

**HARNESSING THE NEXUS BETWEEN MINI-GRIDS AND COMMUNITY
ENERGY RESILIENCE: A CASE OF BONDO HYDRO MINI-GRID IN MALAWI**

PhD (TRANSFORMATIVE COMMUNITY DEVELOPMENT)

VINCENT DODOMA CHIMBIZGANI MWALE

MZUZU UNIVERSITY, MALAWI

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VINCENT DODOMA CHIMBIZGANI MWALE

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**A THESIS SUBMITTED TO THE FACULTY OF ENVIRONMENTAL SCIENCES,
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FOR THE AWARD OF PhD IN TRANSFORMATIVE COMMUNITY
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DECEMBER 2025

DECLARATION

I, Vincent Mwale, declare that the work contained in the thesis is original and has been borne by myself under the supervision of my supervisors. The work has not been submitted to any other university for any degree or diploma. I believe to have conformed to the norms and guidelines given in the Ethic Code of Conduct of the Mzuzu University. Whenever I have used materials (data, theoretical analysis, and text) from other sources, I have given due credit to them by citing them in the text of the thesis and giving their details in the references. Whenever I have quoted written materials from other sources, due credit had been given to the sources by citing them.

Vincent D.C. Mwale



Signature _____

Date 11 December 2025

DEDICATION

To my wife, Glory, and the beloved daughters Christobel and Wongani, for laughter, encouragement and psychological support throughout the study.

To my late grandmother, Agness Nyamwale, and late mother, Colliness Mgemezulu, for the mentorship and guardian angel throughout my life.

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2. **Vincent Mwale.** *Renewable energy systems and community energy resilience: A case of Bondo hydro mini-grid.* Paper presented at the CRS Shelter Cluster meeting held at Sigelege Beach Resort from 2nd to 6th October 2024

LIST OF ABBREVIATIONS AND ACRONYMS

AR5	Fifth Assessment Report
ARPU	Average Revenue Per User
CBA	Community Based Approach
CBQR	Community Based Qualitative Research
CBRLDP	Community Based Rural Land Development Programme
CIF	Climate Investment Fund
DFID	Department for International Development
EEP	Energy Environment Partnership
EGENCO	Electricity Generation Company
ESCOM	Electricity Supply Corporation of Malawi
ESIA	Environmental and Social Impact Assessment
ESMAP	Energy Sector Management Assistance Programme
FGD	Focus Group Discussion
GCF	Green Climate Fund
INDC	Intended National Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
IPPs	Independent Power Producers
IRENA	International Renewable Energy Agency
MAREP	Malawi Rural Electrification Programme
MEGA	Mulanje Electricity Generation Agency
NERA	Malawi Energy Regulatory Agency
MFIs	Micro Financing Institutions

MMCT	Mulanje Mountain Conservation Trust
MMFR	Mulanje Mountain Forest Reserve
MUREA	Mulanje Rural Electrification Agency
MZUNIREC	Mzuzu University Research Ethical Committee
NAPA	National Adaptation Determined Contribution
PUE	Productive Use of Electricity
PV	Photovoltaics
REA	Rural Electrification Agency
REF	Rural Electrification Fund
SAPs	Structural Adjustment Programmes
SDG	Sustainable Development Goal
SHS	Standalone Home System
SLF	Sustainable Livelihood Framework
SSKII	Semi-Structured Key Informant Interviews
TLU	Tropical Livestock Unit
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change

TABLE OF CONTENTS

DECLARATION	i
DEDICATION	ii
ACKNOWLEDGEMENTS	iii
PUBLICATIONS DECLARATION	v
LIST OF ABBREVIATIONS AND ACRONYMS	vii
TABLE OF CONTENTS	ix
LIST OF TABLES	xvi
LIST OF FIGURES	xvii
ABSTRACT	xix
CHAPTER 1: INTRODUCTION	1
1.1. Background Information	1
1.2. Problem Statement	4
1.3. Research Objectives	6
1.3.1. Main Objective	6
1.3.2. Specific Objectives	6
1.3.3. Research Questions	6
1.4. Rationale and Significance of the research	8
1.5. Uniqueness and distinctness of the study	10
1.6. About Bondo Community as a study site	12
1.7. The conception of a mini-grid in Bondo	14
1.7.1. Types of Housing in Bondo	17

1.7.2.	Bondo as a Mini-grid	18
1.7.3.	Tariff structure of Bondo Electricity.....	29
1.7.4.	Briquette Making with use of mini-grid electricity	30
1.8.	Structure of the report	31
CHAPTER 2: LITERATURE REVIEW		33
2.1.	Climate Change and other stressors	33
2.2.	Mitigation and adaptation to climate change and other stressors.....	34
2.3.	Concepts and Definitions	39
2.3.1.	Resilience.....	39
2.3.2.	Community Resilience.....	45
2.3.3.	The Resilience of Rural Energy Systems.....	50
2.3.4.	Community energy resilience	56
2.3.5.	Nexus	61
2.3.6.	Co-design Approach	62
2.4.	Community-Based Qualitative Research (CBQR).....	68
2.5.	Sustainable Livelihood Framework Versus Community Resilience.....	69
2.6.	Related work within Community Energy Resilience	75
2.6.1.	Enhancement of community resilience with electricity access.....	76
2.6.2.	Enhancement of energy-system resilience.....	83
2.7.	Malawi: Economy, Electricity Sector and Vulnerability	92

2.7.1.	The establishment of central government in Malawi.....	94
2.7.2.	Climatic conditions of Malawi.....	95
2.7.3.	The economy and sources of livelihoods of the people of Malawi	96
2.7.4.	Malawi’s Electricity Sector.....	97
2.7.5.	Vulnerability Context in Malawi at Macro level	118
2.7.6.	The economic outlook of Malawi before Independence.....	118
2.7.7.	The economic outlook of Malawi after independence.....	123
2.7.8.	Vulnerability Context in Malawi at Micro-Level	131
2.8.	Mulanje District.....	134
2.8.1.	The History of the people of Mulanje and the land issue	137
2.8.2.	Vulnerability in Mulanje District.....	138
2.8.3.	Mulanje Mountain.....	141
2.8.4.	Community based Rural Land Development Programme (CBRLDP).....	146
2.8.5.	Economic potential of the district	149
2.9.	Related work on co-design.....	151
2.10.	Theoretical perspectives	151
2.11.	Conceptual Framework	153
CHAPTER 3: MATERIALS AND METHODS		157
3.1.	Introduction	157
3.2.	Research Design and approaches	157

3.3. Data Collection Methods.....	158
3.3.1. Focus Group Discussions (FGDs)	159
3.3.2. Semi-Structured Key Informant Interviews (SSKIIs).....	162
3.3.3. Co-design workshops.....	162
3.3.4. Meetings.....	164
3.3.5. Field Observations	165
3.3.6. Field visits to other mini-grid establishments in Malawi	165
3.4. Reliability and validity of data collected.....	165
3.5. Data analysis	166
3.6. Limitations of the study.....	167
3.7. Ethical Consideration	169
CHAPTER 4: RESULTS.....	171
4.1. Introduction	171
4.2. Benefits of electricity in Bondo Community	171
4.3. Vulnerability and early warning systems in Bondo Community	173
4.4. Early warning systems in the community	175
4.5. Enhancement of the resilience of community/households.....	176
4.6. Enhancement of the resilience of Bondo Hydropower system	177
4.7. Enhancement of the community energy resilience	181
4.8. Management of the Load Factor and future plans of Bondo Mini-grid	181

4.9. Co-design as outcome within the community energy resilience.....	182
4.9.1. Canning Factory.....	183
4.9.2. Electric cooking with hot plates.....	184
4.9.3. Electric cooking with pressure cookers	185
CHAPTER 5: DISCUSSIONS	187
5.1. Introduction	187
5.2. Major causes of vulnerability of Bondo community.....	187
5.2.1. Shortage of land and land degradation.....	187
5.2.2. Maize as a staple food not doing well in the area	189
5.2.3. The decline of the banana industry	190
5.2.4. Economic and exogenous shocks.....	191
5.2.5. The Cycle of Poverty	193
5.3. Opportunities and barriers for enhancing the resilience of Bondo Community	193
5.3.1. Opportunities/barriers in animal farming in Bondo.....	194
5.3.2. Opportunities/barriers with bee-keeping.....	194
5.3.3. Opportunities/barriers in fish farming	195
5.3.4. Employment in tea estates and other sectors	196
5.3.5. Opportunities/barriers for irrigation farming	197
5.4. Climate change and its impact on Bondo Community.....	198
5.5. Enhancement of the resilience of Bondo Mini-grid as an energy system.....	200

5.5.1.	Financial and technical resourcefulness.....	201
5.5.2.	Regulation and Registration Challenges	204
5.5.3.	Institutionalisation of Rural Electrification Agency (REA)	205
5.5.4.	Promotion of Productive Use of Electricity (PUE).....	207
5.5.5.	Load Profile and power demand management.....	208
5.5.6.	Capacity Building and Cross-Sector Linkages	209
5.6.	Enhancing community energy resilience of Bondo	210
5.6.1.	Framework for enhancement of CER at Bondo with canning factory.....	211
5.6.2.	Upgrading of the Bondo.....	213
5.6.3.	Framework with the establishment of REA.....	215
5.6.4.	The mini-grid customers not subsidised vs grid customers subsidised	217
5.6.5.	The “dumping” of electricity access in rural areas	218
5.7.	Some pertinent themes that are important to the study	220
5.7.1.	Community Resilience – at a crossroad of mini-grid, biodiversity and watershed 220	
5.7.2.	Energy, water and biodiversity nexus	223
5.7.3.	Electricity by grid or mini-grid – not an easy path	225
5.7.4.	Concessional agreement in managing the Mulanje Mountain Forest Reserve	227
CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS.....		230
6.1.	Introduction	230

6.2. Summary of Key Findings	230
6.3. Implications to policy	233
6.4. Recommendations for future research.....	234
6.5. Concluding Remarks	235
REFERENCES	237
APPENDICES	311
Appendix 1: Guideline for FGD and SSKII.....	311
Appendix 2: Summary on the number and gender of participants and time taken for each of FGD at village level	314
Appendix 3: Ethical Approval from (MZUNIREC)	315
Appendix 4: A summary of the frequencies of mentioned disasters.....	317
Appendix 5: Co-design ideas and their frequencies through SSKIIs and FGDs	318

LIST OF TABLES

Table 1-1. Comparison of tariff structures between MEGA and ESCOM as of October 2023 ...	29
Table 2-1. Installed and available electricity available in Malawi in 2023	102
Table 2-2: Major renewable energy projects under IPP in Malawi in 2022	103
Table 2-3. Major mini-grid establishments in Malawi in 2023	116
Table 2-4. Historical economic growth rates of Malawi averaged 5 years and suggested reasons	124
Table 2-5. Comparative characteristics of the population of Mulanje District against southern region and national data	140
Table 2-6. Population densities of some districts in Malawi in 2008	146
Table 2-7. A summary of differences between the settlers and receiving communities	148

LIST OF FIGURES

Figure 1-1. Location of Bondo Community in relation to Mulanje Mountain in Mulanje District	12
Figure 1-2. The terrain of Bondo Community showing trees and tea shrubs	13
Figure 1-3. A photo of women involved in collection of sand from the river for sale.	14
Figure 1-4. A photo of a standard house found in Bondo Community.....	17
Figure 1-5. Grass thatched house that is mostly do not qualify to get connected to electricity. ..	18
Figure 1-6. Schematic representation for the layout of Bondo Power Plants.....	20
Figure 1-7. A photo of Lichenya River as the water passes through the tree overgrowth and rocks from the mountain.....	21
Figure 1-8. A photo showing diverted water from Lichenya River directed to the siltation chamber of Bondo 1.....	22
Figure 1-9. A photo of showing part of the 238 m long channel for Bondo 1.	23
Figure 1-10. A photo showing the forebay on Bondo 1.	24
Figure 1-11. A photo showing a penstock in the tea shrubs to Bondo 1.	25
Figure 1-12. A photo showing inside Bondo 1 powerhouse where electro-mechanical equipment, mainly turbine and generator, are housed.	26
Figure 1-13. A photo showing a step-down transformer and the houses benefiting from the mini-grid.	27
Figure 1-14. A photo showing the power house for Bondo 3 which also serves as the control room for all the power plants.....	28
Figure 1-15. A photo showing a briquette making machine with some feedstock at Bondo 3	31
Figure 2-1: A diagram depicting resilience as a process and as an outcome.....	41
Figure 2-2. Schematic definition of Resilience.....	43
Figure 2-3. Institutional Framework affecting mini-grid resilience	54
Figure 2-4. The connection between the enhancement of the resilience of energy system and the resilience of the community.....	58
Figure 2-5. The Woman and Child in Bondo vs traditional and Modern Thermal Energy Access	60
Figure 2-6. Steps of a co-design process.	65

