs and women-targeted interventions. As a result, many of the technical experts at the local level are women. One of the main factors causing this low representation is the

lack of knowledge surrounding renewable energy. The concept must be deliberately picked up and included in training programs to ensure that women have access to this knowledge and can participate in the renewable energy sector. By addressing these factors, we can work towards a more gender-inclusive renewable energy sector in our community and beyond."

4.4. All Context's Comparison

The information presented in the Table 68 below provides a snapshot of the demographic and socioeconomic characteristics of the populations in Kenya, Madagascar, and Sierra Leone. Some of the unique characteristics of the populations in each country are highlighted. These insights can be used to inform policies and programs designed to address the specific needs of these populations.

For instance, it is evident that there are significant differences in the gender composition of the populations across the three countries, with Kenya having the highest proportion of male respondents and Madagascar having the highest proportion of female respondents. This can be attributed to the fact that the survey mainly focused on the boda-boda industry both for the riders and customers who were mainly men. Kenya also has a younger generation compared to Madagascar and Sierra Leone.

Similarly, many respondents in all three countries are self-employed, but there are differences in the proportions of respondents in each occupation category. Finally, the data also provide insights into the HH income and monthly HH expenditure on the energy of the respondents in each country. The mean HH income is highest in Kenya, followed by Sierra Leone and Madagascar, while the mean monthly HH expenditure on energy is highest in Kenya.

Table 68: Socio- Demographic Characteristics - all contexts comparison

	Nationality								
	Kenya (N = 537)			Madagascar (N = 659)			Sierra Leone (N = 479)		
Variables	**Frequency**	**(%)**	**Mean**	**Frequency**	**(%)**	**Mean**	**Frequency**	**(%)**	**Mean**
Gender									
Female	115	21.42		293	44.5		237	49.48	
Male	422	78.58		365	55.4		242	50.52	
Other gender	0	0		1	0.2		0	0.00	
Age			31			42			40
Marital status									
Single	256	47.7		83	12.6		92		
Married (Living together)	259	48.2		502	76.2		315		
Separated	15	2.8		62	9.4		37		
Divorced	5	0.9		1	0.2		7		
Widowed	2	0.4		11	1.7		28		
Education									
I prefer not to answer	80	14.9		6	0.9		39		
No formal education	3	0.6		86	13.1		122		
Primary (1-5 years of school)	20	3.7		184	27.9		42		
Intermediate (6-8 years of school)	58	10.8		230	34.9		71		
Secondary (9-12 years of school)	205	38.2		133	20.2		150		
Vocational training	22	4.1		6	0.9		18		
Tertiary (University)	148	27.6		14	2.1		37		
Locality									
Rural	0	0		600	91.0		21		
Intermediate density area	152	28.3		58	8.8		457		
Urban	385	71.7		1	0.2		1		
Occupation									
Student	86	16.0		1	0.2		13		
Unemployed	5	0.9		32	4.9		39		
Employed	59	11.0		77	11.7		47		
Self-employed	386	71.9		526	79.8		305		
Houseman/-wife	0	0		11	1.7		64		
Retired	1	0.2		12	1.8		11		
HH Income			$191.89			$48.55			$97.84
Monthly HH expenditure on Energy			$105.48			$9.15			$17.70

5. DISCUSSION

This baseline assessment report serves as an initial evaluation of the current state of the three project areas; Nairobi - Kenya, Diana region - Madagascar and Freetown - Sierra Leone, socio-cultural and economic set-up, and assessment of energy access to establish and inform the starting point of implementing the demonstrators' solutions from which the progress can be measured, and impact evaluated. In this chapter, the findings of the baseline assessment and their implications for future planning and implementation are discussed including the key opportunities and strengths of the communities. The research questions guided discussions.

5.1. Do people in the three project locations have access to reliable, affordable, and sustainable energy?

Kenya, Madagascar, and Sierra Leone have varying levels of access to reliable, affordable, and sustainable energy. Kenya has the highest level of access to reliable, affordable, and sustainable energy, with almost everyone having access to electricity provided by Kenya Power. Petroleum gas is the most common source of energy for cooking in Kenya, while HH electricity is used for lighting and communication. In Madagascar, only a third of the population has access to reliable energy from Solar Home Systems, and firewood and charcoal are commonly used for cooking. This was from the representative sample of the survey including HH connected to solar power. Hence, the statistics can be lower. In Sierra Leone, most of the population does not have access to energy at all, with charcoal being the most common source of energy for cooking. Satisfaction with energy sources varied, with about half of the Kenyan respondents and almost 40% of Malagasy respondents expressing dissatisfaction which was influenced by the energy provider and energy reliability, but not by the type of energy used.

On average, people in Kenya spend the highest percentage (55%) of their monthly HH income on energy, Sierra Leone 18%, while Madagascar spends the lowest, 16%. While interpreting these results it is important to consider, that the study respondents in Diana mostly had electricity access via nano grids and generators and may not represent the energy access situation for citizens living in other areas of Madagascar. Additionally, in Sierra Leone, most respondents did not have access to energy in their HHs and therewith couldn't buy it and spent money on it. Marginalized communities and low-income earners are disproportionately affected by the high costs associated with energy installation, maintenance, and operation (Ezzati & Kammen, 2002). These communities also serve as representative populations in the demonstrator locations of Kenya, Madagascar, and Sierra Leone. This lack of sufficient and affordable energy access negatively affects their economic opportunities and productivity, limiting their overall well-being.

5.2. Are people aware of climate change and the impact it has on their environments?

The three countries, Kenya, Madagascar, and Sierra Leone, have a general awareness of climate change and its effects on their lives, including extreme weather events and food and water shortages. In Kenya, people who are aware of climate change are more likely to know about RE sources, such as solar energy, but their usage is not diversified especially regarding the use of various appliances and location-wise in marginalized rural areas. In Madagascar, solar energy is the most known RE, and there is support for increasing its use. In Sierra Leone, awareness of RE sources is associated with increased support for their use. According to a study by Bin and Dowlatabadi (2005), HH in the United States was accountable for nearly 70% of both direct and indirect total emissions. Recognizing the significant role of HH emissions in contributing to climate change and acknowledging its impact is a crucial step towards mitigating its effects. The results from the three contexts indicate that a higher level of awareness about climate change is associated with a greater likelihood of adopting RE solutions in all three areas considered. However, more needs to be done to raise awareness and support for RE sources, especially in rural and marginalized areas.

5.3. How is the social fabric in the project locations? Do people see themselves as belonging to a community?

The social fabric in Kenya, Madagascar, and Sierra Leone is strong, with most respondents feeling recognized and proud to be part of their communities. In Madagascar, there is a powerful sense of community belonging and a positive correlation between feeling recognized in one's neighborhood and asking neighbors for help. In all three countries, there is a positive correlation between positive feelings about one's neighborhood and the likelihood of adopting RE sources if most neighbors were doing so. There is a lack of trust in local authorities in Kenya, and the communities in Madagascar and Sierra Leone have limited infrastructure for transportation, sanitation, and energy, particularly in rural areas.

Engaging and collaborating with communities on community projects, while leveraging existing social structures, can have a more sustainable impact. Such an approach not only fosters willingness but also encourages active participation in renewable energy (RE) projects (Koirala et al., 2018).

