CEANGAL

Report on the CEANGAL Demonstration & Assessment Activities to Support Community Renewable Energy Systems Uptake

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Executive Summary

The CEANGAL project aims to transform the energy landscape of rural Malawi by fostering the adoption of renewable energy systems (RES) through community empowerment and multi-stakeholder collaboration. This initiative addresses the urgent need for sustainable energy solutions, as highlighted by a comprehensive needs assessment involving 150 participants, all of whom expressed a strong interest in accessing electricity and adopting renewable energy systems. A significant majority (81%) favored community-based energy systems due to their perceived lower upfront costs and potential for spurring local economic growth through business opportunities such as maize mills and welding shops, and improved service delivery at hospitals and schools. Key to the project's success is the contact center structures established within the case study sites, which play a crucial role in fostering collaboration, promoting transparency, and empowering local communities. These structures leverage the expertise of village heads, technical middlemen, business owners, and community representatives to ensure that interventions are contextually relevant, socially inclusive, and environmentally sustainable. The project also emphasizes the importance of operationalizing multi-stakeholder partnerships involving government agencies, the private sector, donor organizations, NGOs, civil society, community representatives, and research institutions.

Technical feasibility studies indicate that all the sites such are well-suited for the development of solar powered systems. Additionally, a mini-hydro scheme is feasible for Naluwade whereas Matuwambe has a good wind energy resources that can that be hybrize. These findings underscore the need for detailed site assessments, including feasibility studies, environmental impact assessments, and economic analyses to determine optimal system designs and placements. A combined renewable energy approach, incorporating both wind and solar power, could diversify the energy generation portfolio and maximize renewable energy production. The CEANGAL project's overarching objective is to empower communities by building a skilled workforce, establishing an enabling policy framework, and ensuring the sustainability of RES operations. This will enhance energy access, promote environmental sustainability, and foster inclusive development in rural areas of Malawi. To ensure the financial viability of RE projects, key aspects such as customer engagement, tariff structures, revenue collection, service quality, and environmental sustainability must be meticulously considered.. In summary, the CEANGAL project represents a comprehensive approach to renewable energy adoption in rural Malawi, combining technical feasibility, community engagement, multi-stakeholder collaboration, and financial sustainability to create a model for inclusive and sustainable development.

List of Abbreviations

Abbreviation	Definition
CEANGAL	Community-Based Decentralised Renewable Energy Systems and Supporting Structures for Improving Electricity Access in Low-Income Countries
CONREMA	Cooperation Network for Renewable Energy in Malawi
DRES	Decentralised Renewable Energy Systems
ESCO	Electricity Supplying Company
ESCOM	Electricity Supply Corporation of Malawi
GHI	Global Horizontal Irradiation (GHI)
HOMER	Hybrid Optimization Model of Electric Renewables
LCOE	Levilised cost of energ
LIC	Low-Income Countries
LPG	Liquefied Petroleum Gas
MAREP	Malawi Rural Electrification Program
MERA	Malawi Energy Regulatory Authority
MFI	Micro-Financing Institution
MoE	Ministry of Energy
MUBAS	Malawi University of Business and Applied Sciences
NASA	National Aeronautics and Space Administration
NGOs	Non-Governmental Organisations
PAYG	Pay As You Go
PV	Photovoltaic
RE	Renewable Energy
RES	Renewable Energy Systems
SHS	Solar Home System
SPSS	Statistical Package for Social Sciences
SSA	Sub-Saharan Africa
TNM	Telecom Networks Malawi

List of Figures

List of Tables

CONTENTS

CHAPTER 1: NEEDS ASSESSMENT

1.1 Chapter Background

Dependence on connecting households through grid extension has proven to be slow and expensive in hard-to-reach rural areas in Malawi. Off-grid energy solutions are considered a useful option in addressing such challenges. However, the implementation of renewable energy systems (RES) has faced the challenge of sourcing funds for the maintenance and repair of the systems as households in remote areas usuallty cannot afford to pay the maintenance and operation costs. Additionally, there is a lack of proper coordination as communities do not have a clear ownership of the RES projects. It has also been observed that when the projects are handed over to the communities, there is no proper skills transfer to the local members so that they can perform basic maintenance and repair of the RES. Therefore, mechanisms that can be used to expand electricity access in such regions are needed.

Work package 4 of the CEANGAL project highlights the need to carry out demonstration and validation activities to test the framework developed in the project. The activities were carried out to highlight the actual use of CEANGAL solutions in real operational environments. This includes the concept of energy needs assessment and analysis for decentralized renewable energy systems in remote communities that are not connected to electricity. This revolves around identifying the energy needs, challenges, and opportunities in a community. It aims to develop a clear understanding of the local context and the potential for renewable energy solutions to address energy poverty and environmental sustainability. The demonstration and validation activities were executed to provide feedback directly informing the final operable CEANGAL solutions for future sub-Saharan Africa (SSA) Low-Income Countries' (LIC) community users.

1.2 Objectives of the needs assessment

Using a community stakeholder engagement survey, the assessment of the framework aspects was carried out to achieve the following objectives;

i. Assessing the current energy sources in homes and businesses in three selected communities in Malawi, use patterns and uptake potentials
ii. Identification of potential renewable energy sources to meet energy generation
iii. Evaluating the availability and accessibility of energy sources and infrastructure
iv. Determining the specific energy needs of households and business entities as well as their willingness to pay for renewable energy systems

1.3 Methodology

1.3.1 Study Areas

The surveys were conducted in three districts, selected to cover all the regions of Malawi. The targeted villages involved in the testing activities were;

1. Naluwade in the Mulanje District
2. Matuwamba in the Mchinji District
3. Luviri in the Mzimba District

The demonstration sites were selected with assistance from the Ministry of Energy, Malawi on the basis of a priority list of off-grid "pre-electrification" candidate sites. The candidate sites represent an implementation intention in which off-gird technologies are tested in one village, and if successful, would be scaled up to neighbouring communities. To qualify the village had to be more than 10 km from an existing grid line and active in economic activities such as farming. The other aspect that was considered was the energy resources available in each community. The surveys were carried out in all three regions of Malawi so that the study captured potential cultural, economic, and political regional considerations that might influence technology uptake and use that might exist in the different parts of the country.

Table 1-1: Brief description of the study areas

Site 1	**Site 2**	**Site 3**
Naluwade Village	**Matuwamba Village**	**Luviri Village**
		
Naluwade Village is located in the area of Traditional Authority (TA) Mabuka in Mulanje district, Southern Region, Malawi. The village has a population of 121 households. The village is 5 km from existing grid lines. The key economic activity of the village is tea farming. The site is endowed with rivers with the potential for the construction of a hydro mini-grid	Matuwamba is situated in the Traditional Authority of Mkanda, Mchinji district, Central region of Malawi. The village has 409 Households. The village is 10.7 km from existing grid lines. The community is involved in the farming of maize, tomatoes, and g/nuts. etc. The site has solar and wind resource potential	Luviri is in the area of TA Mudzikuola, Mzimba District, Northern Region. The village has 375 households. The village is 17 km from existing grid lines. The communities are involved in commercial farming among the key economic activities. The site has solar and wind resource potential

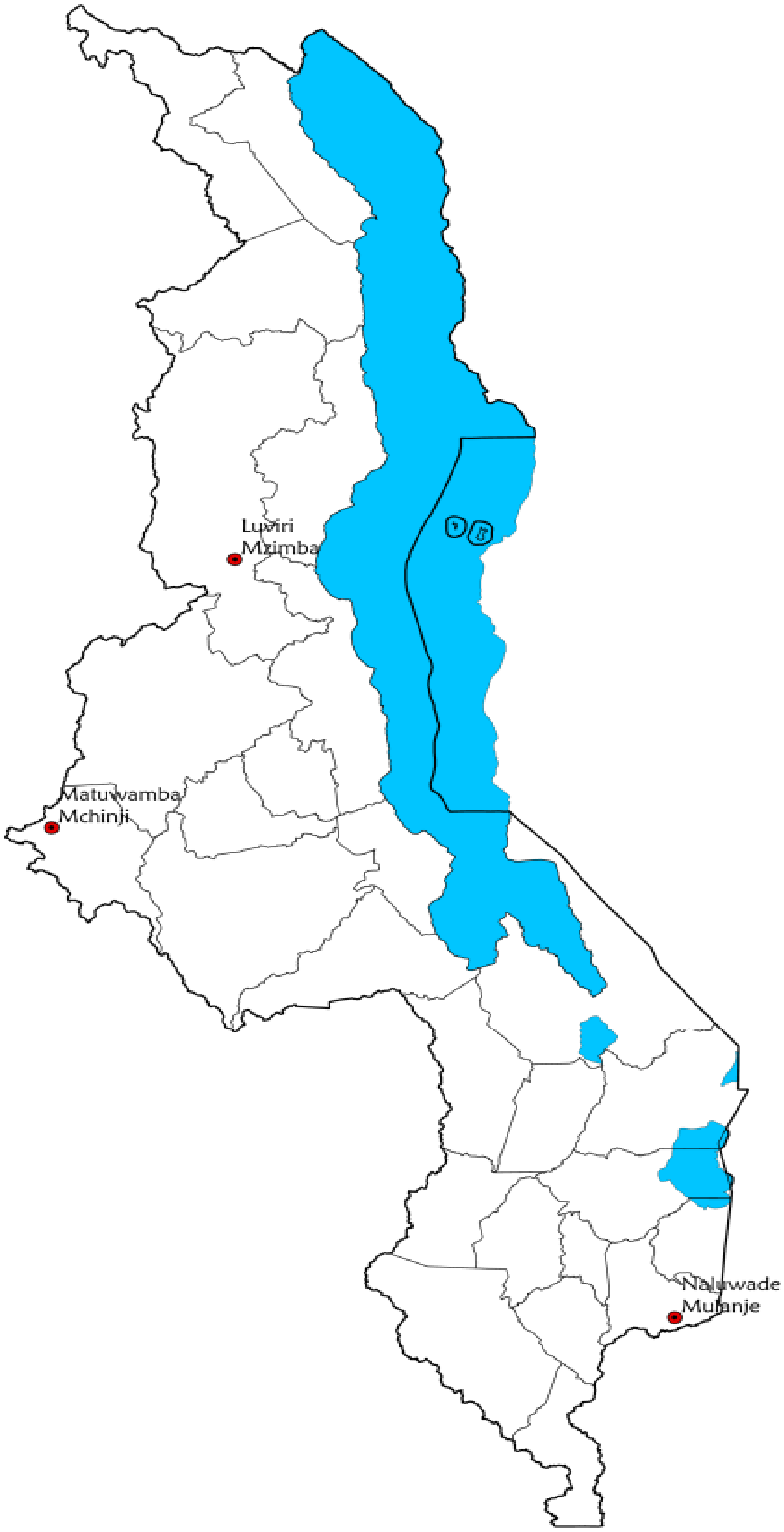

Figure 1-1: A map of Malawi Indicating the sites where energy needs assessments were carried out

1.3.2 Data Collection Methods

Open and closed-ended combination questionnaire was designed to obtain the community's perspective regarding overall energy access, potential requirements, and the ability to purchase and use household and community RES. The survey questionnaire used is attached as Appendix 1 to this report. Mobile data collection platform Kobo Toolbox was utilised, a suite of open-source tools for field data collection that utilises smartphones to collect data which was uploaded to a digital server [3]. The simple random sampling method was used to obtain the households from each of the selected sub-locations [4]. A total of 150 households were surveyed in three sites as presented in Table 1.2

Table 1-2: Sites and number of households surveyed

Site Name	Households Surveyed
Naluwade Mulanje	50
Matuwamba, Mchinji	50
Luviri, Mzimba	50

Figure 1.2: Testing of the CEANGAL framework in Luviri, Mzimba District

1.3.3 Data Analysis

Data collected were first pre-processed where the questionnaires were examined and cleaned to clear errors such as typo mistakes and missing data. Thereafter, the response questions were numerically coded and responses were stored in an Excel file (downloaded from Kobo Toolbox server) and Kobo Toolbox server. The qualitative data collected using the open-ended questionnaire and interview guide was taken in the form of notes and used to complement the quantitative data thematically. The descriptive analysis of the data was performed using SPSS Microsoft Excel. Google Earth and ArcGIS Pro were used for mapping the study sites.

1.3.4 Ethical Considerations

A researcher must embrace the respect, confidentiality, and sensitivities of their research participants and also the integrity of the institutions within which the research occurs and its research policy. As the local custodians, prior to the commencement of the study, permission was also obtained from the traditional leaders in the study areas. Additionally, consent was expressly sought from the study respondents before the survey. The participants' rights and privacy have been addressed as indicated in the preamble of the research questionnaires to guarantee the participants' confidentiality and keep all responses anonymous throughout the study and thereafter.

1.4 Findings and Discussion

1.4.1 Respondents' Demographic Details

Table 3-1 encapsulates a comprehensive breakdown of the demographic and socioeconomic characteristics of the surveyed population. It delves into gender distribution, revealing a slight majority of females at 52.8%, while males make up 48.2%. Family size is depicted across various categories, with a notable portion consisting of households with three persons (17.8%). The majority of the households, however, have six or more persons (37.8%). An analysis of educational attainment showed primary education being the most prevalent (65.2%), followed by secondary education (24.3%). The age distribution spanned from 20 and above, with most respondents in the age brackets of 20-24 (21.1%) and 50 and above (18.5%). Dwelling unit types indicated that a significant proportion resided in semi-permanent structures (43.7%), followed by permanent (33.9%) and traditional (22.4%) dwellings. The study examined the economic landscape in the surveyed villages, with a majority earning below MKW50,000.00 monthly (58.6%) and a smaller fraction earning above MKW200,000.00 (3.3%). Occupational diversity is evident, ranging from subsistence farmers (35.5%) to salaried employees (5.6%) and self-employed individuals (17.1%). Ownership of formal financial products accounts was examined, indicating that people in the surveyed communities heavily rely on the use of digital and mobile wallets in particular Airtel Money (54.6%) and Telecom Networks Malawi (TNM) Mpamba (17.11%), while a notable proportion has no money accounts with financial institutions or mobile platforms (32.9%). Property ownership encompasses a spectrum of possessions, with significant ownership of houses (74.3%), land (69.1%), and mobile phones (61.8%), though ownership of motor vehicles is relatively low (1.3%). Collectively, this data offers a comprehensive snapshot of the demographic composition and socioeconomic status within the surveyed population in the three sites.