Figure 2-7. The Sustainable Livelihood Framework.	70
Figure 2-8. Lifting Households Towards Resilience.	74
Figure 2-9. Map of Malawi showing ESCOM transmission lines, generation and load centres..	98
Figure 2-10. Comparison of electricity access rate in SADC Countries.	100
Figure 2-11. Major sources of existing and untapped hdropower sites.	100
Figure 2-12. Total cost of obtaining permits to set up a mini-grid facility in the 17 surveyed countries.	113
Figure 2-13. Comparison of days before securing a generation license in selected countries. ..	114
Figure 2-14. Comparison of days between securing environmental clearance in selected countries.	1145
Figure 2-15. African Lakes Company ivory store with carriers, c.1889, photographed by Frank Moir, joint manager of the ALC.	120
Figure 2-16. Map showing Mulanje District with Mulanje Mountain stretching into nearby Phalombe District.	135
Figure 2-17. Landsat image of Mulanje Mountain.	142
Figure 2-18. Mulanje Mountain with tea plantation on flatland.	143
Figure 2-19. Conceptual Framework for the enhancement of Community Energy Resilience..	155
Figure 3-1. A schematic diagram showing a summary of how data was analysed.	166
Figure 4-1. Compilation of the main stressors affecting Bondo area. N=91.	166
Figure 4-2. The community’s suggested ways of enhancement of the resilience of Bondo Mini-grid.	178
Figure 5-1: A diagram showing the impacts of COVID-19 to the various sector of Malawi's economy.	192
Figure 5-2: A diagram of the suggested Framework for the enhancement of Community Energy Resilience at Bondo Community	212
Figure 5-3: A diagram showing the flow of support to mini-grid with institutionalisation REA and without REA.	216

ABSTRACT

Provision of electricity access has the potential for economic transformation and resilient building of rural poor. However, the linkage is elusive in many communities and instead the survival of rural electrification including mini-grids is affected. A study on Bondo Community and Bondo Mini-grid in Mulanje District was conducted to understand the dynamics of building the resilience of the community together with building the resilience of mini-grid. The study involved 17 FGDs, 16 SSKIs, three co-design workshops, meetings, field observations and field visits to three other mini-grid establishments in Malawi. Thematic narrative analysis with use of NVIVO (2020) Student Licence was used in data analysis. The findings reveal that access to electricity on its own hardly lead to sustainable development and resilient building of rural communities. The study had shown that socio-economic and transformation of rural communities with electricity access can only be realised when electricity is promoted alongside broader goals of transformation and resilience building. Mini-grids can barely survive on their own, hence the need for dedicated external and state funding. Streamlined regulations and availability of competent personnel for mini-grids are also crucial. The country needs to institutionalise REA and the need for coherent coordination among different stakeholders. The priority of Bondo Community include support for the establishment of a factory for processing fruits and support toward electric cooking. Four separate themes came out of the study are: community resilience – at a crossroad of mini-grid, biodiversity and watershed; the nexus of energy, water and biodiversity; electricity by grid or mini-grid - not an easy path for rural communities and the need for a concessional agreement of managing MMFR.

Key words: *co-design, resilience, nexus, thematic narrative analysis*

CHAPTER 1: INTRODUCTION

1.1. Background Information

The fulfilment of UN Agenda 2030, and Malawi 2063 AU Agenda 2063 is heavily threatened by the frequent threats of climate change, climate variability, land use change, degradation of ecosystems, poverty and inequality, and cultural factors (Lama, Per and Bergstrom, 2017). The greatest threat is climate change hence the urgent call for building the resilience and adaptive capacity of the vulnerable people. This is because climate change undermines the progress of humanity and in other cases reversing the progress that had been achieved.

Halkos (2015) reported that tropical areas, such as Malawi, have higher risks of climate hazards. This is supported by the International Panel for Climate Change (IPCC) fifth assessment report AR5, which identified the country to be at high risk to the adverse effects of climate change (Malawi Government, 2019a). The other challenge is that over 90% of Malawi's population are reported to have low capacity of adaptation to climate change hazards (Malawi Government, 2006). The impact, frequency and spread of hydro-meteorological and climatic hazards such as floods and droughts had been on the increase and expected to worsen in future due to climate change (The World Bank, 2016 & World Bank, 2019a). The country's high vulnerability to extreme weather events has also been attributed to its location within the great African Rift Valley (Malawi Government, 2019a).

While floods and droughts are the most significant and recurring risks in Malawi and can be attributed or being worsened by climate change, other factors such as rapid population growth, environmental degradation, high poverty levels, economic factors such as high inflation and volatile exchange, and exogenous shocks such as COVID-19 and Russia-Ukraine conflicts

exacerbate the existing challenges. In addition, the recurring corruption crises that incite fiscal crunches and aid withdrawals and deterioration of public service (Cammack, 2017), are contributing to miseries of the general communities. The accumulation of these have resulted into high levels of poverty, more especially in rural areas, where 85 percent of Malawi's population lives. With the likelihood of increased frequency and severity of natural and man-made hazards in Malawi, new approaches and new ways of doing things are required to facilitate recovery and resilience building of the vulnerable communities.

Modern energy extended to the vulnerability society can have overreaching effect in the transformation and attainment of resilient and sustainable development. The importance of access to modern energy diffuses in all facets of life, from improved human welfare, increased access to water, increased productivity in agricultural and industrial sector, improved healthcare, improved education to environmental sustainability among many others (Odarno *et al.*, 2017; Traeger *et al.*, 2017; Roser, Mispy and Ortiz-Ospina. (2018) proclaimed that modern energy is central to nearly every major challenge and opportunity the world faces today while World Bank (2017) reported that the provision of access to modern energy is interconnected to 125 of the all 169 targets of SDGs.

Guaranteeing the continuity and affordability of electricity to low-income households for the promotion of social, economic and environmental development has two broader challenges. The first challenge is that the provision of electricity on its own has been observed not to be enough for fostering the sustainable development of target areas (Garniati, Owen and Kruijsen, 2014; Bruderle, Attigah and Bodenbender, 2011). More effort requiring different stakeholders' input including how the community perceives themselves and their situations, is needed to compliment electricity access. The second challenge is that rural electrification does not make economic sense

with energy systems failing to survive even beyond their pilot phases (Luc, Bordeleau and Young, 2015).

The low-income and rural population is characterized by resource poor, mostly illiterate with limited analytical capability, has limited land resource, low economic productivity, poor infrastructure, limited credit opportunities, poor health condition due to HIV/Aids and malnutrition (Verner, 2004; Arrehag *et al.*, 2006; Bangura, 2013). Such is affecting the willingness and affordability of electricity and appliances. Such characteristics is preventing the privileged rural people who have been provided with electricity access not to realise the socio-economic and transformative effect of electricity. The low consumption of electricity in rural areas result to lower energy sales by the energy provider thereby affecting the financial and technical resourcefulness of rural electrification project including mini-grids.

There are interconnections and interdependencies of the community development on one hand and the survival of the electricity delivery system (Gebregiorgis, 2024; To and Vallecha, 2024). This is because the sectors of building the resilience of community and building the resilience of the energy system or project are intertwined and that dealing with one sector should not have undesirable effect on the other. The study had therefore employed the nexus approach.

The building of resilience of the community and energy system requires collaboration, learning and information exchange among stakeholders (Sharifi and Yamagata, 2016). The alignment of different goals and interest of stakeholders with the concept of nexus requires multi-disciplinary and trans-disciplinary approaches. Such being the case, participatory approaches with involvement of government representatives, the private sector, energy provider, energy regulator, communities, academia etc. is preferred. Community members or their representatives had been put at the forefront of the stakeholders' engagement. This has the advantage of harnessing the community's

specialized and experiential knowledge, collective mighty capacity and significant roles to play. In such a case the actual needs, priorities, perception of the vulnerable communities are taken on hold in building their resiliencies.

A study on Bondo Community and Bondo Mini-grid can help in understanding the dynamics of building the resilience of the community together with building the resilience of the energy systems for rural electrification. Bondo Hydropower Mini-grids provides access to electricity to over 2000 households, various businesses and social sectors provide the opportunity for the study.

1.2. Problem Statement

Rural communities in developing countries such as Malawi face significant challenges which are be grouped into climate change, economic shocks and exogenous shocks, and these hinder their socio-economic development and resilience building (Malawi Government, 2018b; Vorobyov and Bugai, 2019; Chishimba and Wilson, 2021). The heaviest impact is brought by climate change which has resulted to increased frequency and severity of droughts, cyclones and floods. With continued dependence on climate sensitive livelihoods such as rainfed agriculture, climate change and its impacts have resulted to decreased crop yields, which in turn has resulted to food insecurity, poverty and displacement. So many interventions have been implemented but the characteristics of rural people of low levels of education, low analytical skills, high population growth among others leave rural people in continuous cycle of vulnerability. The intervention of providing electricity to rural and vulnerable communities is regarded as a huge driver for rural transformation and a prerequisite for spurring the socio-economic development (Terrapon-Pfaff *et al.*, 2018) (Torero, 2016) (World Bank, 2017b) (Diallo and Moussa, 2020) (Salite *et al.*, 2021) (Zaman, van Vliet and Posch, 2021). This is because the lack of electricity access in rural areas of developing

countries including Malawi inhibit the people to generate own resilient and decent livelihood options. Much as the low electricity access rate is so huge a challenge, there are intriguing factors that prevent the privileged few that have electricity fail to move out of poverty and embark on leading resilient livelihoods. Issues of lack of affordability of electricity and appliances and the unwillingness to pay for electricity prevent rural communities to have maximised benefit from electricity access. The building of resilience of rural communities with electricity access is not realised with communities failing to have increased electricity consumption. The low consumption of electricity affects sustainability of rural electrification projects due to low load factor and low electricity sales. This result to the proliferation and sustenance of rural electrification projects including mini-grids being heavily affected in terms of financial and technical resourcefulness. This means the resilience of the energy systems for rural projects cannot be realised (Terrapon-Pfaff *et al.*, 2018) (Riva *et al.*, 2018). Bondo Community as a rural area with access to electricity from a mini-grid, provided a good case study for understanding different ways of enhancement of resilience of an energy system and the enhancement of the resilience of the community. This is because the community has low electricity consumption against available power and the people meaning it has not benefited much in terms of socio-economic development and resilience building from the electricity access. The study considered options for the understanding of how electricity usage can be increased so as to result to resilient and transformative livelihoods. With the increased electricity sales, it is expected that the energy provider will have the benefit of improved financial and technical sustainability or resilient energy system.

1.3. Research Objectives

1.3.1. Main Objective

The main objective of this study is to investigate the factors for simultaneous enhancement of the resilience of community-led mini-grid and the enhancement of community resilience.

1.3.2. Specific Objectives

The specific objectives are:

1. To assess the mitigation and adaptive measures that rural community engage against different stressors;
2. To evaluate measures that are important for the success or failure of mini-grids in the country;
3. To examine the contribution of Bondo Mini-grids to the sustainable development of the area;
4. To appraise the community's practices for enhancing their resilience and the resilience of their energy system; and
5. To conduct co-design for the enhancement of the community energy resilience.

1.3.3. Research Questions

The study is aimed at answering two main questions: (1) what should it take for a rural community to have enhanced resilience building from electricity access? and what does it take to ensure the enhancement of the resilience of rural electrification projects? The detailed sets of questions corresponding to the above questions are as follows

1. Assessing Mitigation and Adaptive Measures:

- i. What are the various climate-related stressors and other challenges affecting the community in the study area?
- ii. What strategies do rural communities in Malawi employ to mitigate and adapt to climate-related stressors and other challenges?
- iii. How effective are these measures in enhancing community resilience and reducing vulnerability?
- iv. What are the gaps in current mitigation and adaptation measures that need to be addressed?

2. Evaluating Mini-Grid Success Factors:

- i. What technical, economic, and social factors contribute to the success or failure of mini-grids in rural Malawi?
- ii. How do community engagement, participation, and ownership impact the sustainability of mini-grids?
- iii. What role do policies and regulations play in supporting or hindering the development of mini-grids?

3. Contribution to Sustainable Development:

- i. How do mini-grids contribute to the economic, social, and environmental development of rural communities in Malawi?
- ii. What are the impacts of mini-grid electricity on household income, health, education, and livelihoods?
- iii. How can mini-grids be designed and implemented to maximize their contribution to sustainable development?

4. Community Practices for Resilience Enhancement:

- i. What practices and strategies do rural communities employ to enhance their resilience and the resilience of their energy systems?
- ii. How do community-based initiatives and social networks support resilience building?
- iii. What are the key factors that influence the effectiveness of community-led resilience initiatives?

5. Co-Design for Community Energy Resilience:

- i. How can co-design approaches be used to develop and implement effective community energy resilience interventions?
- ii. What are the benefits and challenges of co-design approaches in building community energy resilience?
- iii. How can co-design processes be scaled up and replicated in other contexts?

1.4. Rationale and Significance of the research

The justification for this study lies in the critical need to enhance community resilience and sustainability of community-led mini-grids in rural areas. With increasing climate variability, energy insecurity, and socio-economic challenges, rural communities require robust and adaptive energy systems that can support their development and well-being. This study is important for several reasons as explained:

1. **Energy Access and Poverty Reduction:** Community-led mini-grids have the potential to provide reliable and clean energy access to rural communities, thereby reducing energy poverty and promoting economic development;
2. **Climate Change Adaptation:** By assessing mitigation and adaptive measures, this study has informed strategies to enhance community resilience to climate-related stressors and promote sustainable development;
3. **Sustainable Development:** The study has examined the contribution of Bondo Mini-grid to sustainable development, providing insights into the impact of electricity access on economic, social, and environmental outcomes;
4. **Community Empowerment:** By co-designing solutions for enhancing community energy resilience, this study has contributed to the empowerment of local communities so as to take ownership of their energy systems and make informed decisions about their energy future; and
5. **Informing Policy and Practice:** The study's findings has provided valuable insights for policymakers, development agencies, and practitioners working on energy access and community development initiatives, informing policy and practice that supports sustainable and resilient energy systems.