5.4. How receptive are people to RETs and services?

The respondents in Kenya, Madagascar, and Sierra Leone showed a willingness to support RET and services. In Kenya, knowledge, and concerns about the effects of climate change positively influenced their willingness to pay extra energy costs to obtain RE. However, females in Kenya and Madagascar are less likely to participate actively in supporting RE projects than males. In Sierra Leone, dissatisfaction with the current energy system did not significantly influence the willingness to support RE projects, and participants expressed a willingness to pay extra to obtain RE and support others in their community financially. Additionally, females in Sierra Leone were more likely to play an active role in supporting RE projects, and the availability of electricity did not significantly affect the likelihood of participation in RE projects.

Section 2.4 highlights the significant influence of social acceptance on the adoption of innovative renewable energy (RE) solutions. The findings indicate that public awareness plays a crucial role in determining the uptake rates of these solutions. To address current energy challenges effectively, it is essential to implement gender-sensitive approaches when introducing energy innovative solutions. Additionally, creating awareness about RET and their benefits can have a positive impact on the uptake of these energy solutions.

5.5. What are the perceptions of risks and benefits associated with the usage of RETs and solutions? Do they believe that RE solutions have an impact on marginalized communities?

In Kenya, most people have a positive view of RE and do not see any risks in having a RE plant in their neighbourhood. They believe that RE will bring economic benefits to their community, but there are concerns about how to ensure that disadvantaged groups, such as nomads and people in Arid and Semi-Arid Lands (ASALs), also have access to these benefits.

In Madagascar people with lower incomes are more concerned about the risks of RE plants in their neighbourhoods than those with higher incomes. However, trust in local authorities did not seem to affect how people felt about having a RE plant nearby. People who believe that climate change will affect them are more likely to see RE as a solution to reduce those risks.

For Sierra Leone, most people have a positive view of RE and do not see any risks in having a RE plant in their neighbourhood. They believe that RE will bring many benefits to their community, including social benefits like creating local jobs and promoting women's empowerment, environmental benefits like reducing emissions, and economic benefits.

Social inclusion, economic empowerment and environmental benefits were perceived as benefits of RETs to communities in Nairobi, Diana and Freetown. Lack of, could also increase the perception of the perceived risks. To address these and as outlined section 2.5, it is crucial to prioritize the promotion of the benefits of RET especially during the initial stages of project implementation. This will help build confidence among end users, and their confidence will likely increase over time. Recognizing the importance of public knowledge and its connection to perceived benefits and public uptake of RET projects is a key step towards achieving long-term sustainability.

5.6. What are the energy needs and challenges in the respective contexts considering the specific technical solution?

5.6.1. Kenya

The study explores the energy requirements and obstacles associated with the usage of electric motorcycles in the boda-boda industry in Kenya. On average, boda-boda riders cover 124.08KM per day, with a maximum distance of 550 km, while earning an average daily income of $12.19 and spending $5.49 on fuel. Although almost half of the sample group (49.3%) were aware of the existence of electric motorcycles, only 45.3% had used them before. Charging duration, purchase cost, resale value, and speed were the primary concerns for those hesitant to switch to e-bikes. However, 36.5% of respondents would prefer electric motorcycles if given the chance, while 24.6% would opt for traditional boda-bodas. Age may also influence whether individuals have used electric motorcycles before, as those aged 31-40 are more likely to have used them than those aged 20-30.

5.6.2. Madagascar

According to the study, most respondents have access to clean water near their HHs, with wells being the most common source. However, many did not disclose their monthly water expenses and are unwilling to pay for clean water access. The maximum amount they are willing to pay is $14.19, indicating that cost is an important factor to consider.

In terms of cooling and freezing services, most respondents do not have access but are willing to pay for such services in their HHs and neighbourhoods. They plan to use these services for making ice blocks, cooling beverages, and preserving meat and fish. The maximum amount they are willing to pay is $94.61, showing a demand for these services.

Over half of the respondents have access to agricultural machines within their neighbourhoods, mostly from local entrepreneurs or their own machines. The most useful machines were for husking rice. However, most respondents are not willing to pay for access to agricultural machines in their HHs or neighbourhoods, and they currently spend a maximum of $118.26 per month. The study suggests that cost is an essential factor to consider when providing access to clean water and agricultural machines, while cooling and freezing services have a demand for such services, and respondents are willing to pay for them.

5.6.3. Sierra Leone

According to the study, waste management is a great challenge in Freetown, as the current methods are not environmentally friendly. There is a lack of effective drainage plans, leading to uncontrolled dumping and law enforcement issues. Single-use plastics are a major contributor to waste, and there are no policies in place to regulate their use. Additionally, sewage sludge is not managed properly, leading to flooding and the spreading of sewage all over the city. Masada, a youth waste collection service at a fee of one hundred Leons per month per HH, is relied upon by the community for waste disposal, but the dumping site is already full, and HHs unable to afford Masada's services resort to illegal dumping. However, most respondents are willing to pay for waste collection and support the idea of a recycling plant. Additionally, respondents are willing to use fertilizer from recycled waste if it were cheaper than the fertilizer they currently use. Income is a significant factor in determining waste disposal methods, especially for low and middle-income individuals. The study also found that education level does not significantly influence attitudes towards waste recycling initiatives, except for those with higher education levels.

5.7. Delimitation of the Study

This study was location wise limited, specifically focusing on three areas: Nairobi County - Kenya, Diana region - Madagascar, and Freetown Sierra Leone, respectively. In addition, the study focused on a particular technical solution important for the specific context: boda-boda riders and boda-boda customers in Kenya, HHs connected to the nano grids and HHs without electricity in Madagascar, and HHs within the waterloo area in Sierra Leone.

5.8. Limitations of the Study

Some respondents indicated that they were willing to be contacted in the future stages of the project for a mid-term and end-term evaluation but were skeptical about sharing their contact information citing the possibility of voter fraud, especially in the Central Business District of Nairobi. It is to be noted that this study was conducted during the heightened political campaign period as Kenya was preparing to hold its general presidential elections on the 9th of August 2022. It was however explained to the respondent that the data was purely for the study and at no point would it be shared with any agencies for political reasons and any other not intended for the study.

The KII were conducted through a virtual meeting platform, zoom, but unfortunately, most of the respondents in the KII experienced elevated levels of poor network connectivity prompting the interview period to be prolonged more than the planned duration especially in Sierra Leone and Madagascar. There was a language barrier on the open-ended sections of the general population survey as the sections were filled in Malagasy. Local context partner, CLUB-ER was instrumental in aiding with the translation of this section.

5.9. Research Gap

Community energy projects can help place citizens and communities at the centre of the low carbon transition, build local systems needed to stop the climate crisis, reduce energy inequalities, promote social cohesion and interdependence in the community, create spaces to learn about energy, climate and democracy, contribute to creating local circular economies and promote a sense of community and ownership. As is already noted in this study there was no research on the social-cultural contexts of Kenya, Madagascar, and Sierra Leone specifically, on e-mobility, nano grid solutions, and waste management. Also, the social acceptability of RET in these three contexts had not been clearly defined.

6 CONCLUSION AND RECOMMENDATION

6.1. Conclusion

6.1.1. Energy Access

The study concludes that there were disparities among the three different study samples; Kenya, Madagascar, and Sierra Leone. Many respondents expressed dissatisfaction with energy sources, mainly due to energy providers and reliability. The cost of energy is very high in Kenya with most HHs spending up to 55% of their monthly HH income on energy. Efforts should be made to improve affordability, increase access to RE sources, and improve the infrastructure and reliability of existing energy providers. The study highlights the need for sustainable and accessible energy solutions to address the disparities in energy access in these countries.