Table 1-3: Demographic details of Respondents

Characteristic	Variables	Percentage (%)
Gender		
	Males	48.2
	Females	52.8
Family Size		
	1 Person	4.6
	2 Persons	7.2
	3 Persons	17.8
	4 Persons	15.4
	5 Persons	17.1
	6 Persons and above	37.8
Education levels		
	Never Attended School	3.9
	Primary Education	65.2
	Secondary Education	24.3
	Tertiary Education	3.9
	Refused	0.7
Age Groups		
	20-24	21.1
	25-29	18.1
	30-34	11.6
	35-39	11.8
	40-44	11.2

	45-49	7.7
	50 and above	18.5
Dwelling Unit		
	Permanent	33.9
	Semi-Permanent	43.7
	Traditional	22.4
Monthly Income		
	Below MKW50,000.00	58.6
	MKW50,001.00-MKW99,999.00	24.7
	MKW100,000.00-MKW199,999.00	8.6
	MKW200,000.00 and above	3.5
	Refused	4.6
Occupation		
	Subsistence Farmer	35.5
	Commercial Farmer	11.3
	Casual Labour	15.8
	Salaried Employee	5.6
	Pensioner	0.7
	Unemployed	7.9
	Remittances/Gifts	5.7
	Self Employed	17.5
Money Account Owned		
	Airtel Money	54.6
	Village Savings Bank	9.9
	TNM Mpamba	17.11
	Bank	13.2
	None	32.9
Property Owned		

House	74.3
Land	69.1
Mobile Phone	61.8
Bicycle	28.9
Motorbike	7.9
None	2.6
Motor Vehicle	1.3

1.4.2 Economic Activities

The survey scrutinized the socioeconomic endeavors prevalent among the local populace, revealing that a significant majority, comprising 72.4% of the population, are not involved in any entrepreneurial ventures. Conversely, a noteworthy proportion, 26.6%, are actively engaged in a diverse array of businesses encompassing commercial farming, retail shops, restaurants, welding, pubs, barbershops, and salons. Figure 1-3 presents an overview of the myriad business activities undertaken by individuals within the communities in percentages.

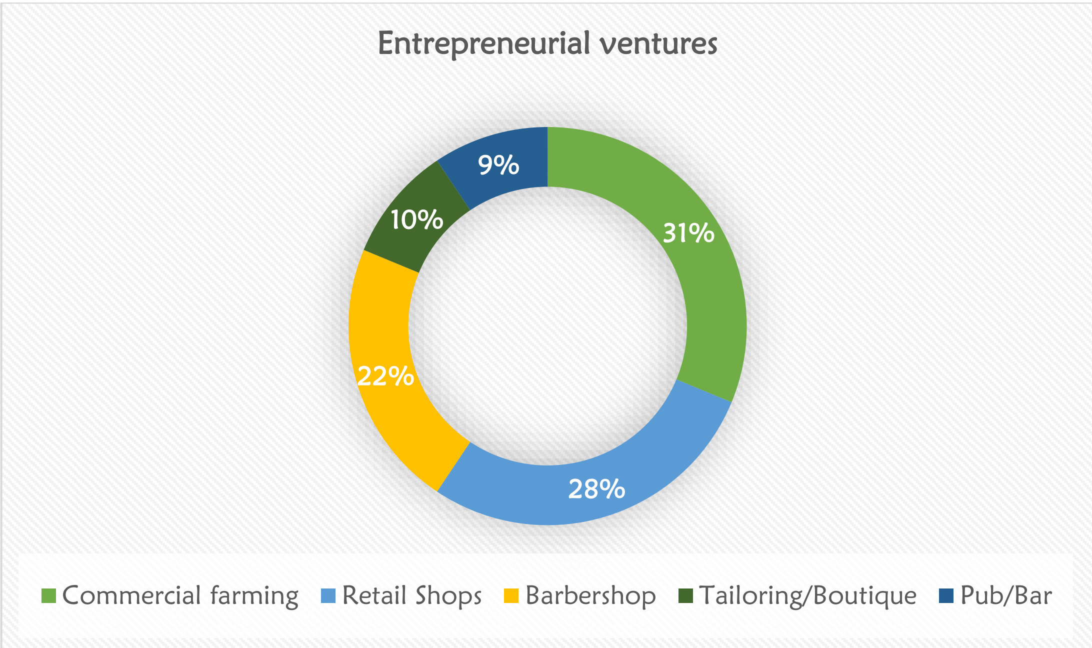

Figure 1-2: Business activities in demonstration sites

When queried about the number of individuals employed by their businesses, it was found that 87.2% of businesses hired either one or two individuals, while 12.8% employed at least three to five individuals. Survey participants were also asked about their willingness to acquire loans to bolster their businesses. Among respondents, 53.8% expressed a willingness to obtain loans for business support, whereas 46.2% showed no interest in acquiring loans, expressing concerns about potential negative impacts on their livelihoods. Among those open to taking a loan, 88.9%

specified a preference for borrowing amounts not exceeding MWK500,000.00, while the remaining indicated a willingness to consider loans ranging from MWK500,001.00 to MWK1,000,000.00. Furthermore, 38.9% of participants indicated a preference for repaying the loan throughout 4 to 5 years, followed by 27.8% who opted for a repayment period of 6 to 12 months.

Figure 1-3: Images of various economic activities in the study sites

1.4.3 Energy Access and Expenditure

The research revealed that 62.5% of respondents reported lacking access to electricity-generating devices. On the other hand, 37.5% stated that they utilize individual-based energy systems, like solar home systems. Participants were queried about their interest in gaining access to electricity and their preferred timing for it. For household owners keen on accessing electricity, the survey delved into their desired timeframe, with the findings depicted in Figure 1.5.

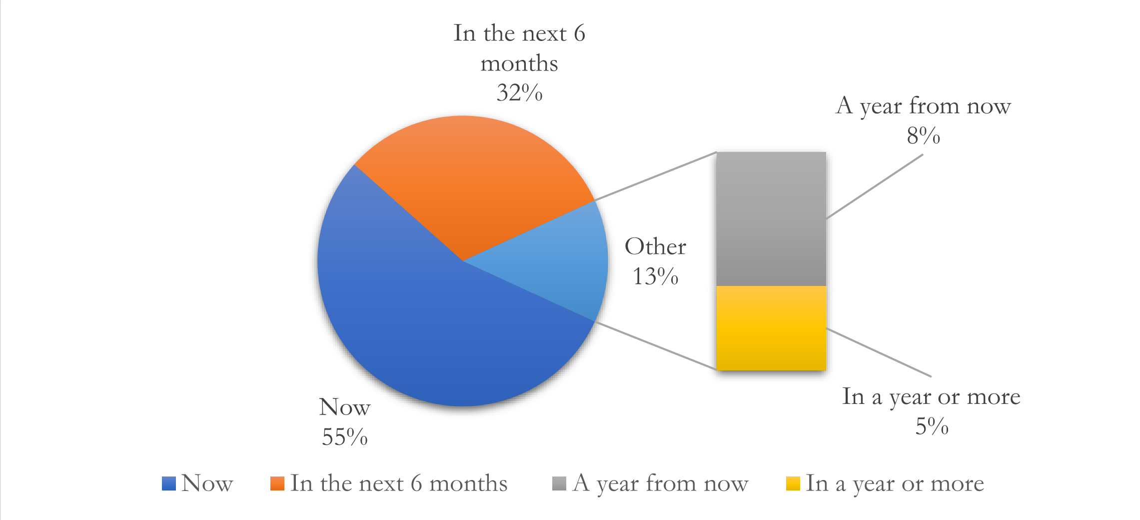

Figure 1-4: A pie chart showing the time households are willing to have electricity

As depicted in Figure 1.5, 55% of respondents expressed a desire for immediate access to electricity, while 32% preferred to obtain it within the next six months. A further 8% aimed to secure electricity within a year from the survey date, while 5% anticipated obtaining it in a year or longer as indicated that they needed more time together with financial resources that would enable them to adopt renewable energy systems. These findings underscore the pressing demand for energy within these communities. In terms of preference, 38% opted for connection to the national electricity grid, 32% favored community-based energy systems, and 30% expressed a preference for individual-based systems. The primary rationale for selecting the national electricity grid or community-based energy systems revolved around the perception of its reliability and lower monthly costs compared to the upfront expenses associated with individualized energy systems. Additionally, respondents believed that these options would generate more business opportunities for the community as a whole. Conversely, those inclined towards individualized energy systems cited ease of maintenance and repair due to having complete control over the system.

1.4.4 Energy usage and demand

1.4.4.1 Usage

The key household energy needs for the three sites are cooking, lighting, entertainment, and cell phones. The energy use pattern shows that, of 150 households that were surveyed, 96% indicated that they use firewood for cooking while 2% said they rely on charcoal, and only 1% use Liquefied Petroleum Gas (LPG) and crop residues as a source of energy for cooking. As a primary energy source for lighting; 60% used battery torches, 34% used solar home systems/lanterns, 4% used candles and 2 percent mentioned the use of mobile phones for such purposes. On entertainment and phone charging, 47% charge their phones using solar home systems, 16% charge at nearby electrified villages, and 3% use car batteries to charge their phones. However, 34% of the respondents currently did not have appliances that require electricity.

Table 1-4: Households' Energy Services

Energy Need	Energy Sources in Use	Percentage (%)
Cooking	Firewood	96
	Charcoal	2
	Crop residues	1
	Liquefied petroleum gas	1
Lighting	Battery Torches	60
	Solar home system/lanterns	34
	Candles	4
	Mobile phones	2
Entertainment and phone charging	Solar home systems	47
	Nearby electrified village	16
	Car batteries	3
	None	34

Asked if the current energy sources meet their energy needs 88% said no, whereas 12% indicated that the energy sources met their energy needs. 92% indicated that they were not happy with the energy sources 6% said they were happy and 2% indicated that they were very happy with the energy sources that they currently use. The dissatisfaction was due to the fact the households were unable to meet energy services such as refrigeration, welding, maize milling, and other business opportunities that might have been introduced in their respective communities with the availability of electricity.

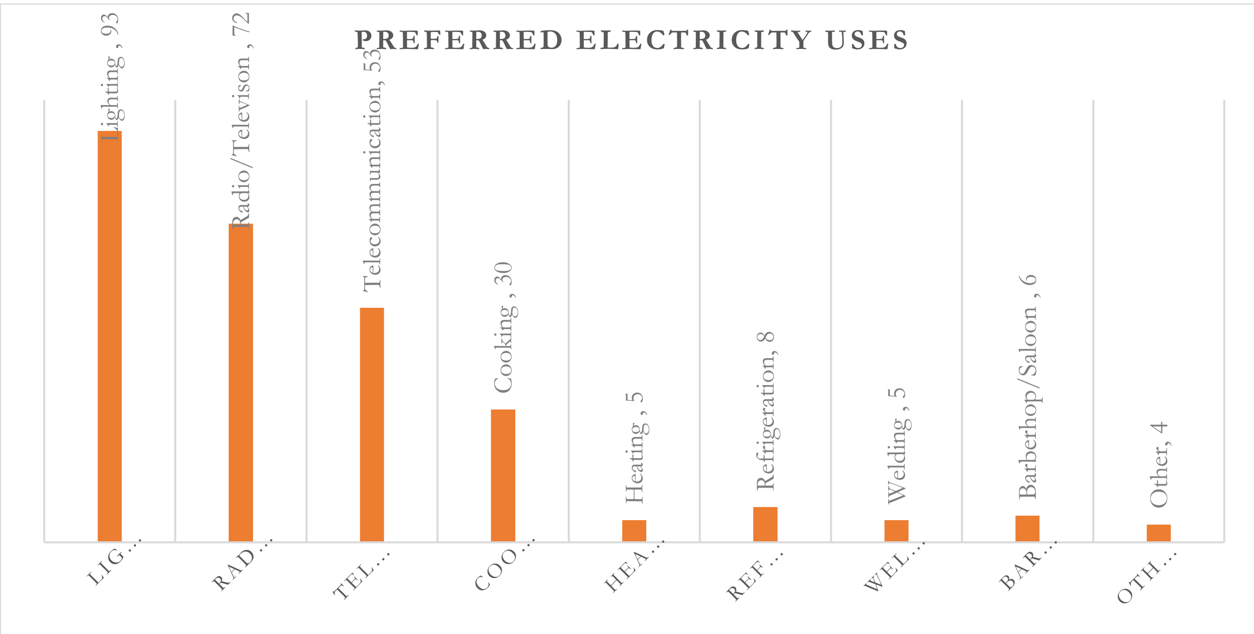

Figure 1-5: A graph showing household' preferred electricity usage

According to Figure 1.6, 93% of participants expressed a desire for electricity primarily for lighting purposes, while an additional 72% sought it for entertainment, such as radio or television. Additionally, 53% indicated a preference for using electricity for telecommunication, with 30% specifying its use for cooking. Other identified uses included refrigeration (8%), welding (5%), and services like barbershops or salons (6%).

1.4.4.2 Electricity Demand

The research also aimed to understand the current electricity demand per household, to estimate the required power capacity for individualized or community-based energy systems. This objective was accomplished by surveying participants about their ownership of electrical appliances and their usage patterns. On average, where available, households typically own mobile phones, radios, and lights. Additionally, projections were made for power demand over the next decade to inform the design of community systems. For example, in the initial years, there was a focus on purchasing entertainment units such as televisions, home theaters, and DVD players. In subsequent years, priorities shifted towards acquiring refrigerators, shavers, and hotplates. By the 5th and 10th years, there is a notable interest in purchasing appliances tailored for business use, including welding machines, maize milling machines, and salon equipment, among others. Figure 1.7 provides a summary of the electricity demand projections for the three sites.