By achieving its objectives, this study has contributed to the body of knowledge on community-led mini-grids and community resilience, providing practical and relevant insights for enhancing the sustainability and impact of these initiatives.

1.5. Uniqueness and distinctness of the study

This study on rural electrification and energy access in Malawi has several unique features that distinguish it from other studies. Some of these features include:

1. The study focused on community-led mini-grids, which is a unique approach to rural electrification. By examining the Bondo Community's experience with a mini-grid, the study provided insights into the potential benefits and challenges of community-led energy initiatives. - The study has also highlighted the importance of productive use of energy in promoting economic development and improving livelihoods in rural areas. This approach recognizes that energy access is not just a social issue, but also an economic one (Riva *et al.*, 2018);
2. The study has addressed contemporary topic of turning energy access to improved livelihood outcome as SDG 7 which is also linked to several other SDGs. It has revealed in part that indeed electricity is an essential part of modern life and its importance is manifested in its linkage to the wider development agenda, including the interconnection to 125 (74%) of all the 169 SDG targets (World Bank, 2017b);
3. The nexus approach of combining the technical aspect of engineering and energy in particular, and the social aspect of community development moves beyond the traditional sectoral thinking. The approach is deeper than the normal nexus of water-energy and food. The nexus approach has been used together with co-design on community intervention, where community members take the lead in defining and implementation of intervention, and this provides novel approach within the academic circle;
4. The methodology used and lessons learnt with use of bottom-up approach provide mutual learning of researchers, community members and employees of the utility among other

stakeholders. It is hoped that community members will be able to continue with the approach of defining own problems, designing own solutions and more importantly implementing what had been designed other than expecting all solutions to come from researchers, donors and government among other benefactors. Such approach is also hoped to provide some form of empowerment and awakening on the part of community;

5. The study has managed to identify and aggregate success factors from past experiences and identify common themes that should enable existing and future mini-grid developments to become more resilient and sustainable. This is because some of the factors that affect the resilience of Bondo Mini-grid are similar to many other mini-grids. These factors have included policies and regulations, institutional frameworks, delivery models and financing, technological solutions, capacity building and cross-sector linkages (IRENA, 2018 & Luc, Bordeleau and Young, 2015) (V. Mwale *et al.*, 2024);
6. The study has managed to introduced a new term of community energy resilience, which has contributed to the better understanding of the contested concept of resilience. Proper understanding of the term has been possible through splitting the words into community resilience as lined to sustainable livelihood framework and energy system resilience within the domain of resilience engineering in the context of a mini-grid. The understanding of the concepts as used in the study have resulted into three journal papers (V. Mwale *et al.*, 2024) (V. D. Mwale *et al.*, 2024) (Nkhoma, Mwale and Ngonda, 2024) thereby contributing the new and contemporary thinking to the global knowledge; and
7. The study was also done close to the diversity hotspot which has provided the opportunity on the linkage of community resilience as part of the conservation effort of flora and fauna.

The result had been a paper that has discussed how energy, water and biodiversity can be managed sustainably (V. D. Mwale *et al.*, 2024)

1.6. About Bondo Community as a study site

The study was carried out in Bondo community on the slopes of the Mulanje Mountain and closer to the Bondo Health Centre as in the Figure 1-1.



Figure 1-1. Location of Bondo Community in relation to Mulanje Mountain in Mulanje District.

((Source: Google Map (2025))

Bondo Community is on the foot of Mulanje Mountains and has an undulating profile as in the Figure 1-2.



Figure 1-2. The terrain of Bondo Community showing trees and tea shrubs. (Source: Photo by the Author)

With the clay type of soil and being on the windward area of the mountain, Bondo Community receives comparatively high rainfall. Such an environment is conducive for the growth of tea, avocado pears and pineapples. Maize cannot do well in such type of soils and the cold weather emanating from the mountain. The flow of water from the mountain carries with it some sand, which is collected downstream as in Figure 1-3. The sand is used in construction works hence people collect it and sell to earn some money.



Figure 1-3. A photo of women involved in collection of sand from the river for sale. (Source: the author)

The collection and sale of sand as an income activity is very useful as this is done during the dry season when farm work has been completed.

1.7. The conception of a mini-grid in Bondo

Bondo is the name of a village in which the three power plants have been constructed, but currently, Bondo Community is referred to the total area that is served by the Bondo Mini-grid. So far, the community continues to expand with 17 villages in 2021 and 21 villages in December 2022. The community was reported to have a population of 25,000 inhabitants of which 8,280 are smallholder farmers engaged in tea growing, while 10-18 percent of the adult population were

employees in the tea industry as of 2015 (Akker and Nyasulu, 2016). Apart from employment and growing of tea as smallholder farmers, Akker and Nyasulu (Ibid) also reported that the area is provided with relatively steady income through farming of avocados, pineapples, mangoes and litchis.

It was reported that the powerhouse for lower Bondo is 8 km from the national grid meaning that the likelihood of the area having access to electricity within the near and distant future was very remote. The idea of generating of electricity taking advantage of Lichenya River in Mulanje for community use is reportedly to have been hatched before 2007. The concept was hatched by Mulanje Mountain Conservation Trust (MMCT) as an exit strategy from a project called Programme for Basic Energy and Conservation in Southern Africa (ProBEC). MMCT is an environmental endowment trust that is supporting research and conservation activities around Mulanje Mountain. The project of ProBEC focused on provision of cookstoves such as chitetedzo mbaula, ken stove and rocket stoves for the efficient use of firewood and charcoal. Mulanje Renewable Energy Agency (MuREA) as an implementation arm of MMCT was formed with the aim of conserving biodiversity through provision of alternative forms of energy. MUREA was officially registered in 2011. MMCT, MUREA and Practical Action teamed up and came up with the idea of hydropower as an alternative energy (MEGA, 2016). With MuREA as an NGO and MMCT as a trust, there was need to have a company to operate the generation and selling of electricity as a business entity; hence, the registration of Mulanje Electricity Generation Agency (MEGA) as a limited company in 2014.

The three power plants planned and the first power plant of Bondo 1 was constructed. Operation wise, several proposals were considered such as each household making a contribution of K1,000 per month. The other one was for chiefs to use electricity for free with the other to have ordinary

villagers using electricity free of charge. DFID, through a project called Business Innovation Facility, supported the development of current business plans replacing previous proposals. Currently, there is a prepaid platform where customers buy electricity tokens. The money and particulars of customers are collected at the power house of Bondo 3 and then sent to MEGA offices at Mulanje District headquarters, 16 km away. The tokens are generated at MEGA office and then dispatched to the power house of Bondo 3 for distribution. A representative of MEGA mentioned that the purchasing of electricity units with use of the platform of the two main operators of mobile phones had been agreed by December 2022 and what remained were just formalities.

It was reported that the first units of electricity started to be sold in January 2016. Village Electricity Committee (VEC) was instituted and capacitated with trainings and visits including a learning visit to Zimbabwe. At first, households that required connection were asked to provide own poles, meaning sub-standard poles were in use in distribution lines. With time and external support from different donors, the usage of any other pole were prohibited and instead standard poles imported from Zimbabwe started to be used.

1.7.1. Types of Housing in Bondo

Bondo Community has different types of houses with some, which can be regarded as standard as made from burn bricks and roofed with corrugated iron sheets as in figure 1-4



Figure 1-4. A photo of a standard house found in Bondo Community. (Source: Photo by the author)

The house as in the Figure 1-4 can have the wiring and electricity connection very easy. The electricity consumption in such a house is expected to be higher as it has several rooms and expected to have some electrical appliances that consume huge electricity. There are other houses that are of low standards and difficult to electrify as in the Figure 1-5.



Figure 1-5 Grass thatched house that is mostly do not qualify to get connected to electricity.

(Source: photo by the author)

The house in the Figure 1-5 has challenges to have electricity extended to it. Wiring can be so difficult and a safety concern with grass-thatching. It is because of this reason that some houses cannot have electricity connection, apart from issues of affordability.

1.7.2. Bondo as a Mini-grid

Bondo hydro mini-grid takes advantage of Lichenya River which is reported to have mean flow rate of $0.2 \text{ m}^3/\text{s}$ (Akker and Nyasulu, 2016). The authors reported that the mini-grid became fully licensed in January 2016. The project for the construction of power plant started with community's involvement including contributing labour and land towards the excavation and construction of 238 m long canal. Bondo 1, which was financed by EU and OPEC Fund for International Development (OFID), has the capacity of 60 kW. The first light powered by the plant on Bondo

Clinic was on July 6, 2014.

With support from Lujeri Tea Company, under Red Rack project, the construction of Bondo 2 power plant upstream of Bondo 1, was started. However, the power plant was washed away by floods on 15th January 2015. Fortunately, the turbine and generator were spared as they had not been transferred to the site by then. Regretably, there was loss of lives of two watchmen, leading to temporal abandonment of the power plant. Thereafter, Bondo 3 power plant rated 100 kW, taking advantage of water flow from Bondo 1 had been constructed with support from Scottish Government and GEF. Of late, Bondo 2, rated 60 kW, had been completed and is part of the whole generation system. With such developments, Bondo Hydro Mini-grid is composed of three power plants with combined installed capacity of 220 kW. In December 2021, the system had only Bondo 3 generating the power for delivery to the community. This is because the three power plants were not yet synchronised. This was the time that the fieldwork of the study was conducted and in all villages engagements participants were complaining of frequent blackouts. It was reported that the blackouts were rampant during peak hours more especially between 5 pm and 10 pm. It was only in March 2022 that the synchronisation had been completed. The subsequent community engagement was in agreement that blackouts had stopped if not totally a thing of the past with synchronisation. Schematically, the mini-grid layout is as in the Figure 1-6.

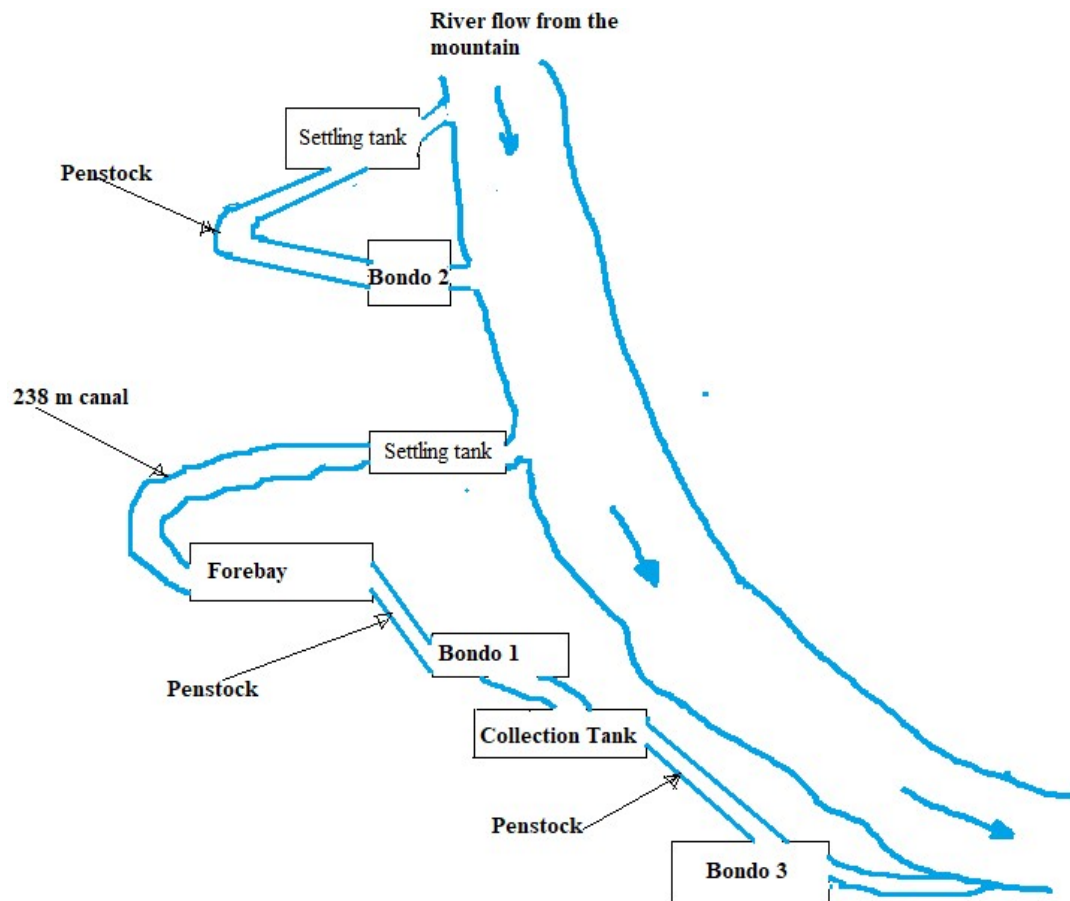


Figure 1-6. Schematic representation for the layout of Bondo Power Plants. (Source: Sketch by the Author)

Bondo 1, the first power plant to be constructed, is in the middle, Bondo 2 is upstream while Bondo 3 is downstream of Bondo 1. The photos are provided to show how water is flowing from the river up to where electricity is generated. The first photo is for the water flowing in the river before some water is diverted for power production as in the Figure 1-7.