6.1.2. Awareness of Energy and the Environment

It can be concluded that while there is a level of awareness of climate change and its potential impact on people's lives in Kenya, Madagascar, and Sierra Leone, there is a need for more awareness about and support for RE sources. It is important to diversify the perception of RE sources, particularly in rural and marginalized areas, to increase their adoption and mitigate the effects of climate change. This can be achieved through increased awareness and education on climate change and RE is necessary for these countries. The adoption of RE sources, such as solar energy, can promote sustainable environmental practices and increase support for RETs.

6.1.3. Community Life

Inequalities especially in lack of access to basic amenities, such as water and sanitation services, are critical factors that have negatively impacted the livelihoods of communities in Kenya. Efforts to provide economic development opportunities, increase employment, and ensure the reliability and affordability of energy can contribute to the overall economic growth of the community. The social fabric in Madagascar underscores the importance of culture, family, and community, but there are challenges such as low levels of education and a culture of easy money that need to be addressed. In Sierra Leone, community cohesion and trust are strong, and promoting the adoption of RE sources can encourage community participation and promote a sense of pride in the neighbourhood. Infrastructure for transportation, sanitation, and energy remains a major challenge, particularly in rural areas, but addressing these challenges can help to improve the quality of life for community members and promote community participation. Overall, addressing inequalities, improving access to basic amenities, promoting economic development, and addressing infrastructure challenges are critical components for improving the social fabric of these communities.

6.1.4. Support and Acceptance of Innovative Technologies and Services

The findings from the research indicate that the communities in Kenya, Madagascar, and Sierra Leone are receptive to RETs and services. They are willing to support the establishment of RE production plants, pay extra costs for RE, and play active roles in RE projects. These communities have a high willingness to learn and participate in RE initiatives, regardless of their income level or concerns about climate change. Additionally, females in these communities are more likely to take an active role in supporting RE projects. These results underscore the potential for RE to be a viable solution for addressing energy challenges in these communities and highlight the need for continued efforts to promote and support the adoption of RETs and services.

6.1.5. Perceived Risks and Benefits

The findings from Kenya, Madagascar, and Sierra Leone suggest that RETs are perceived positively by the community and have the potential to bring significant benefits, including environmental, social, and economic benefits. However, there are challenges that need to be addressed, such as the need for transparency and fairness in the distribution of benefits, the importance of building trust with the community, and addressing the issue of initial costs. In Madagascar, there are mixed perceptions of the risks and benefits associated with RET, and there are challenges posed by powerful authorities and diesel mafias who may try to discourage the uptake of RET by the communities. Therefore, it is essential to implement community projects in collaboration with the community to promote RE solutions and prioritize RE solutions to promote sustainable development. Overall, the research highlights the importance of addressing these challenges to ensure that marginalized communities can benefit from RETs and solutions.

6.1.6. Specific Energy Needs and Technical Solutions

6.1.6.1. Kenya

The study on the boda-boda industry in Kenya highlights the need to address concerns such as charging duration, purchase cost, resale value, and speed to encourage the uptake of e-bikes. There is a need to educate boda-boda riders about the benefits of e-bikes and provide incentives to encourage the switch. Manufacturers of e-bikes should consider providing after-sales services such as maintenance, servicing, and support to address the concerns of the boda-boda riders. Additionally, it is important to target younger age groups to increase the adoption rate of electric motorcycles. Overall, switching to electric motorcycles can offer significant benefits to boda-boda riders, such as reduced fuel costs and environmental impact. However, addressing the challenges identified above will require collaboration between the government, the private sector, and other stakeholders to create a supportive environment for the adoption of electric motorcycles.

6.1.6.2. Madagascar

While access to clean water in Diana, Madagascar is fair, respondents are not very keen on paying for it. On the other hand, access to cooling and freezing services is poor, but respondents are willing to pay for it, with the most common use being for making ice blocks, cooling beverages, and conserving meat and fish. Cost is an essential factor considered by respondents when making decisions on their choice of service providers and locations for access to stationary agricultural machines, with differences in monthly costs being statistically significant between various locations. However, the cost would not be a factor to consider when choosing service providers for cooling and freezing services, as the differences in monthly costs between service providers were not statistically significant.

6.1.6.3. Sierra Leone

It can be concluded that there are significant challenges facing waste management in Freetown, Sierra Leone. These challenges include inadequate waste management structures and facilities, uncontrolled dumping, lack of policy regulations on single-use plastics, and insufficient law enforcement addressing the challenges facing waste management in Freetown will require significant investment in infrastructure, policy regulations, and resources. There were indicators of child labour in the waste management sector which needs to be investigated. The willingness of respondents to pay for waste collection and recycling, and their support for having waste recycling plants in their neighbourhoods can be harnessed to promote sustainable waste management practices. Finally, more targeted waste management education initiatives may be necessary to increase support for waste recycling initiatives in Freetown.

6.1.7. Gender and Energy

The study conducted in Kenya found that while most HHs did not have distinct roles for men and women, HH chores were mostly reserved for women, who had limited participation in RE-related projects due to inadequate information and unavailability of the RE projects. The respondents called for awareness creation, deliberate inclusion of more women in projects, RE campaigns, equitable distribution of resources by the government, and financial support from organizations to promote women's participation in RE projects. Engaging in RE business activities was seen as a factor to potentially promote women's decision-making power, access to education and financial resources, and safety, although there was uncertainty about women's willingness to learn and participate in RE projects. Furthermore, the study found that HHs with no gender-specific roles have higher education levels. Men were also found to be more responsible than women or both partners combined for making energy choices in the HH.

The study in Madagascar highlights the traditional gender roles and responsibilities in HHs, with women responsible for HH chores and childcare, and men being more likely to make energy-use choices. It was interesting to note that HHs with no gender-specific roles have higher education levels. On the other hand, women are more likely than men to be responsible for making choices around energy use in the HH. These findings imply the importance of challenging traditional gender roles and promoting gender equality in HHs, especially in decision-making around energy use. The study also found that engaging in RE projects can promote women's self-worth, decision-making power, and improve their living standards. The respondents call for training and civic education to increase women's participation in RE projects.

The findings from Sierra Leone suggest that traditional gender roles are still prevalent in HHs, with women primarily responsible for HH chores, farming, and taking care of children, while men make decisions around energy use. The lack of education on RE, limited access to financial resources, unaffordable installation costs, cultural and social norms, and stereotypes were identified as significant barriers to women's participation in RE projects. To overcome these challenges, female empowerment, access to finance, and awareness creation on RE were suggested by most of the respondents. Gender roles exist regardless of education level in the HH with men being more likely than women to make energy-related decisions in their HHs. This study highlights the need for greater awareness and education on RE for the whole community, as well as the importance of empowering women to participate fully in RE projects. By doing so, women can benefit from improved access to resources, enhanced decision-making power, and better living standards while promoting safety and reducing gender-based and domestic violence.

6.2. Recommendation

The goal of this study was to understand the specific energy needs, identify available sources of energy, and knowledge gaps, explore opportunities for collaboration and gain insights into the possible solutions to the energy challenges from the RE end users focusing on Kenya, Madagascar, and Sierra Leone contexts and hence advise the ENERGICA consortium on the implementation of the project's activities and tasks. These have been highlighted in the results section and in the discussion sections of this report. However, some critical findings regarding human need were collected through the survey too and would be important to share them for future research to address the knowledge gaps in the research field and bring to light other needs that could be addressed.