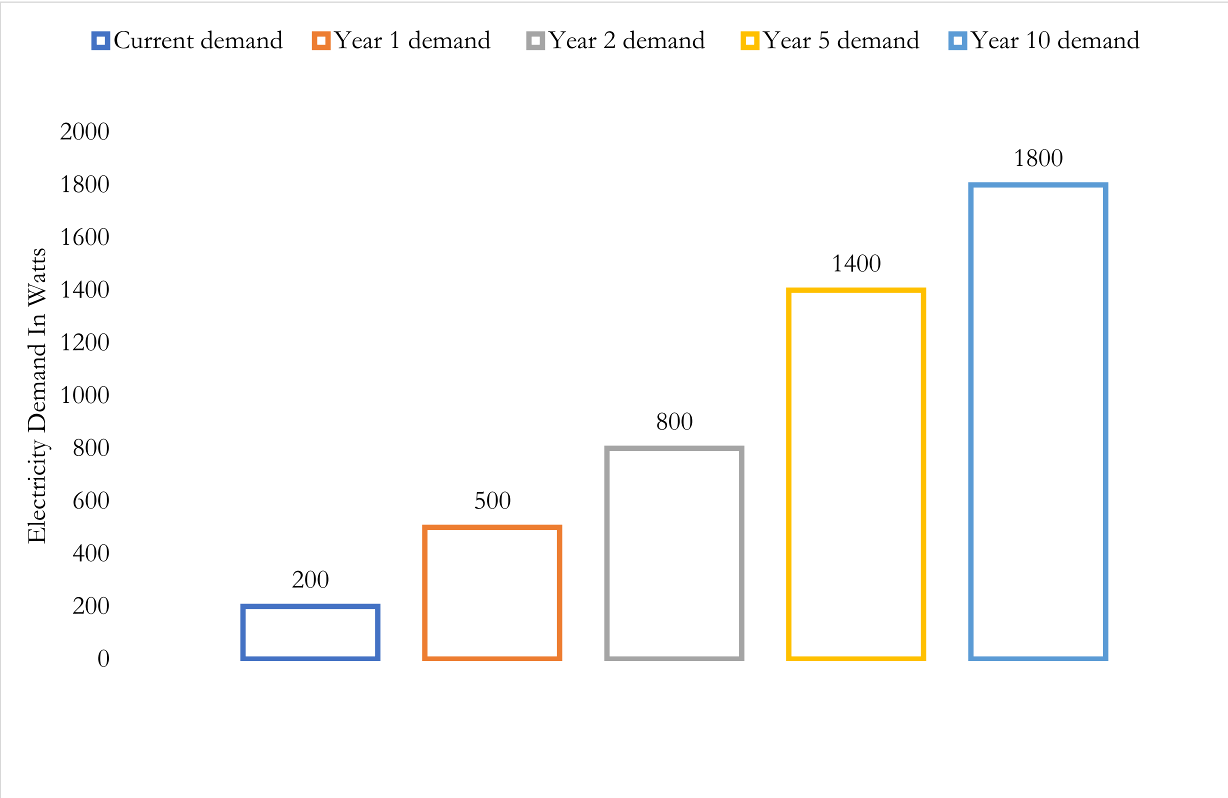

Figure 1-6: Power demand projects per household

1.4.5 Households Expenditure on Energy Services and willingness to pay

1.4.5.1 Expenditure

The table presents a detailed breakdown of expenditures across three categories: cooking and heating, lighting, and phone charging/entertainment. For expenditure on cooking and heating, the largest proportion (47%) falls under the "Free" category as people simply collect firewood from their fields, followed by 13% in the range of up to 2,000 MWK, and decreasing percentages for higher expenditure brackets. Similarly, in the lighting category, the majority (57%) of expenditure is within the up to 2,000 MWK range, with diminishing percentages for higher ranges. Expenditure on phone charging and entertainment follows a different pattern, with 49% falling in the 2,001-5,000 MWK range, and declining percentages for other ranges. Overall, the table offers insight into how expenditures are distributed across different income brackets within each category.

Table 1-5: Household expenditure on energy services

Description	Category (MWK)	Percentage (%)
Expenditure on cooking and heating	Free	47
	Up to 2,000	13
	2,001-5,000	15
	5,001-10,000	15
	10,001-15,000	7
	Above 15,000	5
Expenditure on lighting	Up to 2,000	57
	2,001-5,000	30
	5,001-10,000	9
	10,001-15,000	3
	Above 15,000	1
Expenditure on phone charging and entertainment	Up to 2,000	42
	2,001-5,000	49
	5,001-10,000	6
	10,001-15,000	2
	Above 15,000	-

1.4.5.2 Willingness to pay

The survey was interested in knowing the amount of money households who opted for community schemes would be willing to pay for the energy bills per month if they were connected to electricity, either a community-based system or the national electricity grid. 56% of the respondents who preferred community schemes said would afford to pay MWK2,001.00 to MWK4,999.00 ($1.14 to $2.86) per month, and 19% said would afford to pay an amount below MWK2,000.00 ($1.14). 9% said could afford to pay above MWK10,000.00 ($5.71) on electricity per month. Respondents who opted for individualized stand-alone systems were asked if they were willing to a loan to finance their installation and purchase of renewable energy systems components.

Out of the respondents who were interested in individualised stand-alone systems, 89% said they were willing to take a loan that is below MWK500,000.00 ($285.55) whereas 11% said would take a loan in a range of MWK500,001 to MWK999,999.00 ($285.55 to $571.10). Furthermore, 39% of participants indicated a preference for repaying the loan over a period of 4 to 5 years, followed by 28% who opted for a repayment period of 6 to 12 months. Other participants were willing to repay the loan in 1 to 6 months whereas 11% percent indicated that they were willing to service the loan in 1 to 3 years.

Table 1-6: Households' willingness to pay and take loans for renewable energy schemes

System Type	Category (MWK)	Percentage (%)
Community scheme	Below 2,000.00	19
	2,001.00 to 4,999.00	56
	5,000.00-10,000.00	16
	Above 10,000.00	9
Domestic stand-alone system	Below 500,000.00	80
	500,001 to 999,999.00	12
	Above 1,000,000.00	8

1$=MWK1,195.00

1.4.6 Awareness and Training

Asked if they are aware of renewable energy systems, all the respondents acknowledged that they are aware of RES. The figure presents different types of renewable energy systems of which the community is aware along with the percentages. Of the 150 people surveyed, the results in Figure 1.8 show that 133 respondents knew about solar energy systems, 76 people were aware of hydropower, 15 people about wind energy systems, and only 5 people knew about biogas.

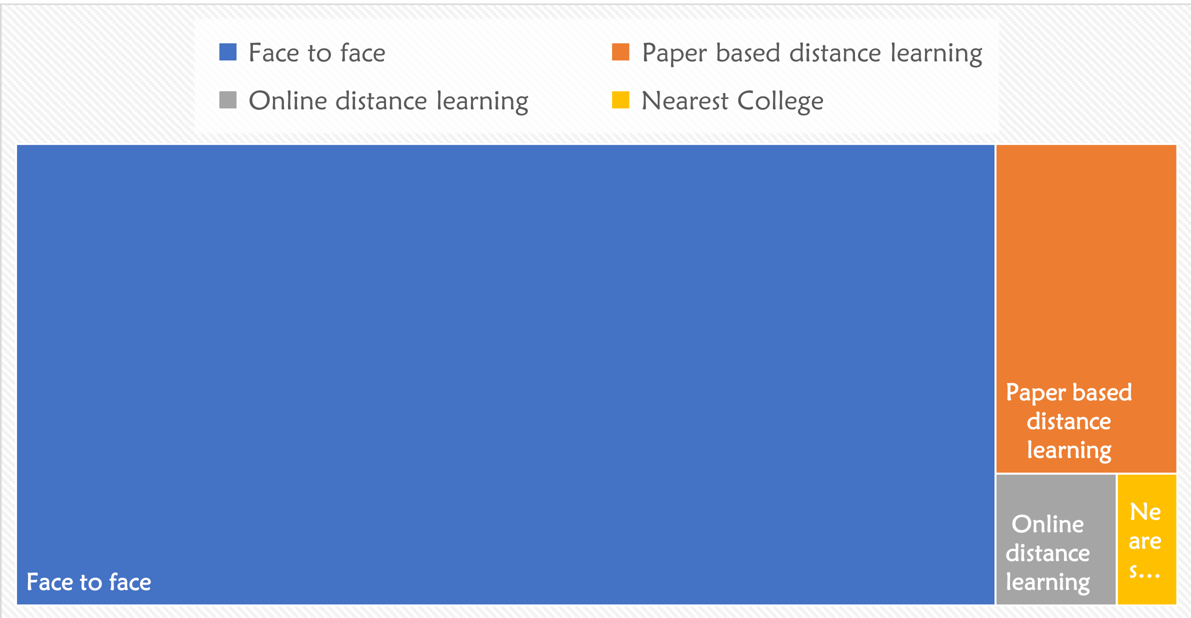

Figure 1-7: Renewable energy sources are known by households at the survey sites

Respondents we asked if they were willing to participate in the training programs to broaden their knowledge of renewable energy systems. 98% of the respondents said were interested in taking training courses to improve their knowledge of how to maintain renewable energy systems while 2% were not. Similarly, the study investigated the preferred training methods for renewable energy technologies. 86% of the respondents preferred that the training should be delivered face to face, and 10% preferred paper-based distance learning whereby they would be given books and study at their respective homes with 3% preferring online distance learning. 1% of the respondents preferred that the training materials should be left at the nearest college or any educational institution where they can easily go and study these training materials/books.

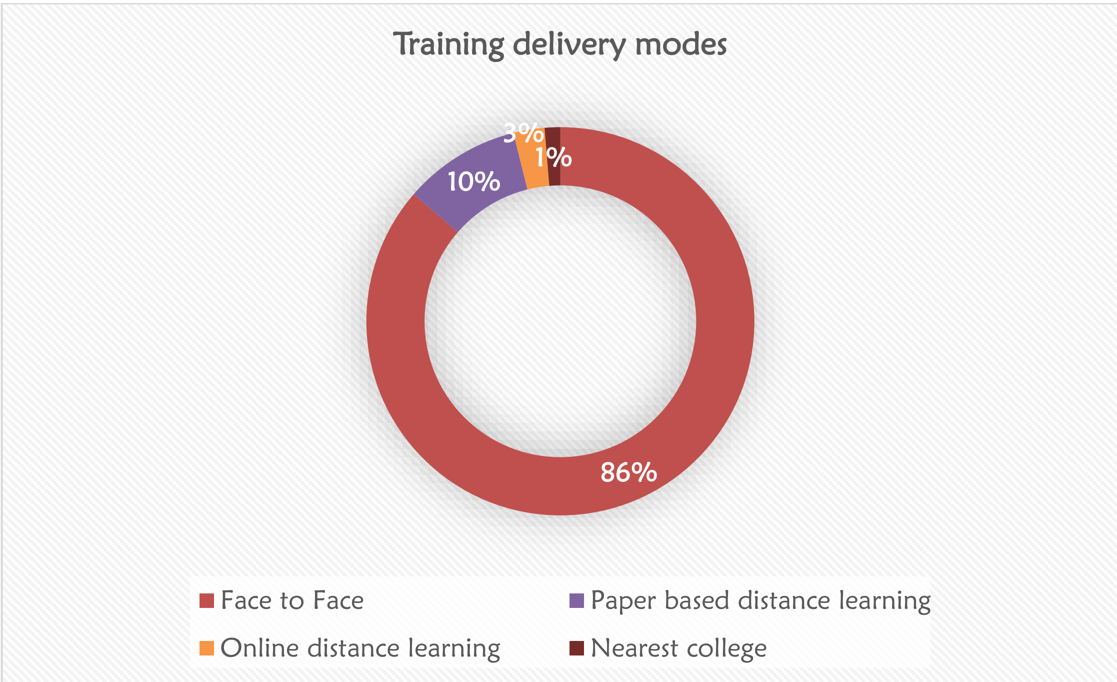

Figure 1-8: A pie chart indicating households' preferred training delivery modes

1.4.7 Chapter Summary

The needs assessment findings show that all 150 participants were interested in getting access to electricity as well as adopting renewable energy systems. It was noted that most people (81%) preferred community-based energy systems over individualized energy schemes (19%) as they believed that there are no high upfront costs with such systems and that community-based energy systems would bring more business opportunities such as opening up of maize mills, welding shops, improved service delivery at hospitals and schools among others. The findings also indicate that all the respondents were interested in participating in the training aimed at improving their knowledge of renewable energy systems repair and maintenance. 86% preferred that this training should be delivered face to face as the majority of the respondents do have the ability to study the training materials/books.

CHAPTER 2: COMMUNITY ENGAGEMENT MEETINGS

The rationale for conducting the community engagement meetings was to among others create contact centre structures in case study sites within the CEANGAL project that would be necessity for effective communication, community engagement, and sustainable development. The task also involved knowing the preferred communication channels of the community, examining their knowledge and opinions in handling renewable energy projects, and the role they anticipate to play in RES projects.

2.1 Contact Centre Structures

These structures are designed to facilitate seamless interaction between project stakeholders, local authorities, and residents, thereby ensuring the success and long-term impact of the project. Below is an overview of the contact structures for the case studies and their relevance throughout the project.

2.1.1 Village Heads/Community Leaders

The relevance of contact centre structures extends beyond the CEANGAL project's demonstration activities to encompass the entire project lifecycle. Before the project, these structures facilitate needs assessment, stakeholder consultation, and project planning. During the project, they support effective communication, coordination of activities, and resolution of challenges. Post-project, they facilitate knowledge transfer, capacity building, and the integration of project outcomes into community development plans.

2.1.2 Technical Middleman

These individuals play a vital role in bridging the gap between project technical teams and the local community. They possess technical expertise and knowledge of local conditions, enabling them to facilitate communication, provide technical guidance, and troubleshoot issues related to project implementation. Technical middlemen contacts are instrumental in ensuring the smooth execution of project activities and promoting sustainability post-project completion.

2.1.3 Community Representatives

In addition to village heads and technical middlemen, the inclusion of community representatives in the contact centre structures enhances inclusivity and participatory decision-making. These representatives serve as voices for various segments of the community, ensuring that diverse perspectives are considered in project planning, implementation, and evaluation. Their involvement fosters community ownership and empowerment, laying the foundation for sustainable development outcomes.

2.1.4 Local Business owners' representatives

Through their insights and connections, they can facilitate partnerships between the contact centre and local businesses, encouraging the adoption of renewable energy solutions for productive purposes. This collaboration not only enhances the economic viability of the project but also fosters sustainable development by promoting local entrepreneurship, job creation, and community economic growth. Thus, the involvement of local business owners is instrumental in maximizing the productive use of energy within the community, driving both social and environmental benefits. The details of contact structures and persons in the case study site are presented in Table 2-1.

Table 2-1: Contact details per demonstration site

Site Name	Name of Contact persons	Phone numbers
Naluwade, Mulanje district	Village head Gumbi	+265993157940
	George Karichero-Technical middleman	+265995188225
	Solomon Lodi- Business owner/community representative	+265897630861
Matuwamba, Mchinji District	Group Village head Matuwamba	+265999300184
	Mark Banda-Technical middleman	+265991140369
	Masautso Panganani-	+265983802111
Luviri, Mzimba District	Group village head Sawagumba	+265992535528
	Wiscott Chirwa -Technical middleman	+265990370727
	Bright Ndolo -Business owner/community representative	+265994430692
Women's cooperative Mdeka, Blantyre district	Mrs. Mdala-Chairlady	+265996555674
	Joshua John- Technical middleman	+265991059168
	Eneless Mponda-Business owner/community representative	+265998555508

2.2 Energy Projects, Expected Benefits, and Anticipated Challenges.

The community representatives were asked if they knew of any energy projects within the community and nearby communities. Representatives at Naluwade Village in Mulanje District indicated that the nearby village has a hydro mini-grid scheme that supplies electricity to over 1000 households, business entities, and private facilities combined. The key challenge that the mini-grid faces is power cuts due to reduced water levels, especially during dry seasons. Representatives from Luviri and Matuwamba Villages indicated that some 2 or 3 years ago, the Ministry of Energy through the Malawi Rural Electrification program (MAPEP), conducted feasibility studies that will see the communities being connected to the national grid. Once the studies are completed the Ministry develops the bill of quantities of the sites and tender to contractors responsible for powerlines construction. The delays are there because there are so many sites that are supposed to be attended to and with financial constraints, it takes time to electrify all the sites in each MAREP phase.