Figure 1-7. A photo of Lichenya River as the water passes through the tree overgrowth and rocks from the mountain. (Source: Photo by the Author)

Water is tapped from Lichenya River as it passes downstream from Mulanje Mountain. A weir was built on the intake for diverting the water to the canal and to the siltation chamber as in Figure 1-8.



Figure 1-8. A photo showing diverted water from Lichenya River directed to the siltation chamber of Bondo 1. (Source: Photo by the Author)

Water from the intake is let to flow into the first part of a canal and then into the siltation chamber as in Figure 1-8. The siltation chamber is important component for trapping sand and stones that are brought by the river flow. From the siltation chamber the water flows through a canal as shown in figure 1-9.



Figure 1-9. A photo of showing part of the 238 m long channel for Bondo 1. (Source: Photo by the Author)

The water from the siltation chamber is let to flow into the 238 m long channel whose construction was part of community's contribution. The canal passes through the garden that has tea, bananas and pineapples as can be observed in Figure 1-9. From the canal, water is directed to the forebay as in the Figure 1-10.



Figure 1-10. A photo showing the forebay on Bondo 1. (Source: Photo by the Author)

The main purpose of the forebay is to concentrate the water and the removal of suspended trash. From the forebay, the water flow is increased due to the gradient of the penstock as in Figure 1-11 ready to drive the turbines.



Figure 1-11. A photo showing a penstock in the tea shrubs to Bondo 1. (Source: Photo by the Author)

The water from the penstock is delivered to the power house ready to have power generated. In the power house, the water drives turbines for the conversion of the energy in the flowing water to mechanical energy by the turbines, and then the conversion of mechanical energy to electrical energy by the generators.



Figure 1-12. A photo showing inside Bondo 1 powerhouse where electro-mechanical equipment, mainly turbine and generator, are housed. (Source: Photo by the Author)

The electro-mechanical equipment found in the power house are as shown in Figure 1-12. The energy in the flowing water hits the blades of the turbines. The force makes the turbine rotate with the energy of the flowing water from penstocks converted into mechanical energy by the rotating turbines. Since turbines are coupled to the generator/alternators, or the turbines and generator share same shaft, the rotation of the turbine; hence rotation of the shaft of the generator result into mechanical energy converted into electrical energy or just electricity. The generated electricity is fed into step-up transformer to have voltage stepped up from 400 V to 11 kV. The stepping up is important to minimise losses that come if electricity is transmitted at low voltage.



Figure 1-13. A photo showing a step-down transformer and the houses benefiting from the mini-grid. (Source: Photo by the Author)

The transmitted power which is at high voltage has to be transformed by the the step-down transformer as in Figure 1-13 upon reaching the load area. In the photo above, there is a step-down transformer that converts the 11 kV power to 240 V power that can be delivered to the houses, businesses and social infrastructures.

Bondo 3 is the main generation system with the other plants coming in when the demand increases. The power house also serves as the control room for all the synchronised three power plants. Bondo 1, the first power plant to be installed, has a three-jet Pelton wheel that had some challenges on power generation, especially during the dry season when water levels are low. It requires a lot of water for optimum power generation. Due to the inefficiencies of Bondo 1 with its Pelton turbine, the water from the penstock or after power generation is let from Bondo 1 to power Bondo 3. Documents from the energy provider, MEGA, show that the flow rate at Bondo 1 hence Bondo 3 is $0.261 \text{ m}^3/\text{s}$ and head of 50m and 55.8m, respectively. The head at Bondo 2 is reported to be 80

m. Crossflow turbines are the preferred turbine for these conditions; hence, their installations on Bondo 3 and Bondo 2. Pelton turbines work better with head of greater than 300 m while crossflow turbines are well suited to the low flow rate and low head of 1.75 m up to 200 m (Anand et al., 2021; Patel & Pakale, 2015, Pereira & Borges, 2014; Sinagra et al., 2014). Cross flow turbines have added advantage of being more efficient and they do not require complex maintenance.

As a control unit, Bondo 3 whose power house is as in Figure 1-14 is where electricity units are sold and it is the power plant that is always in operations with the others coming in to help when more power is needed or when it is under maintenance.



Figure 1-14. A photo showing the power house for Bondo 3 which also serves as the control room for all the power plants. (Source: Photo by the author)

1.7.3. Tariff structure of Bondo Electricity

Pre-paid system of payment is in use and by the end of 2015 it was reported that there were 289 customers connected to the system. As of December 2021, the mini-grid was servicing 1300 customers in 17 villages while in December 2022 the system had expanded to serving over 1600 customers in 21 villages. These customers are businesses, maize mills, welding shops, schools of which one is a community day secondary school, and one clinic etc. By December 2022, there were 8 maize mills which were running on rotational basis of 4 mills operating on a day. There were three different categories of electricity tariffs charged by MEGA – domestic at K88.00 (US\$0.076), business at K105 (US\$0.091) per kWh and social sector at K45 (US\$0.039) for social sector include schools, churches and clinics as of August 2023. A comparison was made with the electricity tariff charged by national utility of ESCOM as in the Table 1.1.

Table 1-1. Comparison of tariff structures between MEGA and ESCOM as of October 2023

SECTOR	Tariff for MEGA (MWK/kWh)	Tariff for ESCOM (MWK/kWh)
Business	105	138.4
Deomestic		
First 50 units kWh	88.0	61.5
Above 50 kWh	88.0	94

Table 1.1 had data collected from receipt of units from ESCOM and the reported data from MEGA officials for comparison sake. The electricity tariffs charged by the utility is far much cheaper than that charged by MEGA for domestic customers for the first 50 kWh. This is because rural customers who have low electricity demand buy less than 50 kWh of electricity units if they are connected to the national grid and pay K61.5 per kWh against K88 per kWh paid by Bondo Community. Business people connected to the grid are paying more than those connected to Bondo Community. It should be noted that pricing of electricity units by MEGA has to undergo the

approval process by the regulator, MERA

1.7.4. Briquette Making with use of mini-grid electricity

MEGA introduced the making of briquettes from bio-degradable dry waste with use of mini-grid electricity. The arrangement was to take advantage of excess electricity generated during off-peak hours. Community members were encouraged to bring the feedstock from their farms and any other sources to be turned into briquettes at no cost. It was reported that the machine had worked for a very short time as a result of low-quality of feedstock. It was reported that good feedstock for briquette needed not to be too oily. I was shown the dried stems of industrial hemp brought from far, which was regarded to be of good quality, not too oily, unlike dried stems and leaves sourced within the locality. The other reason is that feedstock brought by local community was mostly not sorted hence had some stones and metals which were breaking the screen so frequently. The briquette-making machine is as shown in the Figure 1-15.



Figure 1-15. A photo showing a briquette making machine with some feedstock at Bondo 3.

(Source: Photo by the author)

As can be seen from the Figure 1-15, the briquette making machine had not been in use for some years. This is evidenced by some of sacks that have some feedstocks being torn with time

1.8. Structure of the report

In this report, I have strived to provide the understanding of community energy resilience with a case study of Bondo Mini-grid using the bottom-up approach. To achieve this, the report starts with introduction as chapter one. The chapter has sections that provide explanations as the background information on the topic, followed by statement of problem, research objectives and research questions, and significance of the study.

Following the first chapter is the second chapter of literature review. The chapter has sections such as definitions of major concepts pertaining to the topic. Climate change and strategies of responses and discussion on related work within the study area also form part of the chapter. Conceptual framework has been discussed within the chapter.

Chapter three is about materials and methods. The sections included in the chapter are study area, data collection methods and data analysis. Limitations and discussions on ethics pertaining to conducting this study have also been included.

Chapter four is reserved for results of the study. The results have been presented within the context of the wider body of literature and related work within the sector of study.

Chapter five has discussions. The discussions provide various options of how the resilience of the Bondo Community can be enhanced. The resilience of the Bondo Community is discussed together with options of enhancement of the resilience of the energy

The final section of conclusions and recommendations is chapter six. The chapter has section of summary of key findings, implications to policy and the recommendations for future research are part of the chapter.

CHAPTER 2: LITERATURE REVIEW

This chapter is about reviewing some theoretical and empirical literature related to the broader topic of community energy resilience, as has been approached in this research work. Definitions of various terms within the context they have been used have been provided. Climate change and strategies of responses, theoretical perspectives and the related works within the community energy resilience have been included.

2.1. Climate Change and other stressors

Climate change is regarded as one of the most significant challenges that is hindering the achievement of sustainable development (Kyte and Forum, 2014). It is defined as “change in climate attributed directly or indirectly to human activities that change the composition of the global atmosphere and which is, in addition to natural climate variability has been observed over comparable time periods” (Halkos, 2015:5). Goal 13 of UN Sustainable Development Goals emphasises the urgent actions that are required to combat climate change and its impacts as a way of strengthening resilience and adaptive capacity. This is because the increase in frequency and intensity of climate change hazards is making it harder for countries and communities to end poverty and other human ills.

Much as climate change has not left any part of the globe, tropical areas are at a higher risk. Such areas include Africa, South Asia and South East Asia. Other areas with greater risks include part of USA, Italy and Japan (Halkos, 2015a), but these have greater capacity or resources in prevention, managing and coping with such risks. The former, whose most of its people are dependent on climate sensitive livelihoods such as agriculture, are highly vulnerable due to the changes in precipitation, temperatures and the unpredictable climate variability. Timing and length of crop growing seasons are becoming unknown with huge consequences on the yield. Climate

change is contributing to the never-ending poverty by causing extreme changes such as droughts, rising sea levels, heat waves, storms, flooding, worsening air quality, damage to agriculture, melting glaciers, dying ecosystems and displacement. The main worry is that the intensity and frequency of these events are on the increase.

Malawi has been identified as a country at high risk to the adverse effects of climate change by the International Panel for Climate Change (IPCC) fifth assessment report AR5 (Malawi Government, 2019a). The impact, frequency and spread of hydro-meteorological and climatic hazards such as floods and droughts had been on the increase and are expected to continue to worsen in future due to climate change (The World Bank, 2016 & World Bank, 2019a). The country's high vulnerability to extreme weather events has been attributed to its location within the great African Rift Valley (Malawi Government, 2019a). Much as floods and droughts are the most significant and recurring risks for Malawi, other equally worrisome sources of vulnerability include rapid population growth, environmental degradation, poverty and economic factors such as inflation and volatile exchange rates. As if these are not enough, the recurring corruption crises incite fiscal crunches, aid withdrawals and deterioration of public service (Cammack, 2017) resulting to increased miseries to the general communities.

2.2. Mitigation and adaptation to climate change and other stressors

Combating climate change and its impacts calls for mitigation and adaptation strategies. Mitigation strategies such as reduction, removal or prevention of emissions of gases in the atmosphere is explicitly impossible to be thoroughly understood by rural communities (Ayers and Forsyth, 2009). Adams (2017) reported that the IPCC Assessment Report and COP 7 to the UNFCCC in Marrakech recognised that climate change is a problem of development as opposed to the global environment issue. The thing to note is that much as there is need for adaptation, local

communities, as victims of climate change, become reluctant to commit to adaptation as they mostly do not know exactly what they are adapting to (Ayers and Forsyth, Ibid).

Previous adaptation strategies of the top-bottom approach have been recently replaced by the bottom-up approach. The bottom-up approach is community-based and participatory in nature with its strength in building on priorities, knowledge and capacity of local people (Ayers and Forsyth, 2009). This approach, also known as Community based approach, is about communities themselves should be encouraged to come up with plans and coping measures based on their priorities, needs, knowledge and capacity towards poverty reduction and livelihood benefits, as well as reducing vulnerability.

Baas and Ramasamy (2008) provides some guidance on how community-based approach (CBA) should be conducted. The guidelines are about enquiry from local people on characterisation of livelihood systems, profiling of vulnerable groups, assessment of past and current climate change impacts, understanding of impacts, local coping capacities and existing adaptation strategies. CARE International (2015) reports that CBA should be able to recognise inherent adaptive capacity that exists within vulnerable population. These adaptive capacities are strengthened when vulnerable people have more access to the accumulation and control of assets, knowledge and information, confidence in and access to innovations, access to effective institutions and entitlements. Adaptive capacity should mean local people be given the opportunity to make more flexible and forward-looking decisions.

There are differences in both vulnerability and capacity to respond to impacts within community and between women and men of different ages. Differences in roles, power and access to and control over resources enable some groups or individuals to adapt and hinder others from doing the same. Such information is very useful in any research design of this particular nature. In

addition, Renschler *et al.* (2011) highlighted that both the physical and environmental assets as well as the socio-economic-political/organisation aspects of a particular community are important in the characterisation of resilience and adaptation. Resilience is viewed as a property or characteristic of adaptation because the adaptive capacity, adaptive mechanisms and local adaptive strategies provide requirements to improve system resilience and reduce vulnerability (Lama, Per and Bergstrom, 2017).