6.2.1. Energy Access

The recommendations suggest that Madagascar and Sierra Leone prioritize expanding RE sources such as solar and wind power to improve energy access, while energy providers in all three countries should improve infrastructure and reliability. Governments should consider implementing subsidies and improved pricing structures to improve energy affordability in Kenya, promote clean and efficient cooking fuels, and encourage the use of energy-efficient appliances in all three countries. Investing in RE sources such as solar, wind, or hydropower in Madagascar and Sierra Leone is recommended to increase access to reliable and sustainable energy. Partnerships between governments and private companies are encouraged to promote sustainable development, increase productivity, and improve affordability. Further research is needed to understand factors influencing satisfaction with energy sources to develop targeted interventions.

6.2.2. Awareness of Energy and the Environment

The information gathered can be used by policymakers and stakeholders in Kenya to design and implement policies and programs that incentivize the uptake of RE sources, such as investing in RE infrastructure, funding research on RE, and promoting RE as a viable alternative in the HH and transportation sectors. In addition, awareness programs should be implemented through mainstream education, targeted campaigns, media outreach, and community engagement to educate people about climate change and encourage action to mitigate its effects in Kenya, Madagascar, and Sierra Leone. Urgent action is also needed to address the adverse effects of climate change in Madagascar, such as drought, acute famine, deforestation, and water shortages, which could involve providing aid, implementing sustainable land-use practices, and investing in infrastructure (energy and transportation). In Sierra Leone, urgent action is needed to build resilience and reduce greenhouse gas emissions through mitigation and adaptation measures, including infrastructure improvements (road networks and sanitation), disaster preparedness, and community-based approaches.

6.2.3. Community Life

Several recommendations can be made to improve the social fabric in the project locations.

In Kenya, to address the issue of lack of trust in local authorities, promoting transparency and accountability in governance is essential. Community participation in decision-making processes can also help build trust and promote ownership of projects, leading to increased participation in community organizations. Encouraging participation in clubs or social groupings can also help build social cohesion and increase the sense of belonging in the community. Recognizing and celebrating the culture of the communities, as well as supporting their religious affiliations and promoting community activities and life events, can further strengthen the social fabric and increase the sense of pride and belonging among community members.

In Madagascar, women empowerment and sensitization programs are necessary to promote the acceptance of innovative ideas and changes. The government needs to promote universal education through policies, campaigns, and partnerships with stakeholders in the sector. The low levels of education are a major challenge that needs to be addressed to improve the social fabric.

In Sierra Leone, promoting community participation can be achieved through the establishment of local organizations and clubs. These organizations can provide a platform for members of the community to interact and collaborate on issues that are important to them. Efforts can also be made to strengthen trust in local authorities by holding community meetings, establishing community outreach programs, and actively involving community members in decision-making processes. Religious and traditional leaders were identified as entry points in the communities; therefore, involving them in community programs and initiatives can help to build trust and promote community participation. Increased public awareness and education campaigns are needed to raise awareness about sanitation, mental health, and child labour and reduce the stigma associated with seeking help.

Governments, health organizations, and community leaders should work together to develop and implement public education campaigns to improve access to basic amenities such as water, sanitation, and energy. The government should create a business-enabling environment to promote research and adoption of best practices for waste management, sanitation and RE programs.

Improving the social fabric of these communities requires addressing inequalities, improving access to basic amenities, promoting economic development, addressing infrastructure challenges, and building trust through community participation, transparency, and accountability. The recommendations below can help to achieve these objectives and promote a sense of belonging, pride, and cohesion within these communities.

6.2.4. Support and Acceptance of Innovative Technologies and Services

As the results obtained on the support and acceptance of innovative technologies and services in Kenya, Madagascar, and Sierra Leone, it is recommended that efforts be made to increase awareness and accessibility of RETs and services to all income levels. Special attention should be given to women to encourage their participation in RE projects. The government and other stakeholders should support RE projects and provide incentives to encourage more individuals and organizations to invest in the RE production sector.

In Madagascar, the government in collaboration with other stakeholders should explore more RE projects and encourage the participation of females in RE projects. Educational programs and campaigns should be developed in Sierra Leone to increase awareness and knowledge about RETs and services, with a particular focus on males who seem less likely to play an active role in supporting RE projects. Policymakers could consider developing policies and incentives to encourage the adoption of RETs and services, particularly for low-income HHs in these communities. These recommendations highlight the potential of RE to address energy challenges in these communities and the need for continued efforts to promote and support the adoption of RETs and services.

6.2.5. Perceived Risks and Benefits

Based on the findings of research conducted in Kenya, Madagascar, and Sierra Leone, the uptake of RETs can provide significant benefits, including environmental, social, and economic advantages. However, there are challenges that must be addressed to ensure that marginalized communities have access to these technologies. To promote the uptake of RET, all stakeholders must prioritize community projects implemented in collaboration with community members to ensure that solutions meet specific needs and challenges faced by the community. Policymakers should prioritize RE solutions to promote sustainable development and reduce dependence on fossil fuels.

In Kenya, policymakers and energy developers should prioritize transparency and fairness in the development and implementation of RE projects to address community concerns. Efforts should be made to build trust and improve communication between the community and local authorities, including more education and awareness campaigns on the benefits of RE. Subsidies or incentives should also be provided to low-income HHs to help them afford the initial costs of RE adoption. Addressing the needs of disadvantaged groups is also crucial to ensure that the benefits of RE are accessible to everyone.

In Madagascar, policymakers should create awareness and educate the community about the potential environmental, social, and economic benefits of RE technologies, despite the potential risks associated with RE production plants. Policymakers should create an enabling environment for the uptake of RE technologies and address any potential concerns or risks associated with their implementation. It is also crucial to engage with diesel mafias and other stakeholders to encourage them to shift towards RE and reduce their resistance to change.

In Sierra Leone, increasing community engagement and transparency in the planning and implementation of RE projects is necessary to address concerns about grid connection and fairness issues. Governments and organizations can provide support for the initial costs of RE projects through subsidies, grants, or low-interest loans. Improving communication and transparency and ensuring that the community's interests are represented in decision-making processes is crucial to addressing trust issues. Policymakers should also ensure that women are actively involved in RE projects and that their interests are represented both legally and in implementation frameworks to promote women's empowerment.

6.2.6. Specific Energy Needs and Technical Solutions

The success of any project depends significantly to an extent on the input of the stakeholders and the beneficiaries towards the daily operations and undertakings of its activities. The inputs may include the involvement of the stakeholders and beneficiaries throughout the project cycle, financial support from the donor, skilled personnel to undertake the agreed projects, information dissemination about the importance of the programme to the beneficiaries, and the interplay between these key players (Friedman & Miles, 2006).

There must be a total commitment toward the success of these programmes at all levels. These recommendations can be implemented through collaboration between governments, organizations, and communities. Governments can provide financial support for RE projects and ensure that the community's interests are represented. Organizations can work with communities to increase engagement and transparency and provide support for initial costs. Finally, and most importantly, communities should participate in decision-making processes and advocate for their interests. Overall, the key to the successful implementation of RE projects is collaboration and engagement between all stakeholders.

6.2.6.1. Kenya

The research highlights that while many boda-boda riders in Kenya are aware of electric motorcycles, a low percentage have used them. Education through targeted advertising, public campaigns, and demonstrations is recommended to help people understand the benefits and drawbacks of e-bikes. To address concerns about charging duration, fast-charging infrastructure and efficient battery-swapping services can be provided. Subsidies or incentives can be offered to reduce the cost of purchasing an electric motorcycle, and manufacturers can develop more powerful e-bikes to accommodate diversified needs. Affordable financing options can be made available to riders, and policies can be implemented to encourage the adoption of electric motorcycles. Further research is recommended to explore the feasibility of incentives for riders to switch to e-bikes, tax rebates or subsidies, and their potential impact on uptake.