Community representatives from all the sites indicated that once their communities are electrified they expect that would no longer travel long distances to access maize mills which appeared to be one of the major drivers for the need for electricity access. They further stated that it would be easier to charge phones and this would consequently improve communication and access to information. The other expected benefits include; improved health service delivery, entertainment, long hours of business operation, improved security, creation of business opportunities, and enabling students to study for long hours thereby improving their quality of life.

The communities indicated that there are currently a number of challenges that hinder their uptake of energy. These included; financial constraints, unavailability of clean energy technologies in their communities, knowledge gap with regards to where to access renewable energy technologies, and experts that could install such systems. The communities also mentioned the issues associated with their present use of unreliable energy sources such as candles and battery torches.

Asked about the possible challenges that would arise if RES projects are to be implemented in their communities, the representatives indicated that poor road conditions would affect the implementation of the projects. Further to this, they also mentioned that there would be a possibility of the communities not being able to maintain the RES in the long term due to a lack of funds and technical personnel within the communities that know repair and maintenance of such systems. However, they indicated that this could be mitigated by training local communities on how they can repair and maintain the RES. They indicated that their communities were ready to provide skilled and unskilled labour as well as land if a renewable energy project was to be implemented in their communities.

2.3 Community Input on the CEANGAL Framework and Preferred Communication Channels

The refinement of the CEANGAL Project involved seeking the community members from the Matuwamba site in Mchinji, on what can be refined on the CEANGAL framework steps. The framework was presented to community members who were able to understand the framework after translating it to local language. The members indicated the need to establish a revolving fund in the communities where RES projects are implemented. These funds would assist in providing the members an opportunity to start businesses that would enable them to generate funds that would allow them to purchase renewable energy technologies or pay connection fees to energy service providers. This was based on the fact that most people do not have the financial resources to access energy. They also hinted that there has to be a deliberate mechanism that would allow energy films to open satellite shops where community members would easily access renewable energy components rather than travelling long distances to major towns to access energy access. As a way of establishing a communication platform between community members and energy project implementers, respondents were also asked about their preferred communication channels. The community members preferred physical meetings, SMS texts, and community radios as reliable communication platforms.

2.4 Chapter Summary

The contact centre structures established within the CEANGAL project case study sites are integral to fostering collaboration, promoting transparency, and empowering local communities. By leveraging the expertise of village heads, technical middlemen, business owners, and community representatives, these structures ensure that project interventions are contextually relevant, socially inclusive, and environmentally sustainable, thereby maximizing their impact on underserved communities.

CHAPTER 3: MULTISTAKEHOLDER PARTNERSHIP

This chapter presents how these partnerships will be implemented and it incorporates several actors from government agencies, business firms, donor organizations, NGOs, civil society, community representatives, and research institutions.

3.1 Key Stakeholders

3.1.1 Government Entities

The government's ministries, departments, and agencies play an important role in setting the policy framework for the deployment of renewable energy. Their involvement will ensure that the deployment and implementation of renewable energy projects are consistent with regulatory frameworks. Working with local authorities will assist in implementing the project at the community level by ensuring regulation and coordination is seamless. For instance, in the communal energy system project, developers must engage with the Ministry of Energy (MoE) for site recommendations and policy guidance. Developers are also required to be licensed by the Malawi Energy Regulatory Authority (MERA) before project implementation begins. MERA is responsible for approving tariffs for the mini-grids. Before the DRES project is commissioned, MERA is expected to conduct inspections to ensure the system complies with the standards outlined in the Malawi Grid Code. Customers wishing to connect to the National Electricity Grid must apply to the Electricity Supply Corporation of Malawi (ESCOM) and pay a connection fee of MWK 93,200. This fee covers the procurement of service lines and other necessary materials. ESCOM will assess the wiring of the housing structure and the cost of materials needed to connect the facility. Once these steps are completed, ESCOM will connect the facility to the national electricity grid, though this process can be delayed due to bureaucracy and financial constraints.

3.1.2 Private Sector

Financing, construction, and operation of decentralized renewable energy initiatives are dependent on private sector players like businesses involved in renewables development or investors who take up such ventures. When collaborating with other organizations inside the private sphere; this will encompass project financing relationships technology deployment associations operational management alliances. Financing institutions can provide soft loans to community members so that they can enable them to access renewable energy technologies and start businesses that will enable them to meet their needs including purchasing renewable energy systems or payment of energy bills. Additionally, solar-powered systems are provided by commercial companies registered with MERA. Examples of such firms include Yellow Solar, SolarWorks Malawi, Zuwa Energy, and Sonlite Solar, among others. These companies can be contacted through their offices, agents, and social media platforms.

3.1.3 Donor Organizations

Both local and international financiers provide the necessary funds for the implementation of renewable energy projects as well as technical exercises and other necessary resources to support renewable energy initiatives. Partnerships with such institutions will involve accessing funding opportunities, leveraging technical support, and aligning project objectives with donor priorities.

3.1.4 NGOs and Civil Society Organisations

The Non-governmental Organisations (NGOs) and civil Society Organisations engage with communities by raising awareness and advocating for inclusive and equitable energy solutions. Partnerships with NGOs and CSOs will involve community mobilization, stakeholder engagement, and capacity building. The CEANGAL Project is already in collaboration with the Cooperation Network for Renewable Energy in Malawi (CONREMA) on energy project mapping, capacity, and education support.

3.1.5 Community Representatives

Local communities and their representatives in the demonstration sites are key stakeholders who will be actively involved in decision-making and project design. Partnerships with community representatives will involve participatory approaches, needs assessment, and co-design of renewable energy solutions. Collaboration with communities will ensure projects meet local needs, priorities, and aspirations, fostering ownership and sustainability.

3.1.6 Research and Academic Institutions

Research and academic institutions contribute technical knowledge, research, and innovation to advance renewable energy technologies and practices. Partnerships with research institutions will involve knowledge sharing, capacity building, and technology transfer. Collaboration with academia will enhance project design, monitoring, and evaluation, fostering evidence-based decision-making and continuous improvement.

3.2 Operationalizing Multistakeholder Partnerships

3.2.1 Establishing a Multistakeholder Platform

A platform will be established to bring together government agencies, private sector actors, donor organizations, NGOs, community representatives, and research institutions. The platform will serve as a forum for dialogue, collaboration, and coordination among stakeholders. These are some of the aspects that will be considered when operationalizing the multi-stakeholder platform.

3.2.2 Forming Working Groups

Working groups will be established to focus on specific aspects of renewable energy projects, such as financing, technology deployment, community engagement, and monitoring. Each working group will comprise representatives from different stakeholder groups to ensure diverse perspectives and expertise.

3.2.3 Conducting Stakeholder Consultations

Stakeholder consultations will be conducted to gather input, feedback, and buy-in from all relevant actors. Consultations will involve meetings, workshops, and focus group discussions to ensure inclusive participation and consensus-building.

3.2.3 Developing Partnership Agreements

Partnership agreements will be developed to formalize the commitments, roles, and responsibilities of each stakeholder group. Agreements will outline shared objectives, resources, timelines, and mechanisms for decision-making and conflict resolution.

3.2.4 Implementing Action Plans

Action plans will be developed to guide project implementation, outlining activities, timelines, and milestones for each stakeholder group. Plans will be regularly reviewed and updated based on feedback, progress, and emerging priorities.

3.2.5 Monitoring and Evaluation

Monitoring and evaluation mechanisms will be established to track progress, measure impact, and identify lessons learned. Regular reporting and feedback loops will ensure accountability, transparency, and continuous improvement in multistakeholder partnerships.

3.3 Chapter Summary

Operationalizing multistakeholder partnerships for renewable energy projects in Malawi requires concerted efforts from government agencies, the private sector, donor organizations, NGOs, civil society, community representatives, and research institutions. By collaborating effectively, these stakeholders can harness their collective strengths and resources to accelerate the transition to sustainable and inclusive energy systems, benefiting communities, economies, and the environment.

CHAPTER 4: ELECTRIFICATION AND ENERGY SOLUTIONS

This chapter details the electrification options for each of the three surveyed sites. This was done by using the Hybrid Optimization Model of Electric Renewables (HOMER). The details of the assessment of energy solutions will be discussed in the next sections.

4.1 Luviri, Mzimba

4.1.1 Solar Resources

The sites had no weather stations near as such solar radiation data was downloaded from the National Aeronautics and Space Administration (NASA). The data obtained gives an average global horizontal irradiation (GHI) for 22 years ranging from July 1983 to June 2005. The site's GHI ranges from 5.080kWh/m^2 /day to 6.760 kWh/m^2 /day with an annual average of 5.65 kWh/m^2. The clearness index ranges from 0.456 to 0.659.

Figure 4-1: Solar GHI resource for Luviri site, Mzimba

The average global horizontal irradiation (GHI) ranging from 5.080 kWh/m2/day to 6.760 kWh/m2/day with an annual average of 5.65 kWh/m2 suggests a reasonably high solar energy potential in the area. The clearness index, ranging from 0.456 to 0.659, indicates relatively clear skies, which is favorable for solar power generation. Even though the data is based on a 22-year period, it gives a good indication of the solar resources available in the region.

4.1.2 Wind Resources

The sites had no weather stations near as such wind speed data was downloaded from NASA. The data obtained gives an average wind speed ranging from 3.670m/s to 6.500m/s at 10m hub height. The average wind speed is 4.93m/s per second. This data was collected in a period of approximately 30 years from Jan 1984 to December 2013. The period with higher wind speed records is between August and November.

Figure 4-2: Wind resource for Luviri site, Mzimba

The average wind speed ranging from 3.670 m/s to 6.500 m/s at 10m hub height, with an average of 4.93 m/s, indicates a moderate wind resource. However, before proceeding with the development of wind and solar power systems, further site-specific assessments and analyses are recommended to determine the optimal design, sizing, and placement of the renewable energy installations. Additionally, considerations such as land availability, grid connectivity, regulatory approvals, and economic feasibility should be evaluated to ensure successful implementation.

4.1.3 Load Profile; Luviri, Mzimba

The collected data was downloaded in Excel format to establish the load profile. This profile was created based on respondents' answers. When respondents mentioned the appliances they use, they were asked to specify the range of time or number of hours they use each appliance during the daytime and nighttime. These responses were then plotted in an Excel sheet to calculate the total power consumption for each hour. The total hourly consumption was entered into HOMER software as shown in figure 4.3.

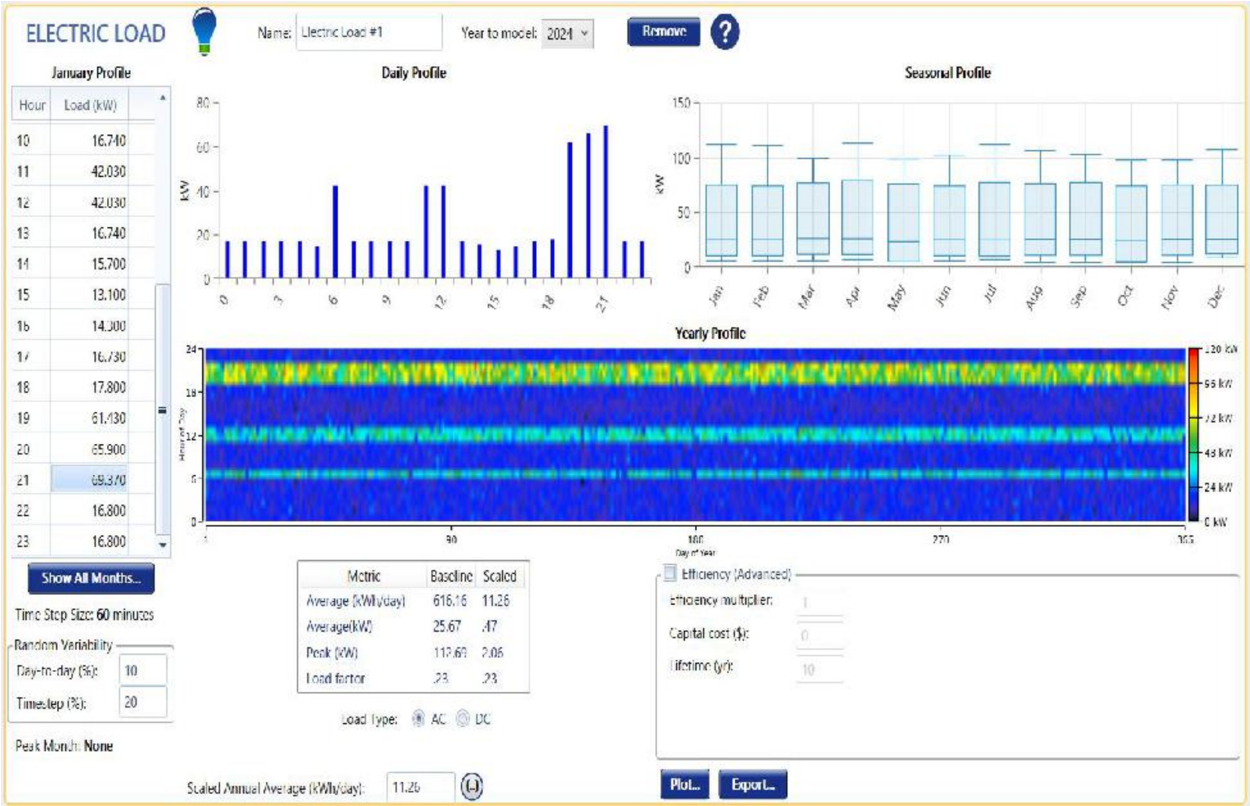

Figure 4-3: Load profile of the Luviri site

As seen in the figure the daily load profile is similar to the industrial load where the peak in the daytime. This is due to the businesses that the respondents are planning to have when they have access to electricity such as maize mills, welding machines, and others productive uses of energy.

4.1.4 Proposed Solar PV Mini-grid for Luviri

4.1.4.1 System Components and Inputs

The study focused on a standalone solar PV mini-grid. In addition to the load, the system components included a converter, modules, and batteries, as shown in Figure 4.4. Quotations for each component were obtained from various suppliers, and details for each component input are discussed in this subsection. Solar PV input was managed by selecting modules from the HOMER library. The chosen module was the CS6X-325P, manufactured by Canadian Solar, with a power rating of 325W and an efficiency of 16.94%. Based on the quotations from various suppliers, the total cost per module was $102.4. The power rating was entered into HOMER in kW as 0.325 kW, with the unit cost per module at $102.4.