Realising that the country is hugely prone to adverse climatic hazards and the need for mitigation and adaptation strategies, Malawi has developed several climate change policy and strategies. IrishAid (2017) and Wisborg and Jumbe (2010) have listed some of these documents as:

1. Mulanje Mountain Forest Reserve (declared 1927 by the then colonial government);
2. Mulanje Mountain Global Biosphere Reserve (MMGBC) (declared in 1990 by UNESCO);
3. Recognised by the World Wildlife Fund (WWF) as one of 200 ecoregions of particular importance for biodiversity conservation and an Afromontane Regional Centre of Endemism;
4. Recognised by the International Union for Conservation of Nature (IUCN) as an International Centre of Plant Diversity;
5. Recognised by Conservation International as an Eastern Afro-Montane Biodiversity Hotspot; and
6. World Heritage Site (application prepared by MMCT and a consultant).

The documents plus other recent ones which have not been listed, provide the needed direction and intervention strategies. However, the challenge has always been on implementation. The usual lack of resources, lack of political will and the silo-thinking unlike mainstreaming climate change as a cross-cutting issue hinder the implementation. On silo-thinking, adaptation need not be

regarded as a concept within one sector like agriculture but be better linked with other sectors such as energy, gender, water, biodiversity and education, among other related sectors. Such has the advantage of solving many linked challenges and that funding, especially climate funding for one sector, can have the potential to solve many challenges (Borgstein, 2017). The resilience and adaptive capacity are so much needed as hazards brought about by climate change, economic and exogenous shocks undermine the ability of humanity to progress and, in many cases, reversing the progress of development that had been previously achieved. Strategies for the adaptation and mitigation to various hazards by rural communities are grouped into ex-ante and ex-post (Makoka, 2008).

A. Ex-ante risk coping strategies

The enhancement of household and community resilience can be focused on ex-ante risk management. This is about communities and households being involved or supported into mitigation strategies implemented before shocks occur (Makoka, 2008). The author had provided examples of ex-ante risk management strategies as livelihood diversification, income diversification and income skewing. Of course, livelihood diversification and income diversification are regarded as one as mostly livelihood diversification leads to income diversification. Diversification, especially away from climate sensitive livelihoods, is one of the best ways for adaptation, mitigation and resilience building against climate change and other shocks at household, village, landscape, community and national levels (Aslan *et al.*, 2018).

The rural communities are required to embark or supported so that they are able to adopt multiple livelihood options/income sources. Such is diversification, which may lead to ‘resilience, flexibility, self-insurance and stability of rural population (Sharma, Malik and Bhatia, 2022:146). Income skewing is about households or communities engaging in low risks and low return

activities (Makoka, 2008). Agriculture is not part of income skewing activities as it is characterised as high risk and low return, which make rural households to generate low income (Liu *et al.*, 2022). The ex-ante coping strategies should involve both off-farm and on-farm strategies such as the sale of wage labour, growing resistant-tolerant crops, growing crops adapted to water logging conditions, sowing early, intercropping, combining cropping and livestock operations, self-employment in small firms, livestock production, processing and trading of agricultural goods and service provision. Manufacturing, proper use of remittances are the other ex-ante risk coping strategies. Electricity access is crucial for the introduction and support of the many of these ex-ante activities.

B. Ex-post risk coping management strategies

Many rural people do not adopt measures in advance to climate and other risks as they have limited information about occurrences of specific types of shocks. They also have limited financial and other resources to engage in ex-ante coping strategies. This leads to the adoption of ex-post adaptation as coping strategies, that is, activities done after the occurrence of shocks has already happened. The ex-post adaptation activities include reduced consumption, borrowing money from friends, neighbours, relatives and moneylenders, dissaving, sale of household assets, increased supply of labour, receiving assistance from government, non-governmental organisations and religious organisations, withdrawing children from school (Malawi Government and World Bank, 2006 as cited by Makoka, 2008; Devereux, Baulch, Macauslan, Phiri, *et al.*, 2006). Ex-post strategies are also known as transitory shocks as they create or deepen chronic poverty through eroding the subsequent capacities and capabilities to generate future decent livelihood (Devereux, Baulch, Macauslan, Phiri, *et al.*, Ibid). With climate change bringing repeated shocks, which continually push rural people, the engagement of ex-post coping strategies is leading many to

chronic poverty and destitution. Much as ex-post activities are the most widely used coping strategy, support is urgently required to equip the rural masses so that they are able to avoid and instead strive to adopt ex-ante coping strategies.

2.3. Concepts and Definitions

There are several terms or concepts used in this report whose definitions are complex or can be contested. These terms such as resilience, community energy resilience, nexus, codesign, and community-based qualitative research (CBQR) require defining within the context they have been used and this has been done in the sub-sections below.

2.3.1. Resilience

One key word that requires understanding within the context that it has been used is resilience. Resilience is reported to be one of the most important researched topics used in scientific disciplines for the analysis and understanding of ecological and socio-ecological systems (Brand and Jax, 2007). It is regarded as a fashionable and attractive concept that has grown among academia, policymakers and practitioners (Woodruff *et al.*, 2018; McAslan, 2010 and Brand and Jax, 2007; Alexander, 2013 & McAslan, 2010).). The concept is widely used in different disciplines such as economics, sociology, planning and political science (Brand and Jax, 2007); ecology, geography, military studies, human resource management, career studies and policy (Bal, 2020); engineering, psychology, organisational management, economics, international development and environmental sciences (Lade, Walker and Jamila Haider, 2020); art, literature, law, science and engineering (Kruse *et al.*, 2017) and climate change adaptation and society security and safety (Bergström, Van Winsen and Henriqson, 2015). Such diverse usage of the concept in unrelated disciplines brings challenges in that there can be no consensus on the

definition and application. It is little wonder that McAslan (2010) reported that the term is contested, ambiguous, contradictory and continue to raise unresolved questions.

The term is traced to have come from the Latin word *resilire* with meanings such as “rebound”, “recoil”, “jumping back”, “rebounding”, “reflecting”, “returning” (McAslan, 2010; Gößling-Reisemann, Hellige and Thier, 2018 & Alexander, 2013). The authors agree that the term was then used within the field of mechanics to describe the strength and ductility of steel beams in the 1800s. This culminated into “Modulus of resilience” as a measure or means of assessing the ability of materials to withstand severe condition in 1856. It is reported that the concept was popularised by Crawford Stanley Holling with his paper titled ‘Resilience and stability of ecological systems’ in 1973. Here it was used within ecosystem as the measure of the ecosystem’s ability to absorb changes and still exist (McAslan, 2010). Since then, the concept has been of use in various disciplines including social sciences and engineering. In this study, the concept of resilience is used within the context of community/household and community electricity-generating system.

Several authors have made several proposition of resilience characteristics, but Maxwell and Reybold (2015) have provided a comprehensive list of issues to consider on the enhancement of resilience among households or communities. These include experience of the people, real or perceived severity of shocks, measures of wellbeing and quality of life, information and aspiration or future-oriented projections, preparedness, acceptance or neglect, attitudes, values, needs and wants, identity and belonging (Sharifi and Yamagata (2016a)). Within the engineering domain, resilience is about putting in the necessary mechanisms so that an engineering system is able to adjust to both unexpected and expected changes as well as surprising developments (Woods, Hollnagel and Leveson, 2006; Woods, 2015). Resilience is therefore an important concept in

dealing with systems such as community/household and energy infrastructure as the world continues to be less stable, less predictable and more complex.

The enhancement of resilience of local community does not require the deficiency approach which is the focus on addressing local needs without some form of empowerment. Such a case has the disadvantage of viewing community members as clients and customers thereby making them powerless and helpless as such, they are unable to exercise their capabilities in creating their resilient and sustainable livelihoods. Instead, the intervention or building community resilience requires focussing on the existing capacities of the community members that should be able to contribute towards building resilience by themselves. The community members need to be imparted with strength that is needed to process and overcome hardships.

Van Breda (2018:4) recommends that research on resilience should be understood to consist three interconnected factors of adversity, outcomes and mediating factors, which are as depicted in the Figure 2-1.

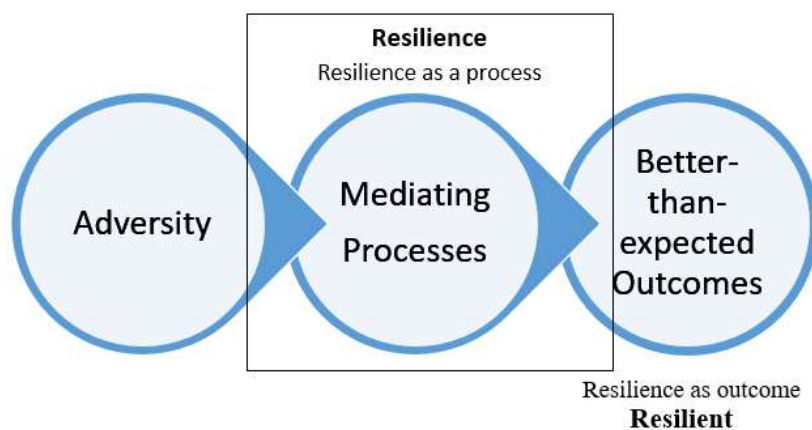


Figure 2-1. A diagram depicting resilience as a process and as an outcome. ((Source: Van Breda, (2018: 4)

From the Figure 2-1, one can consider the concept of resilience mainly with a positioning of an outcome. With this positioning, the concept considers what would be the results after the system has been exposed to the adversity. The outcome of ‘better than expected outcome’ is more of the wish as some systems collapse or have worse state than they were before the adversity. The outcome positioning has the main concern of stopping at the outcome alone, whether positive or negative, and that the processes and actions for reaching the outcome are of no importance. This view does not take into consideration of the various actions or interventions, also called mediating factors, that should be engaged in achieving the intended outcomes. What are the parameters that need to be put in place to reach the positive resilient outcome? This question is not answered. This study is taking a different approach of putting emphasis on the processes or mediating factors that should lead to the positive outcomes. What are the mediating processes and the approaches that should be pursued to enable people and systems achieve better-than-expected outcomes? The definition of resilience as a process has been put into proper perspective as the “multilevel processes that systems engage in to obtain better-than-expected outcomes in the face or wake of adversity” (Van Breda, 2018, p4)). This definition seems to encompass all the parameters that are required and these are broken down as:

“multilevel” means the resilience processes occur across multiple domains or levels of the social ecology or person-in-environment, rather than only in the individual. ‘Systems’ is used so that the definition can be scaled across different system sizes such as cells, individuals, families, organisations and communities, and also non-human systems such as metals, the climate or the economy. ‘In the face of’ suggests that the adversity is ongoing and that the resilience processes are at work while the system is facing adversity,

while ‘in the wake of’ suggests that the adversity has passed and the system is recovering from the impact of diversity” (Van Breda, Idid: 4-5)

In summary, this study is about understanding the mediating processes, also referred to as resilience processes or protective processes, in achieving resilience of various systems. What are the factors that can make a community energy system and the community become resilient? What sort of interventions are important in enhancing the resiliencies of the community and the energy system? What trade-offs should be employed so that the enhancement of the resilience of the energy system should not weaken the resilience of the community? There is need for a way of building of synergy on simultaneously enhancing the resilience of the energy system and the resilience of the community. Such are the questions and enquiries that require answers, but before that, there is need to consider the other perspectives of resilience.

Apart from the representation of resilience in Figure 2-1, there are other several representations found in the literature, one of which is as in Figure 2-2.

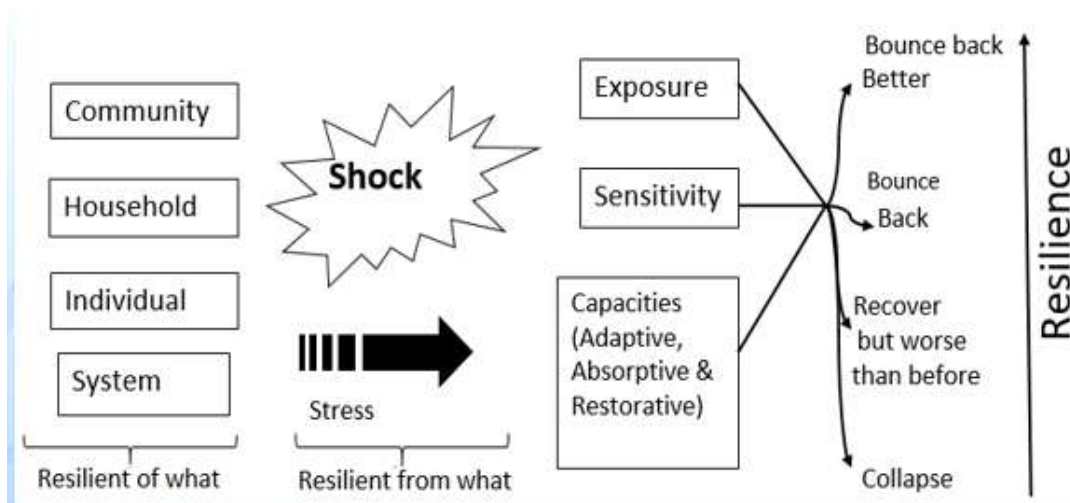


Figure 2-2. Schematic definition of Resilience. (Source: Adapted from DFID (2011: 7))

This approach has presented the concept of resilience differently. The adversities are grouped into shocks and stresses, while mediating factors have just been mentioned without any emphasis. There is also a mention of parameters of household, community, individual and system whose resilience can be enhanced (DFID 2011: 7). The approach is mainly outcome based, with all possible outcomes from bounce back better to collapse. If the reaction of the system is ‘Bounce Back Better’ as in far top-right in the figure, it means the system has increased resilience. It has benefitted from the adversity in that there has been improvement after adversity. If the reaction is collapse, the system was not resilient but was vulnerable. As can be seen, the state of resilience is not fixed, but dynamic with some not necessarily collapsing, but just “bounce back”. It should be noted that the reaction may be dependent on several factors like the magnitude of stressor, extent of exposure and the different capabilities that should be of help in achieving positive outcomes after diversity. This approach of understanding the concept of resilience is equally important considering that it provides more information than Figure 2-1.