6.2.6.2. Madagascar

There is a need to improve access to cooling and freezing services and agricultural machines, and that cost is a significant factor when people are making decisions on their choice of service providers and locations for access to stationary agricultural machines. The findings can be used by policymakers and service providers to design and implement appropriate interventions to address these needs and challenges. It is recommended that organizations and stakeholders should consider cost-effective solutions for providing access to clean water and agricultural machines. They should also consider providing cooling and freezing services as there is a demand for them. However, the cost of these services should be reasonable, and the services should be accessible to the population in the neighbourhoods. Overall, there is a need for a sustainable approach to addressing the energy needs of this population, considering their preferences and limitations. These findings could be useful to policymakers and service providers to design and implement appropriate interventions to address these needs and challenges.

6.2.6.3. Sierra Leone

Based on the findings, it is recommended that Freetown needs to invest in proper waste management structures and facilities that would provide adequate disposal and recycling of waste. Government should invest in infrastructure, urban planning, and resources to support waste management and promote a clean and sustainable environment. This could involve partnering with private waste management companies to provide comprehensive waste management services to the community. Furthermore, policy development, regulations and enforcement structures should be put in place to regulate single-use plastics, encourage waste segregation, and promote recycling. Educational campaigns could also be undertaken to sensitize the community on the importance of proper waste disposal methods, and environmental conservation and incentivize behaviour change. Finally, the study recommends that waste recycling initiatives should be established in neighbourhoods to promote waste reduction, reuse, and recycling.

6.2.7. Gender and Energy

To promote women's participation in RE-related projects in Kenya, it is important to address the barriers identified in the study, such as inadequate information and the unavailability of RE projects. The respondents called for awareness creation, deliberate inclusion of more women in projects, RE campaigns, equitable distribution of resources by the government, and financial support from organizations. Engaging in RE business activities was seen as a factor that could potentially promote women's decision-making power, access to education and financial resources, and safety. To challenge traditional gender roles, it is crucial to promote gender equality in HHs, especially in decision-making around energy use. Although the study found that HHs with no gender-specific roles have higher education levels, it is necessary to increase women's participation in RE projects by providing training and education and promoting civic education.

The study in Madagascar highlights the importance of challenging traditional gender roles and promoting gender equality in HHs, especially in decision-making around energy use. The findings showed that women are more likely than men to be responsible for making choices around energy use in the HH, while men are more likely to make energy-use choices. To promote women's participation in RE projects in Madagascar, it is important to provide training and civic education to increase their participation. The study also found that engaging in RE projects can promote women's self-worth, decision-making power, and improve their living standards. By addressing traditional gender roles and promoting gender equality, women can benefit from improved access to resources, enhanced decision-making power, and better living standards while reducing gender-based and domestic violence.

To promote women's participation in RE projects in Sierra Leone, it is important to address the barriers identified in the study, such as the lack of education on RE, limited access to financial resources, unaffordable energy installation costs, cultural and social norms, and stereotypes. Female empowerment, access to finance, and awareness creation on RE were suggested by most of the respondents. The study also found that men were more likely than women to make energy-related decisions in their HHs. To challenge traditional gender roles, it is crucial to promote gender equality in HHs, especially in decision-making around energy use. The study highlights the need for greater awareness and education on RE for the whole community, as well as the importance of empowering women to participate fully in RE projects. By doing so, women can benefit from improved access to resources, enhanced decision-making power, and better living standards while promoting safety and reducing gender-based and domestic violence.

6.3. Methodological Recommendations

In collaboration with local partners, the implementation of the study yielded key lessons regarding the methodology of carrying the study out, including:

1. Future studies should consider including offline Key Informant Interviews (KIIs) to address challenges with stable internet connectivity, using video recordings and written responses.
2. Lessons learned from interactions with high-level RE practitioners should be leveraged, given that most private practitioners and few public officials lack awareness of policies supporting the involvement of RETs.
3. To support the local contexts, the ENERGICA project team could provide technical support to help community intermediaries disseminate information on RET policies to the broader population in the demonstration context, indirectly increasing the number of last-mile key informants and post-evaluation activities.
4. As language is a critical tool for communication, it is important to incorporate local interpreters whenever required to better implement the bottom-up approach and community involvement and engagement best practices.
5. Future studies should consult with local partners to map out public events and local disruptions to ensure proper realignment of activities.
6. In future, a wider pool of Key Informants should be targeted to manage drop-offs while still maintaining quality and covering all target groups, as some KI may be hesitant to share their knowledge and resources without compensation.

6.4. Significance of the Study

The conducted socio-economic baseline survey has yielded valuable insights and recommendations for the deployment of innovative integrated RE solutions in three distinct regions: the urban area of Nairobi, Kenya, the rural area of the Diana Region in Madagascar, and the peri-urban area of Freetown in Sierra Leone. This study is crucial in providing an in-depth understanding of the socio-economic structures within the communities, markets, and ecosystems of the regions, as well as the specific RET and service needs, concerns, and challenges faced by these regions. These findings and recommendations are a significant contribution to the knowledge of the three countries' contexts, informing the development of sustainable RE solutions. The report will also aid the implementation of most activities of the project in other work packages.

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VIII. APPENDICES

Baseline Assessment Survey Questionnaire

Dear participant,

As part of the ENERGICA project we developed the following questionnaire to assess the opinion of people in different communities towards renewable energies and their possible inclusion in developing models to apply those in their communities.
The survey is anonymous and will take a maximum of 25 minutes to complete.

About our project
ENERGICA is funded by the European Union's Horizon 2020 program and aims at smart energy solutions to decarbonize the energy systems and provide access to energy. We are particularly interested in involving citizens in the process.

About your participation
Your participation in answering this questionnaire is fully voluntary and all data collected will be treated confidentially. The insights and outputs resulting from this work will only include collated data, without the possibility for anyone to identify your individual answers. It is not required that you provide any information that could identify you personally (e.g. your name).
By participating in this survey:

- You confirm that you are at least 18 years old, have read and understood this consent form
- You agree to participate in this research study and are happy for your anonymized answers to be included in our analysis and subsequent research publications.

Would it be possible that we contact you at a later stage of this work again to inform you about developments and consider you in a post-evaluation? It will also take no longer than this first assessment and will be absolutely voluntary.

Yes	
No	

Contact information if applicable:

Code (e.g.: SA10H)

Name of Country you live in (will be included in the code e.g. S for Sierra Leone): …………

The last letter of your mother's first name	The month of your birth	The last letter of your father's first name
e.g. A (for Maria)	e.g. 10 (if born in October)	e.g. H(for Joseph)

Name of village / town you live in (*to be specified for each context*): ………………………..

Section 1: Background information

1. What is your gender?

Female	
Male	
Other	

2. What is your age?*(continuous variable)*____

3. What is your marital status?

Single	
Married (Living together)	
Separated	
Divorced	
Widowed	

4. What is your highest level of education?

No formal education	
Primary (1-5 years of school)	
Intermediate (6-8 years of school)	
Secondary (9-12 years of school)	
Tertiary (University)	
Vocational training	
I prefer not to answer	

5. How would you describe the context where you live?

Rural (thinly populated area)	
Intermediate density area	
Urban (densely populated area)	

6. What is your occupation?

Employed	
Self-employed	
Unemployed	
Student	
Retired	
Houseman/-wife	

7. How much money (Ar. Ksh. Le.) does your household earn per month?.............

8. How many adult people (over 14 years old) live in your household and what is their gender?

Male	
Female	
Other	
Total	

9. How many children (below 14 years old) live in your household and what is their gender?

Male	
Female	
Other	
Total	

Section 2: Energy access

10. Do you have energy in your home?

Yes	
No	

11. Who is your energy provider *(to be specified for each context)* ……………

Sierra Leone	
Electricity Distribution and Supply Authority (EDSA)/National Grid	
Solar Home Systems (SAS)	
Diesel generator	
Other…………….	
Madagascar	
Jiro sy rano Malagasy (JIRAMA)	
Solar Home Systems (SAS)	
Biomass plant	
Wind power plant	
Small hydropower-plant	
Diesel-run electrification scheme	
Other……………………….	
Kenya	
Kenya Power and Lighting Company	
Individual Solar systems	
Diesel/Petrol run Generators	
Other ……………….	