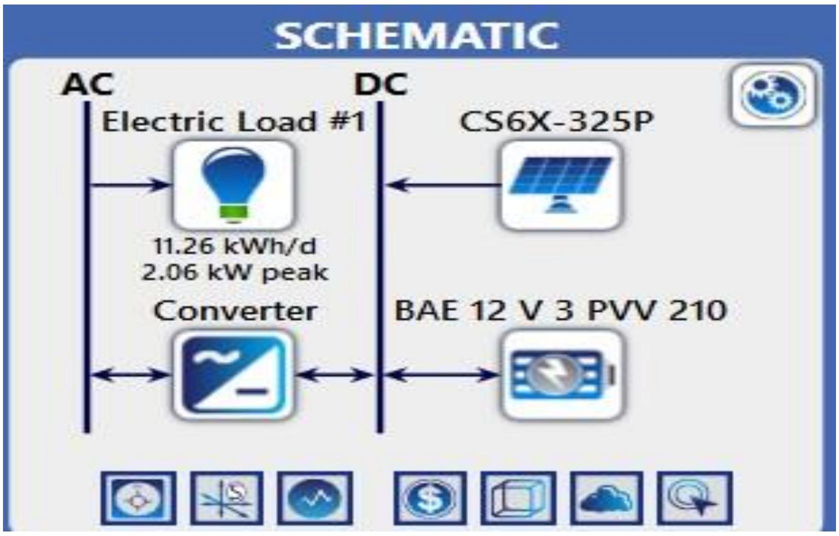

Figure 4-4: Schematic Diagram of the solar PV mini-grid

The system under study was a standalone solar PV mini-grid, making storage critically important. Storage helps reduce fluctuations in electricity supply and provides power during nighttime hours. The storage input used was a lead-acid battery, specifically the BAE PVV 12V 210, a maintenance-free battery well-suited for this application. Based on quotations from suppliers, the cost per unit for the battery was $320.00 which was used as both the capital cost and replacement cost. The string size used was 16 to match the inverter input voltage of 192V. Figure 4.5 shows the details of the battery input. In this system, a converter was used to charge the batteries (DC-DC conversion) and to convert power from DC to AC (DC-AC conversion), which is the energy form used by the loads. The proposed inverter for this system is a 30kW inverter with 95% efficiency. Based on supplier quotations, the total cost of the inverter, including shipping, was $6,643.22.

4.1.4.2 System economic input

To perform an economic analysis of the system, several economic parameters need to be entered into HOMER. These parameters include the nominal discount rate, expected inflation rate, project lifetime, fixed capital cost, and fixed operation and management cost. The nominal discount rate and expected inflation rate, based on the Reserve Bank of Malawi rates from March 2024, were 26% and 33%, respectively. The project lifetime is set to 25 years. System fixed costs were estimated by including distribution costs, costs of prepaid meters, and costs of mounting racks. According to the World Bank, the distribution cost per kilometer is $14,980. The total distance for the distribution system was measured using Google Earth and found to be 2.59 km. The total distribution cost was calculated by multiplying the measured distance by the distribution cost per kilometer, resulting in $38,792.60.

4.1.4.3 Simulation of the Results

The categorized optimization results from HOMER were displayed on the results panel, showing only one system configuration. The net present cost (NPC) of the system was $74,911.00, with a levelized cost of energy (LCOE) of $0.33 per kWh. The operating cost was $834.49 and the initial capital cost was $29,503.00. From the needs assessment findings, on average, a household in consumers 0.87kWh per day which implies a total of 26.1kWh per month. The simulated results indicate an LCOE of $0.33 per kWh which implies that a household is required to pay a sum of (26.1kWh*$.0.33) $8.74 per month.

The needs assessment findings show that 56% of the respondents who preferred community schemes said would afford to pay MWK2,001.00 to MWK4,999.00 ($1.14 to $2.86) per month, and 19% said would afford to pay an amount below MWK2,000.00 ($1.14). 9% said could afford to pay above MWK10,000.00 ($5.71) on electricity per month. This implies that communities would not afford to pay the electricity bills for this mini-grid. Given this socio-economic context of Luviri, chapter 6 discusses a deployment model for such energy systems that could enhance sustainable livelihoods and affordability.

Figure 4-5: Simulation results for Luviri solar mini-grid

4.2 Matuwamba, Mchinji

4.2.1 Solar Resource

The sites had no weather stations near as such solar radiation data was downloaded from NASA. The data obtained gives an average global horizontal irradiation (GHI) for 22 years ranging from July 1983 to June 2005. The site's GHI ranges from 5.410kWh/m^2 /day to 6.750 kWh/m^2 /day with an annual average of 5.79 kWh/m^2. The clearness index ranges from 0.482 to 0.669.

Figure 4-6: Solar GHI resource for Matuwamba site, Mzimba

4.2.2 Wind Resources

The sites had no weather stations near as such wind speed for the site data was downloaded from NASA. The data obtained gives an average wind speed ranging from 4.060m/s to 7.280m/s at 10m hub height. The average wind speed is 5.73m/s per second. This data was collected in a period of approximately 30 years from Jan 1984 to December 2013. The period with higher wind speed records is between August and November.

Figure 4-7: Wind resource for Matuwamba site, Mzimba

4.2.3 Load Profile; Matuwamba, Mchinji

The data collected was downloaded into Excel format so that it can be used to establish the load profile. This profile was established based on responses given by respondents. If the respondents mentioned the appliance they use, they were asked to give the range of time or number of hours that they will be using the appliance in daytime as well as in nighttime. These responses were plotted into an excel sheet to give the total power consumption for every hour that was used as HOMER input. The total hourly consumption was entered into HOMER software as shown in figure 4.8.

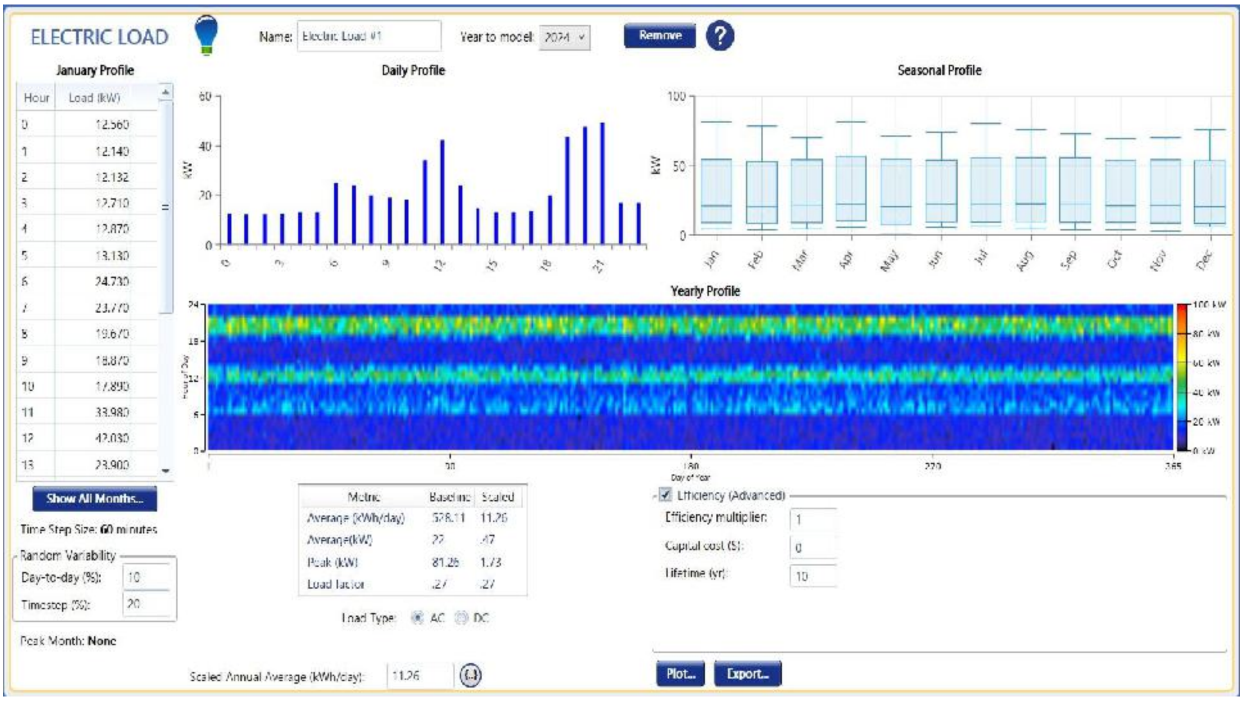

Figure 4-8 :Load Profile for Matuwamba site, Mchinji

4.2.4 Proposed Solar PV-Wind Mini-grid for Matuwamba

4.2.4.1 System Components and Inputs

The study focused on a standalone solar PV-Wind hybrid mini-grid system. In addition to the load, the system components included a converter, modules, and batteries. Quotations for each component were obtained from various suppliers, and details for each component input are discussed in this subsection. Solar PV input was managed by selecting modules from the HOMER library. The chosen module was the CS6X-325P, manufactured by Canadian Solar, with a power rating of 325W and an efficiency of 16.94%. Based on the quotations from various suppliers, the total cost per module was $102.4. The power rating was entered into HOMER in kW as 0.325 kW, with the unit cost per module at $102.4. The wind-powered system rated at 10kW with capital costs and replacement costs rated at $20,000.00 were computed into the software

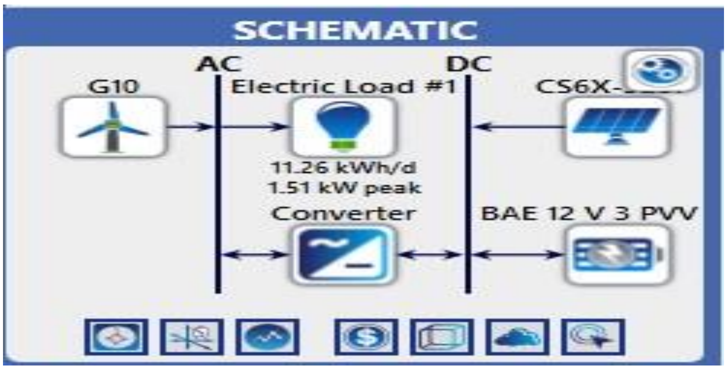

Figure 4-9: Schematic Diagram of the solar PV-Wind hybrid mini-grid, Matuwamba

The storage input used was a lead-acid battery, specifically the BAE PVV 12V 210, a maintenance-free battery well-suited for this application. Based on quotations from suppliers, the cost per unit for the battery was $320.00 which was used as both the capital cost and replacement cost. The string size used was 16 to match the inverter input voltage of 192V. Figure 4.5 shows the details of the battery input. In this system, a converter was used to charge the batteries (DC-DC conversion) and to convert power from DC to AC (DC-AC conversion), which is the energy form used by the loads. The proposed inverter for this system is a 25kW inverter with 95% efficiency. Based on supplier quotations, the total cost of the inverter, including shipping, was $6,643.22.

4.2.4.2 System economic input

To perform an economic analysis of the system, several economic parameters need to be entered into HOMER. These parameters include the nominal discount rate, expected inflation rate, project lifetime, fixed capital cost, and fixed operation and management cost. The nominal discount rate and expected inflation rate, based on the Reserve Bank of Malawi rates from March 2024, were 26% and 33%, respectively. The project lifetime is set to 25 years. System fixed costs were estimated by including distribution costs, costs of prepaid meters, and costs of mounting racks. According to the World Bank, the distribution cost per kilometer is $14,980. The total distance for the distribution system was measured using Google Earth and found to be 2.49 km. The total distribution cost was calculated by multiplying the measured distance by the distribution cost per kilometer, resulting in $37,300.60.

4.2.4.3 Simulation of the Results

The categorized optimization results from HOMER were displayed on the results panel, showing only one system configuration. The net present cost (NPC) of the system was $78,842.00, with a levelized cost of energy (LCOE) of $0.35 per kWh. The operating cost was $1034.49 and the initial capital cost was $23,159.00. The simulated results indicate an LCOE of $0.35 per kWh which implies that a household is required to pay a sum of (26.1kWh*$.0.35) $8.74 per month. The needs assessement findings indicate that approximately a household in Matuwamba consumes an average of 0.97kWh per day which implies that a monthly consumption for a household is 29.1kWh. The simulated results indicate an LCOE of $0.33 per kWh which implies that a household is required to pay a sum of (29.1kWh*$.0.35) $10.19 per month. 56% of the respondents who preferred community schemes said would afford to pay MWK2,001.00 to MWK4,999.00 ($1.14 to $2.86) per month, and 19% said would afford to pay an amount below MWK2,000.00 ($1.14). 9% said could afford to pay above MWK10,000.00 ($5.71) on electricity per month. This implies that majority of the households at Matuwamba would not afford to pay the electricity bills for this mini-grid. Given this socio-economic context, chapter 6 discusses a deployment model for such energy systems that could enhance sustainable livelihoods and affordability.

Figure 4- 10: Simulation results for the Solar PV-Wind Hybrid system for Matuwamba

4.3 Naluwade, Mulanje

4.3.1 Solar resource

The sites had no weather stations near as such solar radiation data was downloaded from NASA. The data obtained gives an average global horizontal irradiation (GHI) for 22 years ranging from July 1983 to June 2005. The site's GHI ranges from 4.200 $kWh/m^2/day$ to 6.380 $kWh/m^2/day$ with an annual average of 5.41 kWh/m^2. The clearness index ranges from 0.498 to 0.624. These values suggest a moderate to high solar resource availability at the site. The clearness index, ranging from 0.498 to 0.624, indicates the clarity of the sky and the absence of atmospheric factors that might obstruct solar radiation. A clear sky with a high clearness index is favorable for solar power generation. However, the site does not qualify for the development of a mini-grid since it is less than 10km from the national electricity grid. Individualised energy systems such as solar home systems are therefore ideal for this site.

Figure 4-11: Solar GHI resource for Nawulade site, Mulanje

4.3.2 Wind Resource

The sites had no weather stations near as such wind speed data was downloaded from NASA. The data obtained gives an average wind speed ranging from 3.670m/s to 6.500m/s at 10m hub height. The average wind speed is 4.93m/s per second. This data was collected in a period of approximately 30 years from Jan 1984 to December 2013. The period with higher wind speed records is between August and November.

Figure 4-12: Wind Energy Resources for Naluwade site, Mulanje

4.3.3 Hydropower resources

The data was obtained by the local renewable energy innovator who has been studying the river for more than 2 years. The flow rate was obtained by using the bucket method where the entire flow is diverted into a bucket or barrel and the time for the container to be filled is recorded. The flow rate is obtained simply by dividing the volume of the container by the filling time.