After providing the understanding of resilience, next is to focus on the whole concept of community energy resilience. Each of the three words of the concept can stand on its own or any two words can be combined and still make sense. In my case, I opted to combine the words so to come up with energy resilience as one part and community resilience as another. In order to be very explicit that the energy resilience is about system which is within the community and that community members take part in decision making, energy resilience is expounded further to community energy system resilience. Community is coming as the common denominator to both resiliencies. In other words, the energy system and the community are interconnected in that the energy system is within the community while the community is served and take part in

management of the energy system. The resiliencies of the two are contextualised and explained in the sections below.

2.3.2. Community Resilience

The concept of community is fluid and complex, hence its definition requires to be seen on case by case basis (Kais and Islam, 2016). One of the complexities originates from the fact that community is composed of heterogeneous sub-groups with differences in decision making, capacities and vulnerability levels, wealth, income, moral standards, and religious status (Meng, Li and Fang, 2018). Preference is given to the definition provided by Pfefferbaum et al. (2008: 50) as “people, organisations, structures, and systems in close geographical proximity and with physical boundaries and borders”. The author continues that a community is the one that is composed of several systems that are linked together for common functioning and support. Bondo fits very well within the definition in that as much as it is vast and had 23 villages in 2023 and keep on expanding, its geographical proximity and physical boundaries and borders is defined by the villages served by the mini-grid. Botterill (2013) as cited by Meng et al. (2018) reported that community resilience was first proposed by Judith Kulig and colleagues at the Alberta Health Service Centre in Canada. Such earlier understanding brought a view that challenges facing a community come from outside sources such as social and political threats plus environmental challenges and that the challenges get complicated with the fragility of communities’ own internal evolution processes. Of course, challenges affecting Bondo come from both within and externally.

With the complexity of bringing consensus in defining community and then resilience, the combined term of community resilience cannot be easily defined. It is little wonder that a review of 62 publications by Patel et al. (2017) brought forth as many as 57 unique definitions. The differences come in because the concept is defined from different angles such as defining the

concept as a process or as an outcome or after the disaster or disruption or in the absence of adverse effect; while others blend the definitions (Patel et al., Ibid). The complexity of community resilience is manifested in that there are also several dimensions of resilience in human systems which encompass capacity to absorb change, preparedness and contingency, innovation and learning, renewal, re-organisation, and development (Jones & Tanner, 2017).

Notwithstanding, the concept of community resilience is an important tool to understand and appreciate as to how individuals, households and communities respond and adapt to many changing shocks and stresses that have a bearing to their livelihood outcomes (Jones and Tanner, 2017). It should be extended that within resilience building, is not enough to just consider coping strategies as human systems are required to undergo continuous transformations, system integrity, self-organising and learning (Sharifi and Yamagata (2016a). Meng et al. (2018)). Therefore, community resilience should go further in understanding that resilience and adaptability of human systems are embedded in the mental and physical health of the people concerned. Community resilience should also be described in terms of other elements of communities such as local knowledge, community networks, communication, health, governance/leadership, resources, economic investment, preparedness and mental outlook (Patel *et al.*, 2017). All the particulars mentioned are so important as human systems require so many attributes to mitigate, adapt and transform within the ever-changing environments. Going further, the proper understanding of community resilience can be achieved based on the perspectives or sectors the term is being used and these are discussed in the subsections as below.

A. Community resilience within socio-ecology

Folke et al. (2016) defines the concept of ecology as the thin layer of planet earth that is able to support life. This thin layer, also called biosphere, has the necessary capacity to support life. The

socio-ecological systems are about people, communities, economies and societies, which are part on their own and intertwined within the biosphere. The concept of community resilience has been defined within the socio-ecological systems in biosphere as the “ability of groups or communities to cope with external stresses and disturbances as a result of social, political and environmental change” (Windle, 2011: p4). Such being the case, the adaptation and transformation of human systems can only be sustainably achieved where there are combinations of knowledge and experience, learning with change, turning crises into opportunities, and governing transformations for innovative pathways in tune with resilience of the biosphere.

The resilience of the community is obviously dependent on necessary resources and capacities of a system organising itself prior to and during times of need (Kretsch & Stange, 2016). The term is further extended in that community resilience depends on the degree to which the community has the necessary resources (capitals) and the capacity of organising itself both prior to and during times of need and based on human dependence on ecosystem coupled with the aid of local knowledge and institutional practices (Kretsch and Stange, Ibid). With all the attributes of community resilience within socio-ecology, the concept is still complex to comprehend or measure as it involves several other factors such as interpersonal or cognitive factors of optimism, intelligence, creativity, humour, social skills, educational abilities and memory above average being very critical factors for individual or community resilience (Tusaie and Dyer, 2004). The understanding of the concept is so difficult if all the dimensions are to be incorporated together with the characteristic of the biosphere, hence trade-offs or simplifications are mostly considered.

The community resilience is dependent on social, physical and natural capitals. For Bondo Community the mountain and Lichenya River are natural capitals. The hydropower mini-grid is

physical capital dependent of natural capital of the river. The mountain and river are part of ecology. This is showing the links between community resilience and ecology.

B. Community resilience within systems thinking

Resilience should also be understood within systems thinking since individuals, households and communities live and function within complex systems (McCaul and Mitsidou, 2016). Some examples of systems are market systems, health systems, educational systems, governance systems, ecosystems. Any disturbance or strengthening of one or more of the systems may result into either positive and/or negative effect on the resilience outcome of individuals, households and communities or any other systems. Human systems of individuals, households and communities also offer desirable and undesirable effects on each other. A systemic approach is an important aspect of community resilience as the community has several systems complimenting or having undesirable effect on the other. The understanding of each of these and their impacts on other systems is key for the enhancement of community resilience.

C. Community resilience within the development agenda

The enhancement of individual, household and community resilience as an adaptation to effects of climate change has emerged as a key development agenda (Jones, Samman and Vinck, 2018). Resilience of community is therefore linked to sustainable development; hence, forming a core element of UN SDGs and other development goals (Kretsch and Stange, 2016). This is because the fulfilment of UN Agenda 2030 and even the AU Agenda 2063 is heavily threatened by the frequent threats of climate change and climate variability resulting to land use change, degradation of ecosystems, poverty and inequality, and cultural factors (Lama, Per and Bergstrom, 2017). The linkage of resilience and sustainable development was well articulated in the UN secretariat report of May 2020 as there had been realisation in that the havoc that was brought by COVID-19

pandemic called for new and increased vigour to having “fewer people living in extreme poverty, less gender inequality, a healthier natural environment, and a more resilient society” (UN, 2020a as cited by van Zanten & van Tulder, 2020. p453). Resilience should therefore be seen as a means of limiting poverty through conservation and development of resources and reduction of vulnerability as the ways of reducing risks to people and their assets (Manyena et al. 2011 as cited by Alexander, 2013).

Resilience, let alone community resilience, cannot be discussed without the consideration of stresses and shocks in the form of adversities, disruptions and disasters, whether real or just risks. If there is to be a discussion of community resilience, risks and real changes need to be defined in terms of shocks and stresses. With specifics to rural communities of Malawi in which the study was carried out, the adversities may be grouped into mainly economic shocks (inflation, interest rates and exchange rates) and climatic shocks (variability in precipitation, which cause droughts, dry spells and floods) (Malawi Government, 2018b). These adversities are aggravated by rapid population growth, poor soils and poor land management practices, and high poverty levels. It is also important to know that there are also other causal or result of the adversities such as the country's narrow economic base, overdependence on rain-fed agriculture and biomass for household energy, adverse impacts of climate change and extreme weather events which are putting increased pressure on limited land resource base, land degradation arising from agricultural expansion and cultivation of marginal lands, and increasing deforestation to meet increasing demands of energy, food and construction purposes (Malawi Government, 2006). Such complex and interlinked challenges require traditional and innovative ways of possible mediating processes to help the communities become more resilient or able to have sustained poverty-escape even in times of shocks and stresses.

The diversities within the community makes it harder in understanding community resilience, unless a narrow angle has been chosen. Livelihood resilience approach, unlike the DRR resilience approach, is preferred in this case as this emphasises the importance of access to productive community assets, institutional structures and processes and the predominant livelihood strategies which should be pursued by member households (Frankenberger *et al.*, 2013). Building community resilience is the total sum of building community capitals and assets which should be enhanced with community's internal capacities and complimented by the external factors. The capitals within the community resilience framework are physical, human, natural, political and financial capitals (Frankenberger, Mueller, Spangler and Alexander, Ibid). Each community or study area is unique hence having different community capitals or assets; hence each community require to be studied as a case.

Enhancement of the resilience of the community is the same as pursuing the development agenda. What is key is to support local communities have increased incomes, enhanced welfare, increase productivity and accumulation of assets over time. These are some of the characteristics of development while at the same time the money and assets accumulated are to be used to bounce back better.

2.3.3. The Resilience of Rural Energy Systems

According to IEA estimates, mini-grids and off-grid systems are to provide over 70 percent of total share to economically reach the target of universal access to electricity by 2030 (Luc, Bordeleau and Young, 2015; IEA, 2017 as cited by Alliance for Rural Electrification, 2018 & DFID, no date). Mini-grids provide the bigger share of 42 percent of reaching the universal access by 2030 (Caprile and Matinga, 2018). However, many mini-grids have struggled to survive and provide maximum benefits beyond pilot projects (Luc, Bordeleau and Young, 2015). For example, Malawi's first 6

Wind/Solar PV mini-grids failed to operate beyond pilot phase due to different challenges of operations, management and politics (Caprile and Matinga, 2018). It is recommended that one of the ways of increasing sustainability of mini-grid is through knowledge sharing on funding sources, the availability of energy resources and mini-grid operational performances (Odarno *et al.*, 2015). In addition, there is need to populate the literature on communities' use of energy, and how the community energy is used and contributing to local economies as one way of improvement of sustainability of mini-grids (Madriz-Vargas, Bruce and Watt (2018).

The resilience of an energy system is better understood within the domain of resilience engineering and a brief history of this should provide a good starting point. That any system possesses a property called resilience (Woods, 2015) within systems engineering was the popular approach during the early days of resilience engineering. This is the reason that the concept of resilience within the context of structural and engineering science was used as a measure for reduction of failure, reduction of consequences of failure and reduction of time of recovery after failure. Not only that, resilience was used as a requirement for the system to be able to meet surge demand, exploit opportunities and successfully counter disruptions created by competitors or other stakeholders (Madni and Jackson, 2009). Resilience need not to be used as global characteristics or as a universal measure of all materials, but referenced for the particular identified system taking into consideration particular challenges. Bergström, Van Winsen and Henriqson (2015) is supportive of this view in that they proposed that resilience should be treated as situational based on specific capabilities that the system can manage that should help it withstand adversity within particular disruptions.

Resilience in engineering is required to have the four characteristics also known as R4 of robustness, redundancy, resourcefulness and rapidity (Patriarca *et al.*, 2018; Tierney and Bruneau,

2007; Hollnagel *et al.*, 2010 & Steen and Aven, 2011). On robustness, the system should have inherent ability to withstand some levels of adversity without significant degradation or loss of performance. On redundancy, the system or part of the system should be able to be substitutable as a way of satisfying some functionality if loss of the whole functionality occurs. Also, a system should have capabilities to mobilise resources and buffers such as materials, monetary resources, information, technology and human resources to withstand some undesirable changes imposed by the external environment. Rapidity is the measure of the system's ability to contain losses or prevent further degradation in a timely manner. The R4 are so important as they provide any system with a measure for reduction of failure, reduction of consequences of failure and reduction of time of recovery after failure.

In engineering systems, adversity are conditions that disrupt or impede normal operations by creating discontinuity, confusion, disorder or displacement. Failure of the system is not always due to malfunction or poor design, but also due to disturbances that are unknown to modern science or because it was unanticipated/unknown during the design of the systems (Madni and Jackson, 2009). It is therefore advisable to build systems with adequate safety margins so that the systems are able to respond to various degree of adversity, able to monitor critical developments, able to anticipate future threats and opportunities and be able to learn from past experiences (Hollnagel *et al.*, 2010; Steen and Aven, 2011). To achieve enough safety margins, there has to be readily available and enough structures that should have been developed before the arrival of adversity. The available structures before the adversity are so important for enhancing the resilience of systems as they will adequately adapt to perturbations and changes in the real world given finite resources and time.

The other important aspect of building resilience in engineering systems is the availability of competent personnel also called human in control (Jackson & Ferris, 2012). The human in control is advised to always be available apart from being part of the final decision-making authority. This is on the understanding that critical and complex systems such as power plants demand quick decisions made by qualified and competent personnel who have to be always called upon to ably deal with unprecedented threats. This is to say that much as automation is an important aspect, there is still need for human interception as final decision or as a compliment to automation, or in cases of failure of automation. This was exemplified by the US-Canada Power Systems Outage Taskforce that was instituted after the US-Canada Blackout of 2003. The taskforce recommended that highly trained operators should always be placed at all nodes of power grids to minimize power grid cascading failures (Jackson and Ferris, Ibid). Mini-grids are therefore required to have competent personnel within reach to handle challenges of power delivery as they happen. The availability of competent personnel requires to be complimented with adequate remuneration to have them retained.