12. Is the energy reliable?

Yes	
No	

13. How many hours per day on average do you have energy access in your household?

0 hrs	
1-4 hrs	
5-8 hrs	
9-12 hrs	
12-16 hrs	
17-24 hrs	

14. What type of energy do you use for the following activities?

Activities	**Energy sources:** 1. Firewood 2. Candles 3. Charcoal 4. Gas 5. Animal 6. Petrol 7. Diesel 8. Batteries 9. Kerosene 10. Solar 11. Electricity 12. Biogas 13. Hydro
Cooking	
Lighting	
Heating	
Transport	
Drinking water pump	
Agriculture	
Communication (Phone, Radio, TV, etc.)	

15. How satisfied are you with the energy sources you are using?

Very unsatisfied		Unsatisfied		Neutral		Satisfied		Very satisfied	

16. What is your monthly expenditure on Energy? (Ar. Ksh. Le.)

Source	Expenditure (Ar. Ksh. Le.)
Firewood	
Candles	
Charcoal	
Petroleum gas	
Animal	
Petrol	
Diesel	
Kerosene	
Batteries	
Solar	
Bio gas	
Electricity - Pay As You Go	
Electricity - Bill	

17. Who in the household is responsible for collecting firewood?

Mother	
Father	
Daughters	
Sons	
Children	
Other ………	
Not applicable	

18. How many days per month do you go to collect firewood? ……………..

19. How many hours per month are spent on collecting firewood?

Less than 10 hours	
10 - 20 hours	
More than 20 hours	

Section 3: Awareness of energy and environment

20. Do you know what climate change is? (*if not sure/no: the long-term shifts in temperatures and weather patterns that have adverse effects on livelihood)*

Yes	
No	
Not sure	

21. If 20 was answered with yes: Do you think climate change will affect you in the future?

Very unlikely		Unlikely		Neutral		Likely		Very likely	

22. If 20 was answered with yes: In which way would climate change affect you?

Food shortage	
Water shortage	
Increased cost of fuel/energy	
Extreme weather events (floods, heatwaves, droughts, etc.)	
Increased water and vector borne diseases	

Increased mental health issues	
Financial strain	
Rising death cases (animals and human beings)	
Other ……………………….	

23. Have you ever heard of renewable energies?
(if not sure/no: clean energy that comes from natural sources or processes that are constantly replenished e.g. sun light, wind, waves, biomas, geothermal heat etc.)

Yes	
No	
Not sure	

24. If 23 was answered with yes: If you had to describe their characteristics in one sentence, what would you say?

25. If 23 was answered with yes: which ones do you know?

Biomass	
Biofuels	
Solar	
Green hydrogen	
Geothermal	
Hydroelectric	
Wind	
I do not know	

26. If 23 was answered with yes: Do you think that there should be more renewable energies in your country?

Absolutely no		No		Neutral		Yes		Absolutely yes	

Section 4: Community life

27. Do you feel you are a recognized part of your neighbourhood?

Absolutely no		No		Neutral		Yes		Absolutely yes	

28. Do you trust the people in your neighbourhood?

Absolutely no		No		Neutral		Yes		Absolutely yes	

29. Do you trust the local authorities of your neighbourhood?

Absolutely no		No		Neutral		Yes		Absolutely yes	

30. Are you proud to be part of your neighbourhood?

Absolutely no		No		Neutral		Yes		Absolutely yes	

31. Would you ask your neighbours for help?

Absolutely no		No		Neutral		Yes		Absolutely yes	

32. Would you adopt renewable energies if you realised the majority of your neighbours are doing so?

Absolutely no		No		Neutral		Yes		Absolutely yes	

33. Are you a member of any club, association or organisation in your neighbourhood?

Yes	
No	

If yes, name: ————————————————————-

Section 5: Support and acceptance of innovative technologies and services

34. Are you happy with the current energy system?

Yes	
No	

35. If not, why: ———————————————————————————————————

36. Would you support having a renewable energy production plant on your property?

Absolutely no		No		Neutral		Yes		Absolutely yes	

37. Would you support having a Renewable Energy Production Plant in your neighbourhood?

Absolutely no		No		Neutral		Yes		Absolutely yes	

38. Would you support a project in your community for more renewable energy?

Very unlikely		Unlikely		Neutral		Likely		Very likely	

39. Would you play an active role in a community renewable energy project in your community?

Very unlikely		Unlikely		Neutral		Likely		Very likely	

40. Would you pay some extra cost to obtain renewable energy?

Very unlikely		Unlikely		Neutral		Likely		Very likely	

41. Would you pay some extra cost for renewable energy, if others in the community with less income would benefit from that?

Very unlikely		Unlikely		Neutral		Likely		Very likely	

Section 6: Perceived risks and benefits

42. Imagine that a Renewable Energy Production Plant was going to be built in your neighbourhood for collective consumption of your local community. Do you feel there are any risks in this?

Yes	
No	

43. If 42 was answered with yes: What risks would you expect?

Worse grid connection	
Transparency and fairness issues	
Hidden or unknown costs	
Safety issues	
Other…………………………..	

44. What benefits would you see in a Renewable Energy Production Plant being built in your neighbourhood? (that means: switching to a renewable energy only collective local production model)

Environmental benefits (e.g. lower emissions)	

A better grid connection	
More reliable power	
Social benefits (e.g. increased local employment, more community engagement, more qualified "green jobs")	
Economic benefits (e.g. lower energy costs, potential income)	
Pumped water, productive use activities (welding, milling e.t.c.)	
Other ……………………………………………………….	

Section 7: Economic aspects (2 questions)

45. Do you think that using renewable energy technology can reduce the energy costs in the future?

Completely Disagree		Disagree		Neutral		Agree		Completely Agree	

46. Do you think a renewable energy production plant in your community will help create more employment opportunities for your community?

Completely Disagree		Disagree		Neutral		Agree		Completely Agree	

47. Do you think renewable energy technologies would have more economic impact on different groups of the community: (men v/s women, physically abled people v/s people with disability, low income people v/s wealthy people, different ethnicities, literate v/s semi/illiterate people, people in powerful political positions v/s people not in powerful political positions)?

Yes	
No	

48. If yes to 47. Which groups?

Men v/s Women	
Physically abled people v/s People with disability,	
Low income earners v/s The wealthy	
Different ethnicities	
Literate v/s Semi/illiterate people	
People in powerful political positions v/s People not in powerful political positions	

Section 8: Context Specific

a. Water Food Nexus *(Madagascar)*

49. Do you have access to clean water?

Yes	
No	

50. If 49 was answered with yes. How far is your access to clean water?

At home	
In the neighbourhood (Less than 100 Meters)	
In the village (Less than 1 KM)	
Further away (More than 1 KM)	
Other ……………………………………………………….	