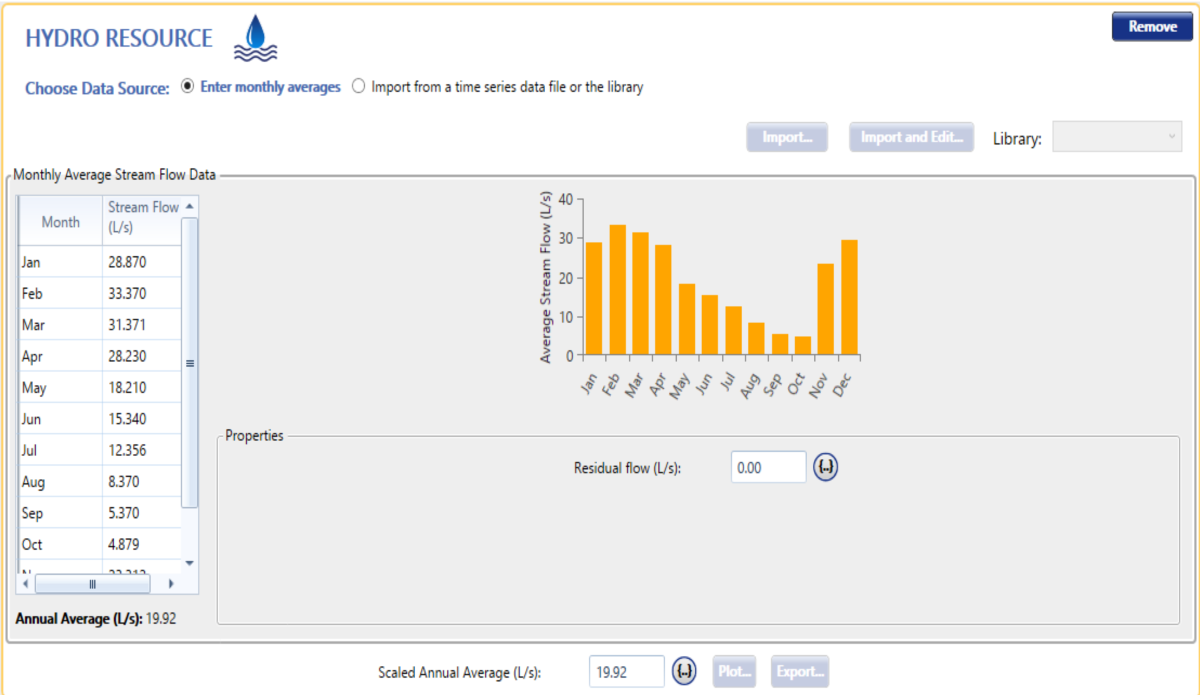

Figure 4-13: Hydropower resources for Naluwabe, Mulanje

As indicated in Figure 4.13, the annual average flow rate is 19.92 L/S with an available head of 15m. The overall efficiency of the hydropower system is 80% and based on these factors the norminal capacity of the mini-hydro scheme is 10.98kW.

4.3.4 Load Profile; Naluwade, Mulanje

The data collected was downloaded into Excel format so that it can be used to establish the load profile. This profile was established based on responses given by respondents. If the respondents mentioned the appliance they use, they were asked to give the range of time or number of hours that they will be using the appliance in daytime as well as in nighttime. These responses were plotted into an excel sheet to give the total power consumption for every hour that was used as HOMER input. The total hourly consumption was entered into HOMER software as shown in Figure 4.14.

Figure 4-14: Load profile for Naluwabe site, Mulanje

4.3.5 Proposed mini-hydro for Naluwabe

4.3.5.1 System Components and Inputs

In addition to the load, the system components included a converter and hydro turbines, generators, runners penstocks, and all the necessary components for the mini-hydro power plant. Quotations for each component were obtained from various suppliers, and details for each component input are discussed in this subsection. Based on the quotations from various suppliers, the total capital costs for the mini hydro scheme was $80,000.00. The replacement costs and the operating costs were $80,000.00 and $2,400.00 respectively. The lifespan of the scheme was 25 years. The capital costs and replacement costs for the inverter were $12,000.00

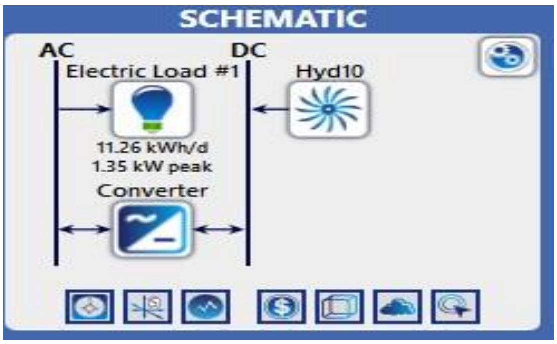

Figure 4-15: Schematic Diagram of the mini-hydro scheme, Naluwade, Mulanje

4.3.5.2 System economic input

To perform an economic analysis of the system, several economic parameters need to be entered into HOMER. These parameters include the nominal discount rate, expected inflation rate, project lifetime, fixed capital cost, and fixed operation and management cost. The nominal discount rate and expected inflation rate, based on the Reserve Bank of Malawi rates from March 2024, were 26% and 33%, respectively. The project lifetime is set to 25 years. System fixed costs were estimated by including distribution costs, costs of prepaid meters, and costs of mounting racks. According to the World Bank, the distribution cost per kilometer is $14,980. The total distance for the distribution system was measured using Google Earth and found to be 2.65 km. The total distribution cost was calculated by multiplying the measured distance by the distribution cost per kilometer, resulting in $39,697.00.

4.3.5.3 Simulation of the Results

The categorized optimization results from HOMER were displayed on the results panel, showing only one system configuration. The net present cost (NPC) of the system was $210,683.00, with a levelized cost of energy (LCOE) of $0.23 per kWh. The operating cost was $2401.00 and the initial capital cost was $80,045.00. The needs assessment findings indicate that approximately a household in Matuwamba consumes an average of 0.71kWh per day which implies that a monthly consumption for a household is 21.3kWh. The simulated results indicate an LCOE of $0.23 per kWh which means that a household is required to pay a sum of (29.1kWh*$0.23) $4.89 per month. 56% of the respondents who preferred community schemes said would afford to pay MWK2,001.00 to MWK4,999.00 ($1.14 to $2.86) per month, and 19% said would afford to pay an amount below MWK2,000.00 ($1.14). 9% said could afford to pay above MWK10,000.00 ($5.71) on electricity per month. This implies that majority of the households at Matuwamba would not afford to pay the electricity bills for this mini-grid. Given this socio-economic context, chapter 6 discusses a deployment model for such energy systems that could enhance sustainable livelihoods and affordability.

4.4 Chapter Summary

Given the favorable solar irradiation and wind speed conditions, it is technically feasible to develop solar and wind power systems at the Matuwamba site in the Mchinji district. Solar home systems would be ideal for Naluwade considering that the settlement pattern of the area is dispersed such that it would be expensive to construct powerlines. A mini hydro scheme with an estimated nominal capacity of 10.9kW would be ideal for Naluwade as well. The resource assessment has indicated that Luviri has a good solar resource that can be used to develop community-based solar energy systems or individualized solar energy systems such as solar home systems. However, detailed site assessments, including feasibility studies, environmental impact assessments, and economic analyses, should be conducted to determine the optimal sizing, design, and placement of renewable energy installations. Additionally, factors such as land availability, grid connectivity, regulatory requirements, and community considerations should be taken into account for successful project implementation. In practice, a combined renewable energy approach incorporating both wind and solar power could be considered to diversify the energy generation portfolio and maximize renewable energy production. The simulations have shown that the tariffs in all three sites would not be affordable by the communities due to the low-income status of the majority of the household owners. Given this socio-economic context, chapter 6 discusses a deployment model for such energy systems that could enhance sustainable livelihoods and affordability. However, the next chapter delves into aspects that must be considered to promote local ownership of the RES as well as the issues of capacity building. This will assist in ensuring the successful implementation of the business/financing models for RES deployment.

CHAPTER 5: LOCAL OWNERSHIP AND CAPACITY PROMOTION

This chapter outlines a comprehensive approach involving the role of government agencies, international donors and NGOs, local communities, the private sector, educational institutions, and research experts in promoting local ownership and capacity building when implementing renewable energy projects.

5.1 Skilled Labour Force Development

To address the need for a skilled labour force in renewable energy, training programs will be implemented with the collaboration of educational institutions and technical experts. The Malawi University of Business and Applied Sciences through the Department of Electrical Engineering will provide hands-on skills in renewable energy technologies, project planning, and maintenance. Community members will encouraged to participate and acquire relevant skills that enable them to efficiently install, operate, and maintain renewable energy systems such as solar home systems.

5.2 Policy Framework Creation

The Ministry of Energy and Malawi Energy Regulatory Authority (MERA) will have to be involved in developing and implementing policies that encourage local ownership and capacity building in renewable energy. These policies should create an enabling environment for community-led renewable energy initiatives which may include such things as incentives for local investment, streamlined regulatory frameworks, and supporting capacity expansion programs.

5.3 Community Empowerment

It is essential to enhance just community engagement and participation in energy projects toward more equitable access to improved services. The CEANGAL project will utilize the partnership it has with CONREMA and other NGOs, or local leaders to mobilise community members in the demonstration sites and raise awareness about how beneficial alternative power sources can be as well as what it means to empower whole societies. Participatory decision-making processes will be promoted, allowing residents in different communities to make inputs on how the projects are designed, implemented, and monitored.

5.4 Sustainable Operations

To ensure that renewable energy systems remain functional throughout their useful lives, capable technicians from within the demonstration sites will be empowered to play certain significant responsibilities. The capacity-building program is oriented towards the provision of skills and knowledge for maintenance purposes as well as technology management for the local people. Community-managed structures shall be put in place to enhance a sense of ownership and responsibility over system maintenance. This will be spearheaded by the CEANGAL team at the MUBAS's electrical engineering department.

5.5 Economic Opportunities

The development of entrepreneurial prospects in renewable energy will be encouraged with the aim of generating employment opportunities and stimulating local economic growth. Private sector involvement is being sought through investment in renewable energy projects which create space for participation by local entrepreneurs in project planning, supply chains, or service delivery. Training and mentoring programs are available to assist aspiring entrepreneurs who intend to start up and grow green businesses. This will involve partnering with financing institutions such as banks so that soft loans are provided to low-income income households intending to purchase renewable energy systems or those interested in indulging in businesses related to the productive use of energy.

5.6 Chapter Summary

The objective of the CEANGAL project is to facilitate community empowerment for sustainable renewable energy solutions in Malawi through fostering collaboration among government agencies, international donors and NGOs, local communities, private sector entities, educational institutions, and researchers. Implementing this initiative should result in a skilled workforce, an enabling policy framework, and empowered communities able to sustain the operations of RES. These initiatives will enhance access to energy, promote environmental sustainability, and foster inclusive development in rural areas of Malawi.

CHAPTER 6: SUSTAINABLE BUSINESS MODELS

6.1 Pay as You Go

The Pay as You Go, (PAYG) business model is an innovation that is aimed at providing electricity generated from renewable energy sources at an affordable cost by ensuring that customers do not pay the entire upfront cost of an off-grid energy system [6]. In this business model, an energy service provider bears the overall costs of the RES bulk purchase and sells the products to the community consumers at regular payments. In cases of defaulters, the service provider can remotely disconnect the service. In addition to community or neighborhood level i.e., mini-grids, PAYG models can be employed for individual-level systems such as solar home systems (SHS). Here a supplier bulk buys the SHSs, and the individual consumers intending to use such products can obtain them and make regular periodic payments for their use.

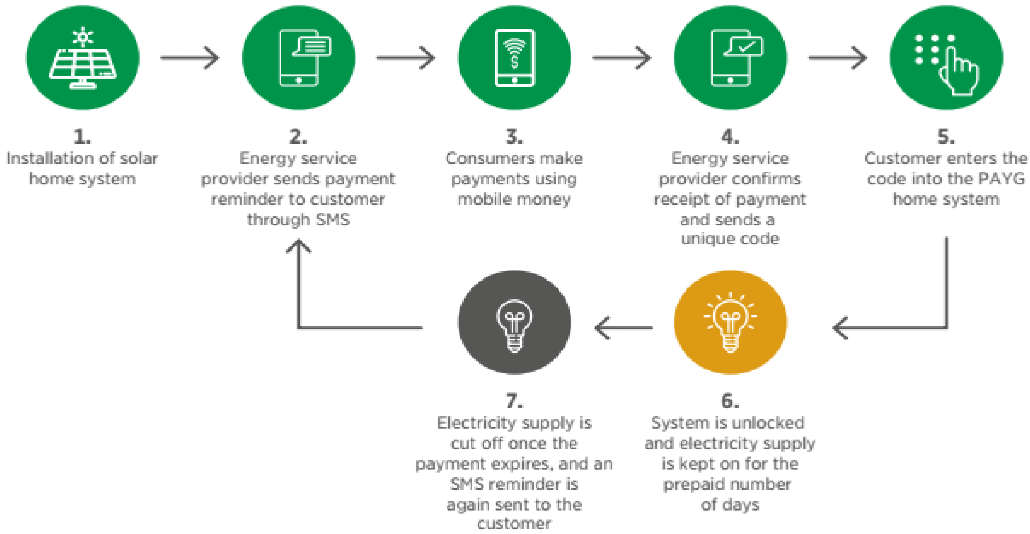

Figure 6-1: Pay as You Go Basic Concept, adapted from [6]

The Pay as You Go model can be applied to all the demonstration sites (Naluwade, Luviri, and Matuwamba) of the CEANGAL Project. The needs assessment in all these sites indicated that households cannot purchase renewable energy technologies as 59% of the households earn less than MWK50,000.000 per month. One of the issues that were noted during the needs assessment of the demonstration sites was that people had difficulties accessing RE systems and products since most energy firms that supply and provide support services for the installation, maintenance, and operation of decentralized renewable energy solutions are based in urban areas. To overcome this, such RE firms can set up booths as well as link up with sales outlets and shop owners in rural trading centres where RE systems and products can be sold. With regards to financing end users who cannot afford to pay through this model, government agencies can potentially liaise with financial lending institutions such as banks to provide loans to such households. The loan would be used to finance the household's income-generating activities and consequently enable the household to purchase the RE (i.e., solar) product as well as pay back the loan to the lending institution.

As earlier alluded, the major economic activities in the demonstration sites include farming. The community members who are into farming can utilise the PAYG model to purchase solar PV (photovoltaic) systems that would be employed in productive agricultural income-generating activities such as powering drip irrigation and crop processing. A solar PV-powered energy kiosk can also enable communities to indulge in economic activities such as mobile charging business, power computers for digital business, or power refrigerators for improved food or medical storage and icing making [8]. These activities in turn pay a charge for the consumption of the electricity consumed. Therefore, such productive uses of renewable energy systems can contribute generation of higher income for consumers. Furthermore, the payment data gathered through PAYG models can be analysed to assess the creditworthiness of customers, which can then be used in planning for other DRES projects in communities with similar economic profiles.