The energy systems considered in this study are those to do with generation and delivery of electricity. Delivery of electricity can be done through grid extension, mini-grids and Standalone Home Systems (SHS). Mini-grid sector is the focus of this study. Luc, Bordeleau and Young (2015) specifies that the major challenges to mini-grids and any other community energy systems are related to regulatory, policy, socio-economic and financing issues. An energy system operates within the web of regulatory, policy, socio-economic environment and the accessibility to finances within the operating environment. To some extent, Madni and Jackson (2009) is right that failure is not necessarily a consequence of malfunction or poor design, rather it is as a result of the web

of ongoing interactions and adaptations that characterises complex systems' behaviour in the real world.

A resilient energy system will be dependent on the structures that have been built or influenced to change before chaos arrives (Woods, 2015). Within the characteristics Sharifi and Yamagata (2016) contends that a resilient system is the one that should be supported to provide resistance or fortified against known shocks and stresses. The resilience of community energy system is dependent on different structures in the form of institutions and stakeholders, which are regarded to be the mediating processes as in Figure 2-3.

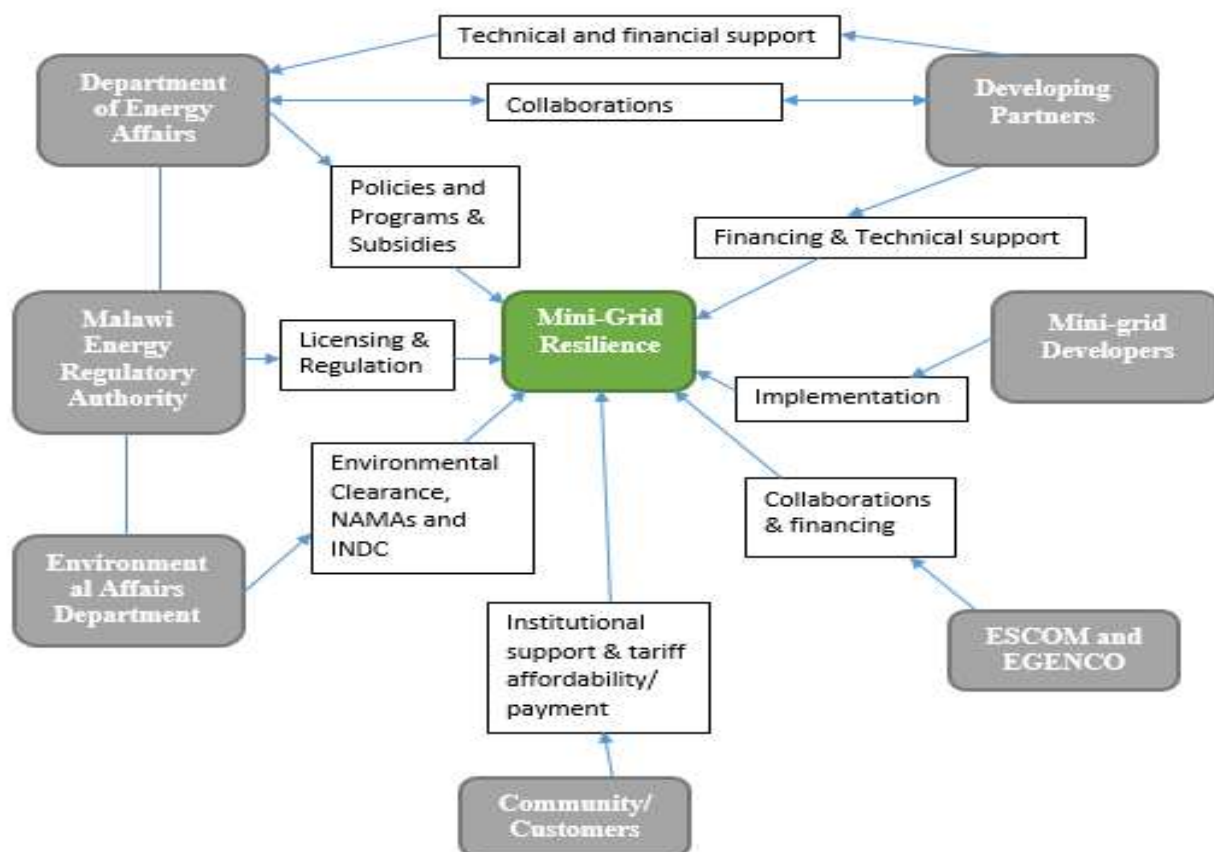


Figure 2-3. Institutional Framework affecting Mini-grid resilience. (Source: Adapted from ESMAP (2019: 38))

The health and sustainability of a community energy system depend on several institutions as indicated in Figure 2.3 with each making its own unique contribution. Ministry of Energy is one important part of resilience of mini-grids as it is at the centre of developing policies, strategies and masterplans. The ministry is also responsible for the provision of subsidies apart from collaborating with other institutions, including donors for support of the sector. Funding from central government and levies are coordinated at ministry level for the support of different sectors including mini-grids. Development partners or donors play a huge role in technical and financial support of mini-grids, whether directly or through the Ministry of Energy. For example, Bondo has benefitted through direct support from development partners such as UNDP, Practical Action, Scottish Government, and GEF.

Then there is Malawi Energy Regulatory Authority (MERA) as a regulator, which plays a critical role in areas of licensing, regulations and enforcement plus approval of tariffs of mini-grids (Malawi Energy Regulatory Authority, 2020). How the subsector of mini-grid is regulated has a bearing on the sustainability or proliferation of the systems. In many cases, streamlined regulations for mini-grids provide a conducive environment unlike hardhanded regulations or mini-grids being treated in the same way as grid-connected systems (Odarno *et al.*, 2017). Utility companies cannot be taken out of the loop as they are collaborators and inhibitors since some tend to encroach the catchment area of mini-grids. The utilities also have a role in establishing own mini-grids such as Wovwe hydropower in Karonga District and Likoma Solar PV/Diesel mini-grid on Likoma Island. Malawi Environmentally Protection Agency, formally called Environmental Affairs Department, as a government arm is another important institution with a mandate to approve projects through environmental and social impact assessment (ESIA) and as the receiving arm of climate global funding. Stringent measures for ESIA even for small systems as mini-grids and the exclusion of

mini-grids as part of adaptation and mitigation strategies to climate change related hazards are inhibitors to the sector (Malawi Government, 2006).

Of more importance is the community whose activities in which the energy system had been developed may cause harm or provide the needed support. Many community energy systems, especially those developed for rural areas, have their main objective of stimulating sustainable rural development and contributing to resilient livelihoods of the people. Communities or household should achieve increased usage of electricity which should lead to increased standard of living. The inherent small consumption of electricity by rural communities means there is no powering of sectors that should contribute to transformative and resilient livelihoods (Soni and Kawahara, 2020). Increased electricity usage means mini-grid operators have increased income from electricity sales. There are also other stakeholders such as micro-financing institutions (MFIs), banks, district/city/town councils, members of parliament, and councillors who have various roles of direct and indirect support towards mini-grids (Flammini *et al.*, 2014; Aboellnga *et al.*, 2018; Hasan *et al.*, 2017; Ferroukhi *et al.*, 2015). All the institutions and stakeholders are very important. However, the focus of this study is on various roles of community members towards supporting the Bondo Mini-grid and how the mini-grid can enhance the resilience of community. Mini-grids have to be resourceful, able to meet surge demands, exploit opportunities, and rapidly and successfully counter disruptions. Literature provides several enabling environments that can help in making mini-grids achieve resilience and these are extensively explained within the chapter.

2.3.4. Community energy resilience

Low uptake of electricity in rural areas is the major concern leading to electricity systems having low load factors. The low uptake of electricity is mainly due to inability to pay, unwillingness to

pay, lack of appliances for use and lack of exposure/experience on taking the advantages of the use of electricity (Bruderle, Attigah and Bodenbender, 2011 & Contejean and Verin, 2017). The low load factor results into mini-grid operators having inadequate finances, leading to challenges on the functionality of rural energy systems. There is need for rural communities to have increased income and other assets so that they are able to spend more on electricity. It is the increased uptake of electricity that can lead to enhanced resilience of mini-grids, while increased income from use of electricity should lead to community resilience. Of course, there are other complementary factors that should be harnessed in the realisation of the resilience of the electrical system and the resilience of the community or harnessing the community energy resilience.

The study is about community energy resilience, which has the combination of the resilience of the rural/community energy system and resilience of the community. The enhancement of community energy resilience requires to consider factors that simultaneously enhance the resilience of the energy system and the resilience of the community. Figure 2-4 depicts the link as to how the resilience of the energy system can be enhanced with the support of the community and vice versa.

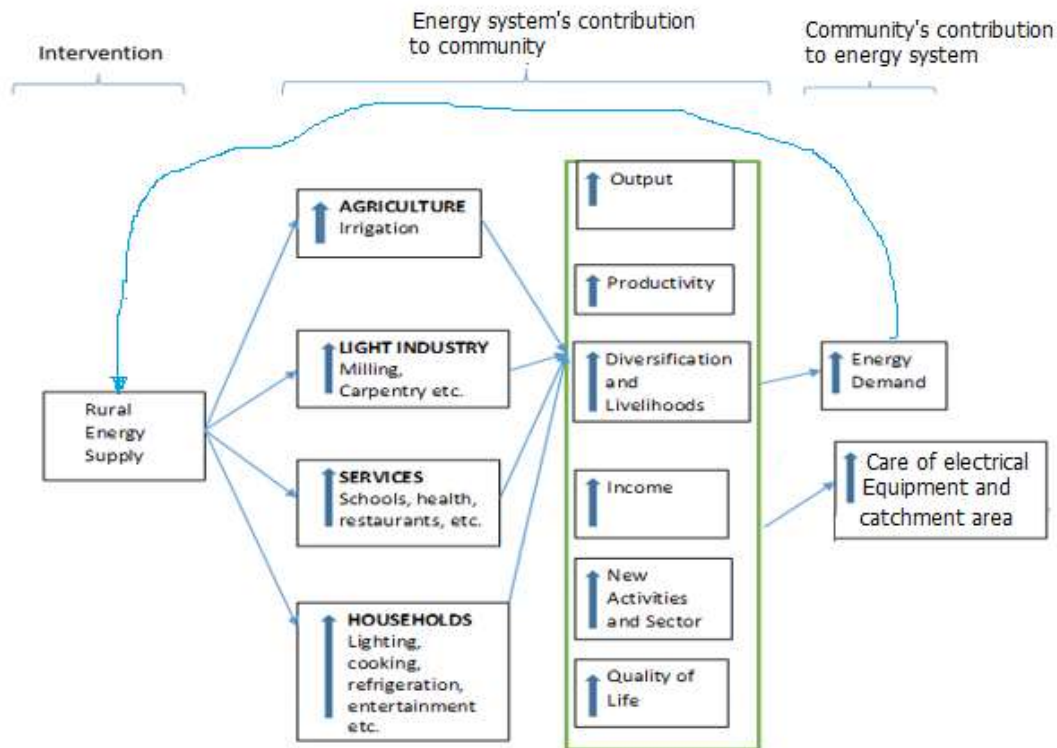


Figure 2-4. The connection between the enhancement of the resilience of energy system and the resilience of the community. (Source: Adapted from UNCTAD (2017:33))

Figure 2.4 clearly shows how the energy system is interconnected with the community's wellbeing. The energy system supports various sectors that form livelihood options of the community such as agriculture, light industry, service sector and general household activities. With quality of electrical services in required quantities, the expectations are that there should be increased productivity and income, improved quality of life, diversification of livelihoods and establishment of new sectors or activities within the community. Such representation is showing how so much benefit towards enhancement of the energy system trickles to livelihood options of the community serviced by the energy system. The accrued benefits from increased electricity usage by the community are expected to result to increased electricity uptake. The community served by the

electricity system and massively benefit from it are expected to value and support the mini-grid establishment.

Care and protection of the system requirement by the community comes in naturally and if it is hydropower system, the catchment area is valued and taken care of. Community members should be able to help in conservation of the catchment area of the hydropower system and caring of various equipment such as transformers, poles and conductors that help bring electricity. The increased uptake of electricity and care of the energy system are the benefits to the mini-grids; hence, contributing to its resilience. The financial resources mean the mini-grid operator is able to attract qualified and competent personnel, with the energy provider being able to make timely repairs to the system. In other words, the R4 are available for the resilience of the system. It should also be noted that any breakdown on the loop, whether on the mini-grid or the community, will have a negative impact on the other; hence affecting the whole of community energy resilience.

The concept of community energy resilience can also be better understood with the photo of a woman carrying firewood and a baby while in front of her there is a pole carrying electricity as in the Figure 2-5.



Figure 2-5. The Woman and Child in Bondo vs traditional and Modern Thermal Energy Access.