51. If 49 was answered with yes. Where do you get your clean water from?

Municipal water (Private connections)	
Well	
Fountain	
River	

Other …………………………………………………….	

52. If 49 was answered with yes. For what purpose do you use clean water?

Drinking	
Cooking	
Washing dishes	
Washing Clothes	
Home cleaning	
Showering	
Brushing teeth	
Flushing toilets	
Irrigation garden	
Irrigating crops	
Other …………………………………………………….	

53. If 49 was answered with yes. What is your household cost for water per month (Ar.)? ……………………….

54. If 49 was answered with no. Would you pay to have access to clean water in your neighbourhood?

Absolutely no		No		Neutral		Yes		Absolutely yes	

55. If 49 was answered with no. Would you pay to have access to clean water in your household?

Absolutely no		No		Neutral		Yes		Absolutely yes	

56. If 49 was answered with no. For what purpose would you use the clean water?

Drinking	
Cooking	
Washing dishes	
Washing Clothes	
Home cleaning	
Showering	
Brushing teeth	
Flushing toilets	
Irrigation garden	
Irrigating crops	
Other ………………………………………	

57. If 49 was answered with no. What is the maximum amount (Ar.) per month, you would be willing to pay to have access to clean water? …………….

58. Do you have access to cooling or freezing services for food and beverages?

Yes	
No	

59. If 58 was answered with yes. How far is your access to cooling and freezing services for food and beverage?

At home	
In the neighbourhood (Less than 100 Meters)	
In the village (Less than 1 KM)	
Further away (More than 1 KM)	

Other …………………………………………………………..	

60. If 58 was answered with yes. Where do you get your cooling and freezing services for food and beverage?

Personal petrol or gas fridge	
Personal electric fridge	
Ice blocks	
Local shops with refrigerator or freezer	
Other ……………………………………..	

61. If 58 was answered with yes. For what purpose do you use cooling or freezing?

Make ice blocks	
Make ice creams	
Cool alcoholic beverages	
Cool other beverages	
Conserve meat	
Conserve fish	
Conserve fruits & vegetables	
Conserve other foods	
Conserve medicine	
Other ……………………………………..	

62. If 58 was answered with yes. How much per month do you spend on cooling or freezing (AR.)?

63. If 58 was answered with no. Would you pay to have access to cooling or freezing in your neighbourhood?

Absolutely no		No		Neutral		Yes		Absolutely yes	

64. If 58 was answered with no. Would you pay to have access to cooling or freezing in your household?

Absolutely no		No		Neutral		Yes		Absolutely yes	

65. If 58 was answered with no. For what purpose would you use cooling or freezing?

Make ice blocks	
Make ice creams	
Cool alcoholic beverages	
Cool other beverages	
Conserve meat	
Conserve fish	
Conserve fruits & vegetables	
Conserve other foods	
Conserve medicine	
Other ……………………………………..	

66. If 58 was answered with no. What is the maximum amount (Ar.) per month, you would be willing to pay to have access to cooling and freezing services ……………..

67. Do you have access to stationary agricultural machines (like mills, rice huskers, shredders, etc)?

Yes	
No	

68. If 67 was answered with yes. How far is your access to stationary agricultural machines?

At home	
In the neighbourhood (Less than 100 Meters)	
In the village (Less than 1 KM)	
Further away (More than 1 KM)	
Other ……………………………………………………….	

69. If 67 was answered with yes. Where do you get the stationary agricultural machines from?

Personal petrol or diesel machine	
Personal electric machine	
Local entrepreneur with a machine	
Other ……………………………………………………….	

70. 67 was answered with yes. For what purpose do you use stationary agricultural machines?

Husking rice	
Polishing rice	
Milling rice	
Milling other	
Grinding	
Other ……………………………………………………….	

71. If 67 was answered with yes. How much per month do you spend on the use of agricultural machines (AR.)? ……………………………….

72. If 67 was answered with no. Would you pay to have access to a stationary agricultural machine in the neighbourhood?

Absolutely no		No		Neutral		Yes		Absolutely yes	

73. If 67 was answered with no. Would you pay to have access to a stationary agricultural machine in your household?

Absolutely no		No		Neutral		Yes		Absolutely yes	

74. If 67 was answered with no. For what purpose would you use stationary agricultural machines?

Husking rice	
Polishing rice	
Milling rice	
Milling other	
Grinding	
Other ……………………………………………………….	

75. If 67 was answered with no. What is the maximum amount of money (Ar.) per month you would be willing to pay to have access to a stationary agricultural machine? …………….

b. Transport *(Kenya)*

b.1. Riders

76. How many Kilometres on average do you cover per day ………….

77. How much money (Ksh.) does it cost you to fuel your motorcycle per day? ………

78. How much money (net Ksh.) do you make per day from your motorcycle business?.....

79. Do you know of electric motorcycles (If No. Electric motorcycles are motorcycles that do not use fuel but have batteries which are charged using electricity)?

Yes	
No	

80. If 79 was answered with yes. Have you used them before?

Yes	
No	

81. If 79 was answered with yes. How do you compare an ordinary motorcycle to an electric motorcycle? ……………………………………………………………………

82. What would make you switch to an electric motorcycle?

Cut down on cost of fuel	
Charging frequency	
Accessible and reliable charging stations	
Increased daily net income	
Training on the use and maintenance of the cycle	
Maintenance cost	
Purchasing cost	
Other …………………………..	

83. What would be your main concerns/fears on switching to electric motorcycles

Purchase cost	
Maintenance and repairs cost	
Charging duration	
Riding range	
Speed	
Customer preference	
Resale value	
Other …………………………..	

84. How can those fears be addressed?...
………………………………………………………………………………..

b. 2. Passenger

85. Have you ever used or been ridden on an electric motorcycle?

Yes	
No	

86. Given a chance, which would you prefer?

Electric Motorcycle	
Ordinary Motorcycle	
Both	

87. What are the reasons for your choice?...

c: Waste and chemicals *(Sierra Leone)*

88. Where / How do you dispose off your waste?..

89. Would you pay to have your household waste collected and disposed off correctly and for recycling?

Absolutely no		No		Neutral		Yes		Absolutely yes	

90. Would you support having a waste recycling plant in your neighbourhood?

Absolutely no		No		Neutral		Yes		Absolutely yes	

91. Would you use fertiliser from recycled waste if it were cheaper than the fertiliser you currently use?

Absolutely no		No		Neutral		Yes		Absolutely yes	

Section 9: Gender and energy (2 questions)

92. What do you think when you hear of the word gender (if not sure/no: gender is the socio-cultural phenomenon of the division of people into various categories such us male and female, with each having associated clothing, roles and stereotypes)………

93. Are there different roles for men and women in your household?

Yes	
No	

94. Which roles are played or taken up by women in your household?…………………
………………………………………………………………………………………..

95. Who in your household is responsible for making choices around energy use *(cooking, lighting, heating, transport e.t.c)*?

Woman	
Man	
Both	
Other ………	

96. Do women in your household participate in renewable energy related projects?

Yes	
No	
Maybe	
I don't know	

97. If 96 was answered with no/maybe; Why?

They lack/have inadequate education on renewable energy	
Unavailability of renewable energy sources/projects	
They have limited access to financial resources	
They can not afford the high installation cost of renewable energy	
They are prevented by the cultural and social norms in decision making (e.g. gender roles)/role of men in decision making around energy choices	
Stereotypes on gender roles (asset ownership, purchase and maintenance)	
Such projects do not involve both genders (men/women)	
Other …………………………..	