6.2 Fee-for-Service

In the fee-for-service model, an energy company invests in RE systems hardware - usually decentralised individual systems on individual houses - and starts selling an energy service for a fee. In this case, the energy service company (ESCO) remains the owner of the hardware and is responsible for the installation, maintenance, repair, and replacement of the RE system [13]. The end-user is responsible for paying a connection cost as well as a regular price, which is typically paid monthly but may also be charged per kWh. The end-users never acquire ownership of the system; instead, they pay as long as the energy service is provided. However, just like the national grid connections, the end-user usually owns the wiring, and appliances utilising the generated electricity.

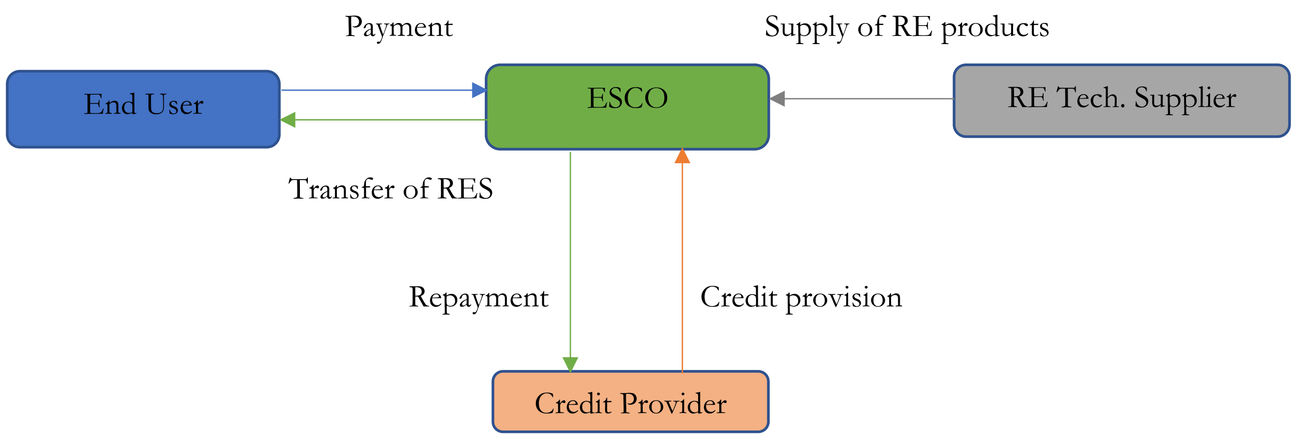

Figure 6-2: Fee-for-Service relationship diagram

The fee-for-service model is also popularly employed in mini-grid development where a developer will generate and supply electricity for a specified community at a determined electricity tariff. End users pay based on their electricity consumption. This model can be applied at Luviri Village in Mzimba and Matuwamba in Kasungu. These sites are over 10km from the national electricity grid, unlike Naluwade village which is 5km from the national grid. This is attributed to the fact that electricity from the national grid is sold at a subsidized price and therefore it would not be economically viable to implement a mini-grid that will have higher electricity tariffs as people would for cheaper electricity. Consequently, it would be only viable if the mini-grid tariffs are lower than ESCOM's tariff or subsidised.

6.3 Dealer Credit Business Model

This is an ownership business model, where the RE system supplier provides the initial credit for the system to the customer. This sees a financial institution i.e., a micro-finance institution (MFI or bank) potentially working collaboratively with an energy/technology company to provide simple and standardised (accredited) energy products together with loans to the underprivileged consumers. The micro-finance institution is responsible for the collection of down payments, monthly instalments, and system/capital recovery in case of default. The technology and support functions provided by the RE supplier include marketing, installation, customer training, and after sales service [18]. Upon full loan repayment in an agreed period, the consumer has full ownership of the RE system. There are two main forms of the dealer credit model: in the "one-hand" model, a single company provides both the RE technology and the financing, and in the "two-hand" model, the technology company and the MFI are separate entities but work closely together in a long-term partnership.

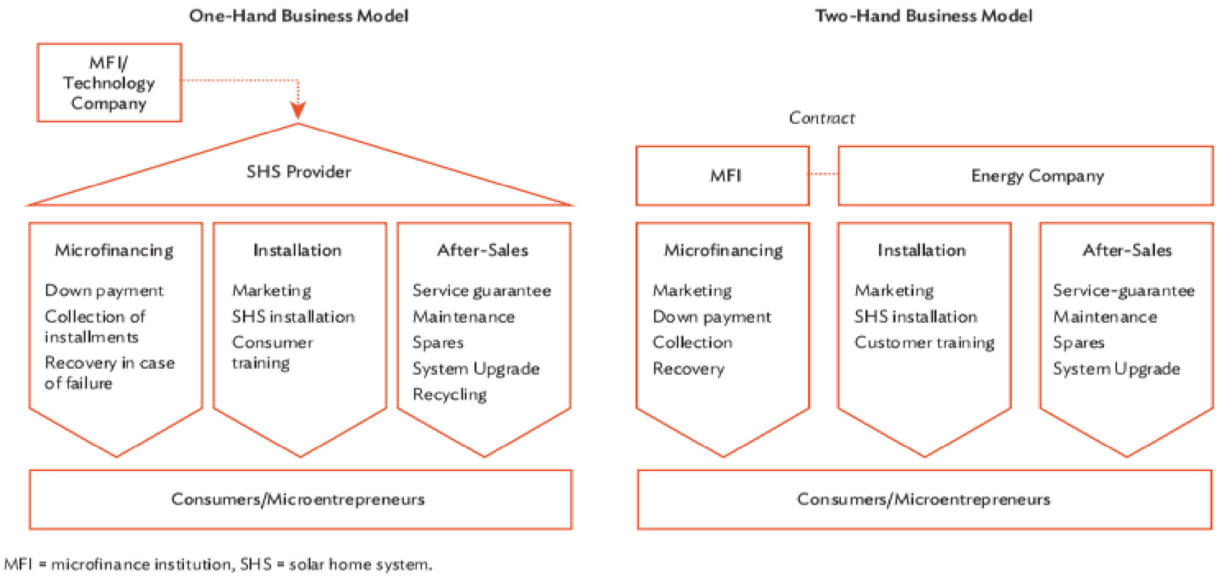

Figure 6-3: Relation diagram for the one-hand business model and two-hand business model [14]

The two-hand form makes it easier to diversify and customize energy products, but at the additional risk that the MFI may need to take over the project if the technology company fails to deliver proper services or product guarantees that are essential for loan repayment [14]. The dealership Credit Business Model can be applied to all the demonstration sites as it can be applied to both indivialised and communal-based energy systems. The model resonates with the communities' opinion that there has to be an establishment of a revolving fund so that people can borrow funds for their businesses and purchase renewable energy systems.

6.4 Lease-to-own model

The entire generation capacity (i.e., a solar home system) is paid in instalments by customers over an agreed period. This approach is also known as the "consumer finance retail" model. Ownership of the RE system may be transferred to the lessee (sometimes for an additional fee) or remain with the lessor after the contract period, depending on the terms of the agreement. [6]. If a customer consistently fails to pay the daily, weekly, or monthly rates, the the energy service provider will go to the customer's house and remove the systems. However, it has to be noted that the lease-to-own model might be difficult to apply to RE systems aggregation i.e., community-owned mini-grids where ownership responsibility is not as defined.

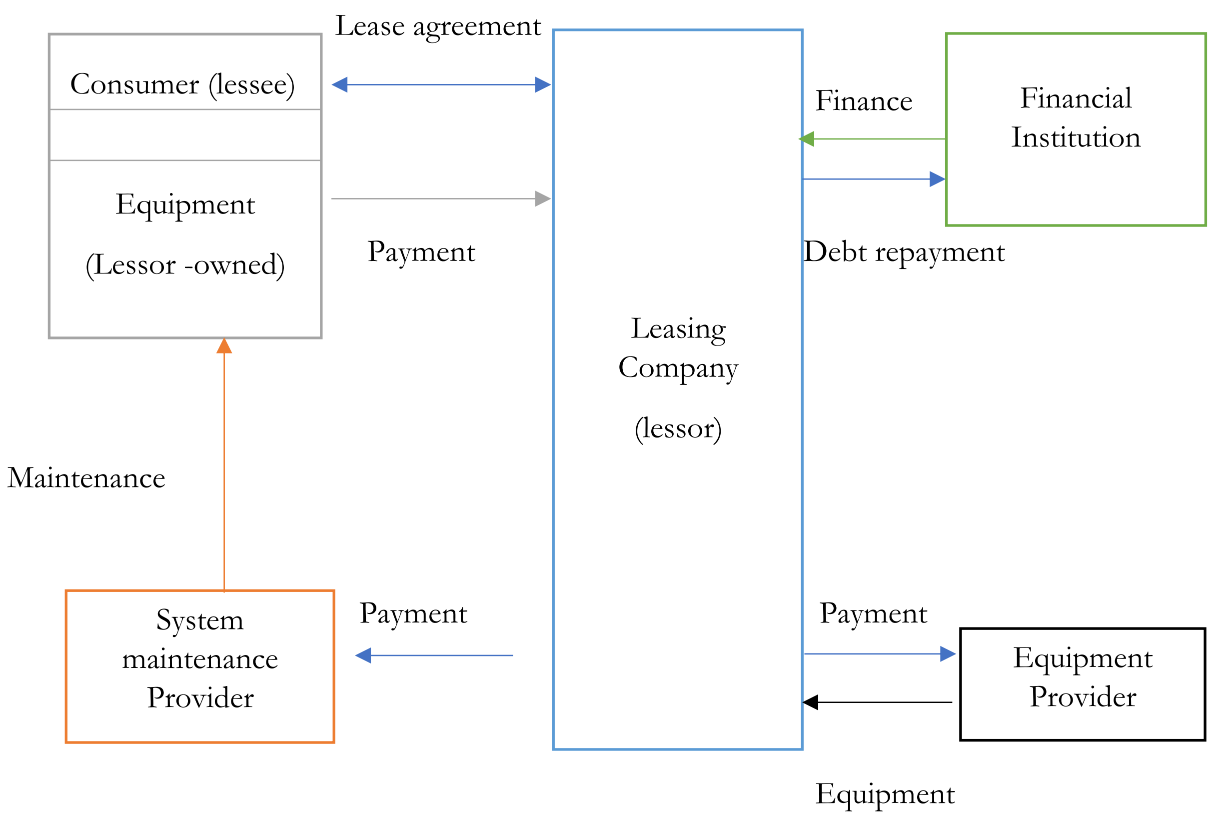

Figure 6-4: Lease or Hire Purchase Model Relationship Diagram

Because majority (59%) of the households in the demonstration sites earn less than MWK50,000.00 the lease or hire purchase model can assist the people in Naluwade, Luviri, and Matuwamba to afford the purchase of renewable energy systems such as solar homes systems. Based on the needs assessment presented in chapter 1, majority of the people in these communities can afford to lease energy systems that cost not more than MWK500,000.00 through loans.

6.5 User Cooperative

Commonly applied in the agricultural sector, a user cooperative business model or energy cooperative involves the establishment of a non-profit community organization owned and managed by its members. Projects are funded by member contributions, with or without outside private or public support [25]. The cooperative handles all administrative and operational functions, including the installation, maintenance, and safe operation of RE projects, as well as financial management and payments between users, contractors operators, and the cooperative. The tasks are usually performed by managers selected from among the members. As the managers may be volunteers, a lack of commitment and appropriate management skills may hamper the efficient management of cooperatives. The user-cooperative model provides a mechanism for governments or NGOs to support RE projects at the local level [14]. For example, an NGO or government could assist in financing such projects through up-front investment grants or interest-free loans to the user cooperative, allowing the system to be installed and reducing user charges

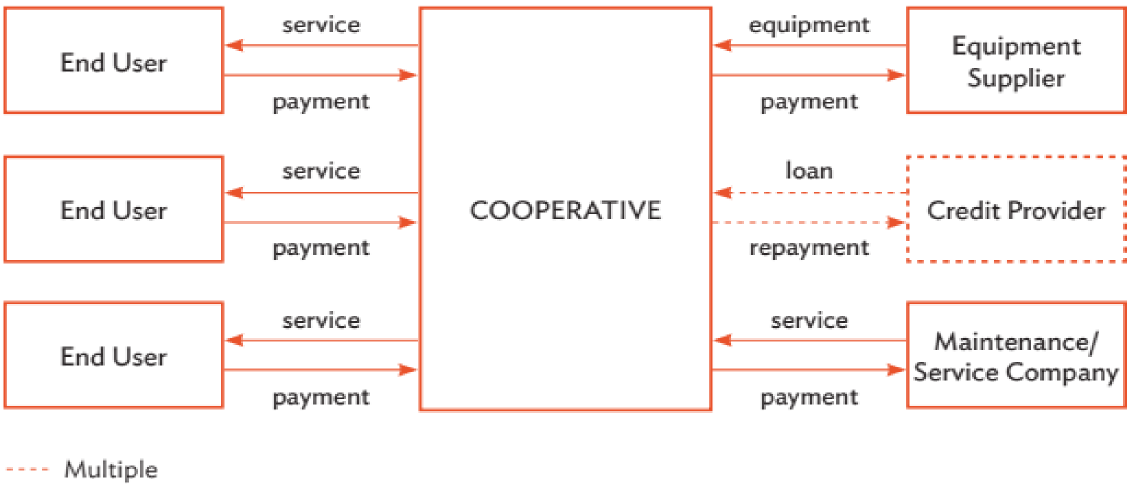

Figure 6-5: User cooperative Model adapted from [14]

The communities of Naluwade, Luviri, and Matuwamba can take advantage of the already established operational contact centres in forming groups that will generate funds through contributions that will meet large upfront capital resources to purchase home RE systems (i.e., SHS). User cooperatives are often set up for rural electrification projects such as battery charging stations, (mini-grids, and community solar systems). Experience has shown that one key to the successful application of cooperatives is active participation by the community from the inception of the project. Formal processes and a supervisory structure should be developed, and legal rules and binding contracts should be signed to secure payments with clear penalties in case of contract breaches [9].

6.6 OSUSU Micro-Financing Model

An expansion of the "OSUSU" micro-finance capital accumulation mechanism, also known as "Chipeleganyu" in Malawi, is being practiced in several African communities. How this "Osusu" works is that a group of people contribute fixed amounts periodically, with one of the groups given an upfront lump sum, with the intention that they will keep contributions so that other members can enjoy similar benefits [29]. This model has been used in various sectors including agricultural and energy sectors, to promote access to finance for purchasing farm inputs and decentralised renewable energy systems components.