98. What would you suggest as the possible solutions to the challenges you have highlighted above?

99. To what extent can renewable energy services promote the following;

i). A woman's sense of self-worth and her decision-making power?

More time to spend on income generating activities	
Savings from the cheaper energy option can be invested	
Improved health and less death rates	
Reduced physical time consuming hard labour	
Time for leisure activities	
Improved access to communication and awareness	
Other …………………………..	

ii). A woman's access to opportunities and resources, same as a man's?

Affordable transport allowing for social, economic and political opportunities	
Increased access to financial resources	
Increase variety of entreprises	
Improved medical facilities for maternal care e.g. refrigeration, sterilisation, incubation	
Improved life standards	
Decreased dependence on public utilities and aid	
Improved access to educational opportunities	
Reduced trips to the market and forest to collect kerosene/candles & wood/charcoal	
Other …………………………..	

iii). Safety for a woman?

Making streets safer for women to participate in evening activities	
Reduced stress, gender based violence and violence against children	
Less competition for resources hence fewer conflicts	
Reduced crimes e.g. robbery and burglary cases	
Social cohesion	
Other …………………………..	

100. Are the women in your household willing to learn about renewable energy and participate in renewable energy projects?

Yes	
No	
Not sure	

101. Are you willing to learn about renewable energy and participate in renewable energy projects?

Yes	
No	
Not sure	

Section 10: Final Comments:

102. Are there any other comments you would like to make?

Key Informant Interview Guide

(This guide had comparable topics to those in general population survey but involved detailed discussions with representation from government ministries, parastatals, research institutes, small-scale renewable energy companies, community-based organisations, and civil society organisations).

At least 15 respondents per context

- 4 government representatives (in the renewable energy section - e.g. Ministry)
- 2 Parastatals representatives (implementing renewable energy-related projects)
- 2 Research Institutes (conducting/have conducted research on renewable energy)
- 4 representatives from small scale renewable energy companies
- 3 representatives from CBOs implementing community renewable energy projects/solutions

Dear participant,

Thank you for agreeing to participate in this interview as part of the Key Informants for the project's baseline assessment, which seeks to assess the opinion of key stakeholders in the field of renewable energies and their possible inclusion in the development of renewable energy models that can be applied in their communities. The interview will be virtual, last up to a maximum of **1 hour,** and will be audio and video-recorded for the purpose of data analysis and report writing. The recordings will not be shared and safely stored ensuring the protection of (personal) data.

About ENERGICA project

ENERGICA is funded by the European Union's Horizon 2020 program and aims at smart energy solutions to decarbonize the energy systems and provide access to energy. We are particularly interested in involving citizens and end users in the process. The project will be implemented in Africa in three countries' contexts; Kenya (East Africa) Sierra Leone (West Africa) and Madagascar (Southern Africa).

ENERGICA seeks to develop nano grid solutions to support Madagascar's 2015 energy policy which targets accelerated electrification rate through renewable energy to 70% by 2030. The solution will help tackle both infrastructure cost and energy access rate through the Water, Energy and Food nexus system. The project demonstrator will be implemented in three rural districts of the Diana region in Northern Madagascar (Ambanja, Ambilobe and Diego II districts).

Access to energy and fertiliser for efficient local food production is a global sustainability challenge, but more so in Sub-Saharan Africa. The ENERGICA's Water, Energy & Food nexus demonstrator for Sierra Leone will be in the peri-urban setup of Freetown. This will be aligned with the local policies to tackle the risks and vulnerability of poor waste management systems and will be implemented successively.

Kenya's 73% of energy is derived from renewable energy sources (Hydro, Wind, Solar, Biomass & Geothermal) but still faces challenges with energy access, transport, pollution and congestion as a result of an inefficient transportation system and old vehicle fleets. As such, the country is uniquely positioned to support ENERGICAa's e-mobility project through use of electric motorcycles. The demonstrators will first be in Nairobi and replication in Kisumu and Homabay counties.

About your participation

Your participation in this interview is fully voluntary and all data collected will be treated confidentially. The insights and outputs resulting from this work will only include collated data, without the possibility for anyone to identify your individual answers. The report from this interview will feed into publicly available and/or confidential reports. All data will be anonymised but may include direct quotes.

By participating in this interview you confirm that:

- You are at least 18 years old, have read and understood this consent form.
- You agree to participate in this research study and are happy for your anonymized answers to be included in our analysis and subsequent research publications.
- You were provided with a copy of this information sheet and consent form, and you read the information and agreed to be interviewed.
- You understand the interview will be recorded and that anonymous quotes from you may be used in the ENERGICA project and reports.
- You are willing to be contacted at a later stage of this project to be informed about the developments and possibly considered in post-evaluation.
- Your consent to this interview will be recorded.
  Do you consent to this interview

Date …day/month/year……

Section 1: Background information

1. What is your current position? …………………………………..
2. What is your current place of work/the institution you represent?

Section 2: Awareness of energy and environment

3. What are some of the effects of climate change that you are already experiencing in your community (insert context)?
4. What possible solutions do you suggest to these effects of climate change you are already experiencing?
5. What would make your community make a choice in favour of renewable sources of energy?

Section 3: Community/Social life

6. Describe five most specific aspects of this community
7. Name five things that people in your community like?
8. Describe 5 most challenging things in your community?
9. How do people in your community engage with each other?
10. What is their motivation?
11. Do people in your community feel laws, regulations, and policies support renewable energy?

Section 4: Economic aspects

12. Do you think renewable energy technologies would have more economic impact on different groups of the community: e.g. *men v/s women, physically abled people v/s people with disability, low-income people v/s wealthy people, different ethnicities, literate v/s semi/illiterate people, people in powerful political positions v/s people not in powerful political positions*?
13. Explain your response to question 12. If yes, which groups and how? If no, why?

Section 5: Context-Specific

Madagascar (Water & Food Nexus - Nano grids)

14. What is the food production situation with relation to renewable energy in the Diana region ?

15. What renewable energy services are currently in use for the production of food in the communities of Diana Region? *E.g. rice, cocoa, sugarcane, shrimps, and other farming activities e.t.c-*
16. What would be the ideal renewable energy use to the farming communities of Diana region?

Kenya (Transport) - Briefly introduce the electric mobility concept to the respondent

17. What is the transportation situation with relation to renewable energy in Nairobi?
18. What would be the main risks/concerns/fears of switching to electric motorcycles to the communities of Nairobi?
19. How can those fears be addressed?

Sierra Leone (Waste & Chemicals)

20. What is the waste management situation in Freetown?

21. Are you concerned that unmanaged waste can have a negative impact on the communities of Freetown?

22. What would you suggest as the possible use of recycled waste products in the communities of Freetown?

Section 6: Gender & Energy

23. What is the current gender representation/ratio in the renewable energy sector in your organisation? What factors are causing this?

24. What is the current gender representation/ratio in the renewable energy sector in your community (Insert context)? What factors are causing this?

25. What is your organisation currently doing to address the challenges, if any, (insert context)

26. Which energy practices, if implemented in your community, will promote women empowerment and reduce gender inequalities? *(examples of energy practices: Inclusive social energy policies, (Companies/Institutions) Strategies including all genders/Gender-responsive implementation strategies, Gender-sensitive enquiry and complaint mechanisms, Civic education, Participatory project implementation/mobilising all genders to participate in RE projects)*

Section 7: Final comments

27. Are there any other comments you would like to make?

Thank you!

Age Range

Age Group	Range
20 - 30	1
31 - 40	2
41 - 50	3
51 - 60	4
61 - 70	5
71 - 80	6
81 - 90	7
91 - 100	0

Source: Author 2023