Around 10% of the households in the three demonstration sites of the CEANGAL Project are already involved in a similar arrangement. The communities of Naluwade, Luviri, and Matuwamba can take advantage of the already established operational contact centres in forming groups that will generate funds through contributions that will meet large upfront capital resources to purchase home RE systems (i.e., SHS). The contributions form a basis of savings that can be utilised for providing loans or credit to members. Each member of the group can be given an upfront lump sum which can be used to purchase and install renewable energy systems such as SHSs. The borrower repays the loan through regular contributions such that funds are reinvested back into the group, replenishing the pool for savings so that the remaining members can also access the funds to purchase and install the RES. Once all the members have accessed the loan for RES purchase and installation, the same principle can be applied to raise funds for the repair and maintenance of the RESs. The groups can however be supported through technical assistance, training, or sharing best practices for sustainable energy use. In cases of defaulters, group members can agree on what collaterals (equivalent to the amount of loan borrowed) can be provided to a member. By utilising OSUSU micro-financing model in the energy sector, individuals and communities can overcome the upfront cost barrier associated with clean energy solutions. The mechanisms can empower individuals to access affordable financial options as well as promote the sustainability of RES projects in the demonstration and the entire country at large.

6.7 Local or Community Energy Agencies

Local energy agency tasked with electricity generation is formed, provide valid verifiable business and operational plans, and receives direct funding in the form of long-term soft loan from government or international agencies, with long-term payback of the capital to a dedicated "energy access improvement facility". The repayment can be through the collection of electricity tariffs from their communities. This energy access facility can then be used to finance the expansion of energy access and support of other local energy agencies in other communities.

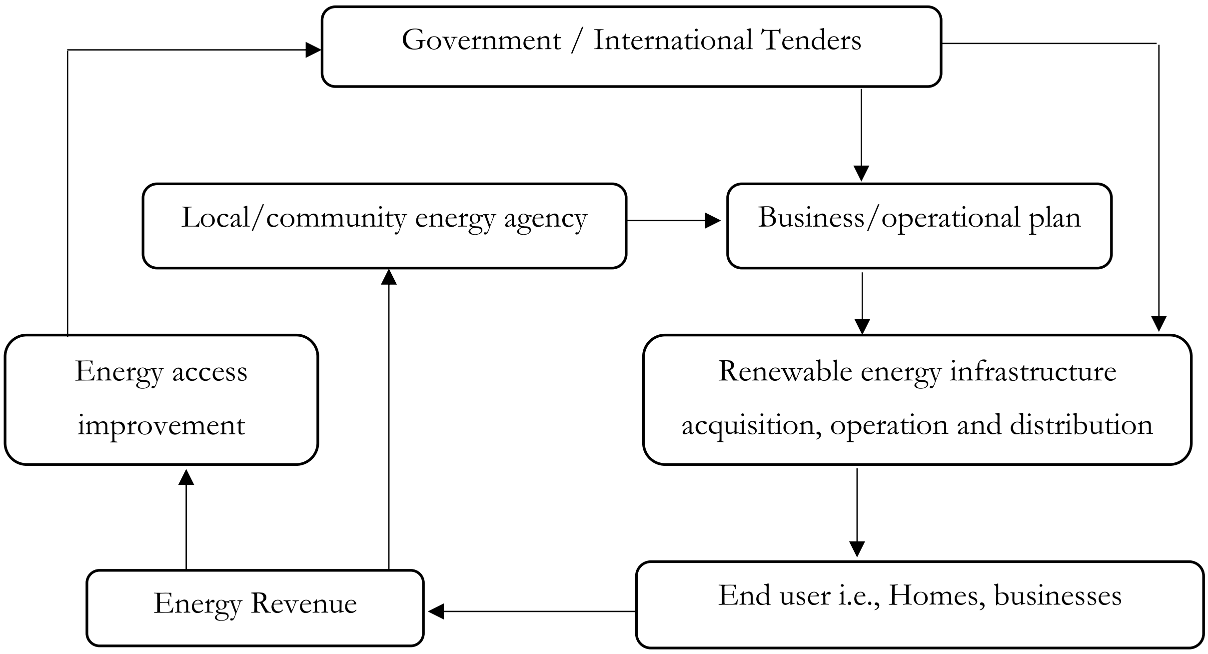

Figure 6-6: Graphic representation of the local/community energy agencies

The communities of Naluwade, Luviri, and Matuwamba can utilise the established operational contact centres in forming local energy agencies. With technical assistance from the Department of Electrical Engineering at the Malawi University of Business and Applied Sciences (MUBAS), they can develop Business and operational plans for the RE systems that can be submitted to potential funders in the form of soft loans. The loan can be repaid when the communities members in the demonstration pay tariffs.

6.8 Chapter Summary

For any financing mechanism to be successful in RE project implementation, key aspects such as customers, tariffs, revenue collection, service quality, and environmental sustainability must be considered. There is also a need to devise strategies to boost revenue generation by the RE project implementers. These may include; demand side management, productive use, and DRES clustering i.e., building more than one RE system in close proximity to another to allow interconnection hence creating more resilient power networks.

CHAPTER 7. CONCLUSION AND RECOMMENDATIONS

7.1 Conclusion

The comprehensive needs assessment and subsequent chapters highlight the critical importance of renewable energy systems (RES) in transforming the socio-economic landscape of rural Malawi. The overwhelming interest from community members in accessing electricity and adopting renewable energy underscores the urgent demand for sustainable energy solutions. The preference for community-based energy systems reflects a collective vision for shared benefits, including enhanced business opportunities and improved service delivery in essential sectors like healthcare and education. The CEANGAL project case study demonstrates the efficacy of establishing contact centre structures to foster collaboration and inclusivity, ensuring that interventions are contextually appropriate and sustainable. The emphasis on multi-stakeholder partnerships is pivotal, as it leverages the collective strengths of diverse entities including government agencies, private sector players, NGOs, and local communities. This collaborative approach is crucial for accelerating the transition to sustainable and inclusive energy systems in Malawi.

Technical feasibility studies affirm the potential for developing solar and wind power systems at various sites, highlighting the importance of detailed assessments to determine optimal system designs and placements. The combined use of solar and wind resources could diversify and maximize renewable energy production, enhancing energy security and resilience. Renewable energy projects should empower communities through capacity building, enabling policy frameworks, and sustainable operational practices. Achieving these objectives will enhance energy access, promote environmental sustainability, and drive inclusive development in rural Malawi. Finally, the success of financing mechanisms for renewable energy projects hinges on a balanced consideration of customer needs, tariff structures, revenue collection, service quality, and environmental sustainability.

7.2 Recommendations

1. **Expand Community-Based Energy Systems:**

Implementers of renewable energy projects should prioritize the development of community-based renewable energy systems to meet the high demand and preference expressed by the majority of participants. These systems should aim to create business opportunities and improve essential services, fostering economic growth and social development.

2. **Enhance Training Programs:**

For RE projects to be sustainable, Implement face-to-face training programs to build local capacity in the repair and maintenance of renewable energy systems. Tailor these programs to be accessible and practical, ensuring broad participation and skill development among community members.

3. **Strengthen Multi-Stakeholder Partnerships:**

The sustainability of RE projects needs a strong collaboration among government agencies, private sector entities, NGOs, civil society, and research institutions. These partnerships are crucial for pooling resources, sharing expertise, and ensuring the sustainability and scalability of renewable energy projects.

4. **Conduct Detailed Site Assessments:**

The findings have also demonstrated the need for project implementers to perform comprehensive feasibility studies, environmental impact assessments, and economic analyses for potential renewable energy sites. The implementers must consider factors such as land availability, grid connectivity, and regulatory requirements to ensure successful implementation.

5. **Implement a Combined Renewable Energy Approach:**

When developing DRESs, it is important to consider a diversified energy generation portfolio by combining solar and wind power systems. This approach can maximize renewable energy production, enhance reliability, and create more resilient power networks.

6. **Develop Financing Mechanisms:**

To support low-income households, project implementers must establish robust financing mechanisms that address key aspects such as tariffs, revenue collection, and service quality. There is a need to explore strategies like demand-side management, productive use, and the clustering of distributed renewable energy systems (DRES) to boost revenue generation and enhance project viability.

7. **Empower Local Communities:**

Finally, the CEANGAL framework proposes community empowerment by involving local stakeholders in the planning, implementation, and management of renewable energy projects. Empowered communities are more likely to sustain and benefit from these projects in the long term.

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Appendices

Appendix 1: Energy Needs Assessment Questionnaire

Name of Region, District, & village :		Date:	Start-Stop time:	Questionnaire number:

Type of energy consumer :	Household ☐ Business ☐ Institution ☐ Specify institution
	Household of Type:

Respondent's Demographic Data		
Respondent ID:	Phone number:	Education:
Age:	Gender:	Occupation:
Type of Bank/mobile owned	Property owned:	
Family Size:		

Energy for productive use activity type (tick the box)		
Barbershop	Welding	Retail shop
Salon	Maize Milling	Boutique/tailoring
Mobile charging	Restaurant	Pub/bar
Irrigation	Video show centre	Other:

Current energy expenses	
type of energy:	***Expenses per month (Malawi Kwacha-MWK)***
diesel/fuel	
mobile phone charging	
candles	
Battery charging	
Charcoal	
Firewood	FREQUENCY
Other (specify……)	
TOTAL:	

Consumer income source (MWK)			
	Income source	***Amount (lower bound)***	***Amount (Upper bound)***
1			
2			
3			
4			
	TOTAL:		

Consumer stated ability to pay (MWK)		
	In low seasons	in high seasons
Amount per month		

Electricity needs of the consumer					
Item	***Appliances***	***Power (in W)***	**Number of appliances**	**Daily use (in hours)**	**Total Watt-Hours**
1	Light bulbs				
2	TV				
3	Radio/CD				
4	Phone				
5	Fan				
6	Fridge				
7	Computer				
8	Pump/Weldering				
9	Others (1,2)				
		TOTAL:			

Planned load and demand forecast (only if the consumer plans to stay in the village for the next 2 years)						
Planned appliances		***Number in 1 year***	***Number in two years***	***Number in 5 years***	***Number in 10 years***	***NOTES***
1	TV					
2	Fridges					
3	Air conditioner					
4	Fan					
5	Radio					
6	Phones					
7	Computers					
8	Light bulbs					
9	Iron					
10	Others(precise)					

Energy Consumer Preferences					
	Please tick				
	Are you interested in getting connected to electricity?	YES	NO		
	If yes, through what means?	National electricity grid	Community-based energy system	Individual-based system	Other
1	What is important to you	The cost of electricity	The quality of electricity	The duration of the supply	
2	WHY What most likely will drive you to connect	Neighbors connected	Own need for electricity	Low connection fee	
4	On which base do you think the provision of electricity should be?	on a free base	on a commercial base	Don't Know	
7	If yes, how happy are you with your current electricity supply source	Very happy	Not happy	Can live with it	
8	If yes, Does your current electricity supply meet your all electricity needs	YES	NO	Percentage (if partially)	
9	Are you aware of Renewable Energy Systems, RES	YES	NO		
10	If yes, what type of RES?	1= Solar, 2=Wind, ,	3=Hydro, 4=Biogas/biomass	5=other (list)	
11	Are you interested in being trained on RES?	YES	NO		
12	If yes, are you interested in taking training courses to improve your knowledge of how to maintain such systems?	YES	NO		
13	If yes, what mode of delivery would you prefer?	1=Face to face, 2=Nearest college,	3=Online distance learning,4=Paper based distance learning,	5= Other (please list)	

14	What kind of benefits do you expect from an electrification project?				
15	Have you ever been previously involved in any renewable energy scheme?	YES	NO		
16	If yes, what kind of scheme was this?	1= Solar Pico Lights, 2=Mini-grid,	3=Solar home systems, 4= Energy Kiosk,	5=Other (please list)	
17	If yes, what was your experience (challenges and successes) with such schemes?				
18	Are you interested in adopting RESs	YES	NO		
19	If interested, will you be interested in community schemes or domestic stand-alone renewable energy systems	1= Community schemes,	2=Domestic stand-alone systems,		
20	What is the reason behind your choice?				
21	Are you willing to take a loan to support your purchase of Renewable energy systems for your household?	YES	NO		
22	If yes, up to what amount can you afford to repay these loans?	1= Below MK500,000.00	2=MK500,001 to MK1,000,000,	, 3= Above MK1,000,000.00	
23	For how long can you afford to service this loan?	1=1-6months	, 2=6-12 months,	3=1-3years,	4= 4-5 years

Appendix 2: Community Engagement Questionnaire

Dear Valued Participant, My name is Peter Sandula from the Malawi University of Business and Applied Sciences, MUBAS formerly known as The Malawi Polytechnic. The department of Electrical Engineering at MUBAS in collaboration with Atlantic Technological University Sligo is implementing a project known as "CEANGAL" meaning "connect" in Irish. The project aims to connect underserved communities to sustainable electricity, by connecting such groups to mechanisms and tools to ensure ownership and sustained operation of RES. Under this project, we are conducting a focused group discussion to learn from various players in the communities on issues of access to electricity through renewable energy systems. Additionally, we are investigating opinions and general perceptions regarding overall energy access, potential requirements, and the ability to use Renewable Energy Systems, RES. The information you provide to us will be kept strictly anonymous and confidential and will be used solely for the study.

SECTION 1: Details of the site

Village Name, Traditional Authority, District and Region

Distance of the village from the national grid in kilometers

Voltage level of the nearest powerline: 1=11KV, 2= 33KV, 3= 66KV, 3=132KV, 4=400KV

List of participants, roles, and phone contacts

Description of the village; (distance from national grid, public facilities, economic activities, estimated number of households and available energy resources

SECTION 2: Awareness of Renewable Energy Systems (RES) Project

1. Are you aware of any renewable energy project in your community or nearby community ?
2. Is the RES Project (s) functional ?
3. What are the success stories of these projects and how did the community contribute to these projects?
4. What are the challenges faced in implementing these projects and what is/was being done to address these challenges ? If the community (ies) took part please explain

SECTION3: Communication Preferences

5. Which communication channels do you frequently use or prefer for receiving information?

1=Social media , 2=Radios, 3=Community meetings/Physical visit, 4= Printed Materials, 5=Mobile PA systems, 6=SMS Text, 6=Website, 8= Telephone, 9= Other

6. How often would you like to receive updates about the RES project?

1= Weekly, 2= Biweekly, 3=Monthly, 4=Quartley, 4=Annually, 5=Neither, 6= Don't know

7. How would you prefer to share your feedback or suggestions regarding the RES project?

1=Online platforms, 2=Community meetings, 3=SMSsTelephone calls, 4=Other

SECTION 4: Community Expectations and Support

• What benefits do you expect the RES project to bring to your community? (Economic, environmental, social, etc.)

• How do you think the RES project could improve the quality of life in your community?

• What are your expectations or hopes regarding RES project?

• Are you willing to actively participate in initiatives related to the RES project? (Education sessions, skill-building programs, etc.)

• How do you think the community can support the success of the RES project?

• What challenges or obstacles do you foresee in implementing the RES project from your community participation aspect?

• How do you think these challenges can be addressed or minimized?

• Is there anything else you would like to share or any additional suggestions regarding the planning and execution of the RES project?

Thank the participants and close the interview