Source: (Bparthan (2019)

The photo in Figure 2.5 depicts a ‘lose-lose situation’ where the woman is forbearing the drudgery of walking long distance to fetch firewood, carry the firewood on her head and a child at her back. The mother has very little time of the day for other productive chores as upon reaching home she will have to fetch water, cook for the family and participate in farming activities. As expected, she does not have time to educate or empower herself, let alone take good care of the child. The cycle of activities is expected to start all over again on the next day. All this is done despite a pole carrying electricity in front of her. If she is to use electricity for cooking and water brought nearby through pumping, the burden on her would be lessened. The woman can then have enough time which she can use for other productive activities and also do away with drudgery. The child would also benefit as he/she would be supported better if the mother is at home. She may be involved in some businesses that require the use of electricity such as saloon, local bakery, selling of cold drinks and fizzes.

The increased usage of electricity through cooking and business activities can result in more income for the family. The increased income to the family means issues of unaffordability and unwillingness for electricity and electricity appliances are solved. The increase in electricity usage means the energy operators have increased income for improved service and expansion where needed. But with the women still dependent on collecting firewood from long distances, the opportunities for building community resilience cannot happen and the electricity-provider is affected through reduced electricity sales. If the woman or women are to be supported so that they are able to cook using electricity and use the time gained for productive activities, there will be winning on both sides. Such a situation provides the connectedness of community resilience with the energy system resilience.

2.3.5. Nexus

Nexus is another important concept used in this research work. Mohtar and Lawford, (2016:193) came up with a proper definition of the term nexus as, ‘a connection or link – often causal – between a group or a series of objects and/or ideas. The nexus approach is preferred and it had been employed in that the suggested interventions in the resilience building of the community need not be done at the expense of sustainability of the electricity delivery, and vice versa. The resilience of the community and resilience of the energy system are linked or connected hence the need to be achieved simultaneously. Nexus approach has its own challenge as the sectors that are intertwined or interconnected may have decisions and policy making being done by different stakeholders and mostly in isolation of each other.

Much as there are complications, many authors are of the view that a better understanding of the nexus with regard to different stakeholders with different, and sometimes competing, goals is through stakeholders’ engagement and dialogue (Flammini *et al.*, 2014; Aboellnga *et al.*, 2018;

Hasan *et al.*, 2017; Ferroukhi *et al.*, 2015). The alignment of different goals and interest of stakeholders with the concept of nexus requires multi-disciplinary and trans-disciplinary approaches. Such being the case, participatory approaches with involvement of local government, the private sector, communities, academia and others is preferred. Of more importance is the bottom-up or community-based approach which puts the community at the forefront of the stakeholders' engagement. Harnessing the resiliencies of the intertwined and interconnectedness sectors of the energy system, which is engineering in nature, and the community which is social or socio-ecological in nature, requires nexus approach. The local community members and their representatives are put at the forefront so that their specialised and experiential knowledge, collective might, their capacity and their significant roles should be the main driving forces. In such a case, the actual needs, priorities, and perception of the vulnerable communities are taken on board in building their resiliencies and making suggestions on how the resilience of the energy system can be enhanced.

2.3.6. Co-design Approach

Apart from resilience and nexus, another concept that requires defining within the context it had been used in this study is co-design. Co-design is defined as an activity or intentional approach aimed to combine views, inputs and skills of people with many different perspectives and perceptions, experiential knowledge, practical and tacit knowledge to produce artefacts, systems, work organisations to address a specific problem (Dollinger and D'Angelo, 2020 & Spinuzzi, 2005). Community members and users are the important part of the co-design process. The involvement of community or users and other stakeholders in the design of technology or community's intervention provides the advantage of bringing in a shared vision, social learning and mutual understanding among all those involved (David and Cantoni, 2015).

It is reported that the concept of co-design gained prominence within the academic and applied disciplines due to three major reasons. The first is within the industrial sector as there is need for companies to produce high standard products and services, which conform to the actual needs of the users. The increased competition among manufacturers and service providers has forced companies to involve users in design so as to gain insights into the actual needs and views of end-users (David, Sabiescu and Cantoni, 2013). Such a reason is very important within the industrial sector but not so useful in the case of this research. This is because there is no competition for manufacturing apart from bringing an intervention that is mostly a project that may require once-off support. The second reason, as explained by the same author, is that some solutions/technology/interventions that had been successful in developing countries or other locations have failed to be implemented successfully in other sectors or settings. This is mainly because of the differences within the social, cultural and political contexts. Such reasoning calls for co-design so that the solutions or intervention for a particular setting should come from or have huge contribution from the users themselves for increased impact, easier acceptance and ease of implementation.

The third reason, which is termed as the “Deficit model” (Lam *et al.*, 2017), is an approach in which external agencies are fond of engaging communities solely to identify shortcomings of a particular community and then the agencies go back to recommend interventions away from actual users or beneficiaries. The approach has a weakness in that it prolongs perpetuating dependences and disempowerment of target communities. The true co-design process for intervention of disadvantaged community is required to have communities, stakeholders and those proposing interventions to be actively involved from the start to finish. Of course, the involvement of the community in the design process has challenges which is that community members or their

representatives may not have the necessary skills, exposure and knowledge to effectively participate in the co-design process. They therefore require to be equipped with power and basic knowledge if they are to be actively involved in the co-design process.

The community members or their representatives require enough time and other resources if they are to gain the much-needed confidence, knowledge and skills so that they are able to take control of their own lives and the community's future development (Calvo and Sclater, 2020). To counter this shortfall, some researchers or professional experts resort to conducting interviews so as to come up with participants with background and familiarity of what is intended to be achieved (Bell and Nusir, 2017). The planning of co-design should therefore be able to support communities to be able to propose new ideas and then being actively involved in transforming such ideas into reality.

Within the development studies, Goodyear-Smith, Jackson and Greenhalgh (2015) propose that recipients of intervention or technology and those responsible for implementation should be actively engaged and involved unlike just being consulted if the process is to be genuinely called a co-design. Zamenopoulos and Alexiou (2018) & Giolite (2017) have made the proposition that researchers or professional experts need not influence communities' ideas, but rather act as enablers, mere participants or observers, advocates and translators. This is done on the background of the constructivist paradigm in that knowledge cannot be completely formalised and classified or be taken as a privilege of the few such as researchers and professional designers. Gaining knowledge and learning takes place in a dynamic system through the interactions made among people, practices, artefacts, communities and institutional practices (Adom, Attah and Ankrah, 2016; Alzahrani and Woollard, 2013 & Dagar and Yadav, 2016). It should be understood that professional designers and researchers have the skills and knowledge in their domain of

specialisation, the local community has tacit knowledge that is helpful to the designs that will affect them.

Tacit knowledge is difficult to express or extract, and more difficult to transfer to others by means of writing it down or verbalizing it. Tacit knowledge that includes personal wisdom, experience, insight and intuition can only come out through interaction as it is rarely or difficult to be documented. Co-design is one important way of gaining tacit knowledge which is aimed at bringing a shared vision, social learning and mutual understanding among those involved or affected in the design process. Co-design process is suggested to be simple if a “code of conduct” by David and Cantoni (2015) can be followed. The first step is to ensure that any co-design process that would want to come up with intervention for a particular community has communities’ views and concerns for consideration. The second is that the participants within the co-design, regardless of their educational background, and social status, be considered as equal and experts in their own right. Lastly, the main source of design ideas and innovation should be the community. These basic tenets are of essence and have been followed in conducting the study.

Abrams, Man and Mcleod (2019) provided the five-stage process of co-design as in the Figure 2-6.

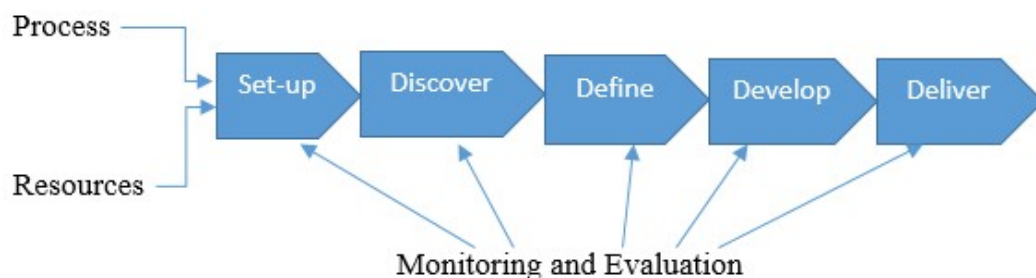


Figure 2-6. Steps of a co-design process. (Source: Abrams, Man and Mcleod (2019:7)

From the Figure 2-6, the first thing before contemplating to undertake the co-design process is to ensure that there are enough resources and that the objectives have been clearly defined. Such assurance of resources and processes being pooled together fall into the stage of *set-up*, which is the first stage. The discovery stage is achieved through various interactions with users and community members after which there are stages of *define* and *develop*. Both *define* and *develop* stages are achieved through stakeholders engagement of workshops, focus group discussions, scoping sessions and interviews (WACOSS, 2017 & Calvo and Sclater, 2021). The final stage, which is *deliver*, is about coming up with actual or prototype of what was defined and developed. The advantage with this five-stage process is that there is monitoring at every stage. It should be common knowledge that a reverse loop is embedded in the stages so that where something is amiss along the way, the activities can start all over again or started at any of the previous stages. The approach with stages is very helpful in providing guidance as to how co-design process can be implemented. The stages had been emulated on conducting the co-design within this research work.

Co-design is being questioned by many researchers as it has no coherent methodological approach nor evaluative criteria (Spinuzzi, 2005). The frequency and duration of the interactive sessions are not defined hence evaluation can be difficult as the required activities may not be known whether they had been completed or not. Then there is a contentious issue of reciprocity. During co-design process, the researchers get paid for the work they are doing while local participants who commit their time and energy towards the activities of the co-design at the expense of their day-to-day economic activities and/or entertainment are hardly remunerated. The main excuse or reasoning is that they may get swayed with the payment hence their expected contributions could not be neutral. The other reason is that the provision of incentives or remuneration would bring tension and

disagreements within the community between those involved and those not involved. Lastly, remunerating participants of co-design or any other community engagement will make research expensive, especially for students, as it will be a norm through precedence. Ssozi-Mugarura, Blake and Rivett (2017) have argued that some form of reciprocity is required so that community representatives who are experiential designers are compensated for their effort let alone the time which they would have used for their economic and material benefit. With this in mind, securing the commitment of the local participation to form the co-design team can be difficult if members do not see the benefit or are not incentivized to leave their livelihood activities so as to commit to the co-design activity. No remuneration was provided under the study, except provision of meals where needed and/or direct reimbursements. Of course, higher amounts of transport reimbursement than what had been spent was provided to community representatives, with extra amounts not specified as payment for time and effort on attending the co-design.

Lastly, the other challenge of co-design is that the involvement of local participants on complex technology such as mini-grids can be a challenge as community participants may not have working principles of the particular technology. Then there are also technical terms or jargon specific to the technology like inverter, charge controller, synchroniser among others, which may be difficult for rural communities to comprehend or to be interpreted in local languages. Such cases make co-design difficult as some members and in other cases all members of the local team could lack basic understanding of technology or intervention. In such situations patience and more sessions of familiarisations are required, of course, at an increased expense of time and cost. The challenges of co-design are real and expected, but the benefits outweigh them.

2.4. Community-Based Qualitative Research (CBQR)

There are four different participatory designs or action-oriented models (Leedy and Ormrod, 2021:314) of action research, design-based research (DBR), participatory action research (PAR) or youth participatory action research (YPAR) and community-based research (QBR) or community based qualitative research (CBQR). In some cases, all the participatory designs may mean one thing or the other, but without labouring with explanations of similarities and differences, this study adopted Community Based Qualitative Research (CBQR). CBQR utilises qualitative methodology to investigate and address issues and problems in a particular community settings (Johnson L.R., 2017 as cited by Leedy and Ormrod, 2021). CBQR requires researcher(s) having close collaborations with the community members/representatives so that together they make substantial improvements through changes on condition and resources within the community.

The study at Bondo involved close collaborations among community members, researchers, energy supplier' representatives and other stakeholders in finding out the various options as to how the energy system can continue functioning normally and thriving while at the same time the community members are to have increased benefits out of their energy system. Such an approach fits very well with CBQR as the end result is on contributing to the transformation on the condition of the people in the community so that they embark in activities that have increased usage of electricity. The other important tangible outcome of the research that made the study qualifying within the CBQR is the implementation of a co-design. The co-design as an outcome is aimed at contributing to the enhancement of community resilience and energy system resilience and this had to come from community engagement.

Of course, CBQR has its own challenges such as the need for the researcher to surrender some controls in respect of community's authority and leadership. This is about managing powerplay between community members and researchers on one hand and community members themselves on the other hand. It is reported that CBQR requires enough time and commitment so as to build rapport and reciprocal relationships if community members are to fully and fairly contribute to the problems at hand. Such can have a bearing on cost and time. The other challenge is that data collection strategy is required to capture issues that are emergent, iterative and collaborative. This can be too involving and require increased attention during interactions. All these were considered within this study.

2.5. Sustainable Livelihood Framework Versus Community Resilience

There is a close linkage between community resilience and the sustainable livelihood approach or framework. This is on the pretext that livelihood is defined as living (Natarajan *et al.*, 2022) and that living requires capacities, assets and activities (DFID, 1999). Sustainable livelihood is defined as a living in which households and communities are able to cope with and recover from shocks and stresses, able to maintain their capabilities and assets while at the same time be able to provide livelihood opportunities for the next generation. Sustainable livelihood is extended to helping others at local and global level as a way of attaining their own decent living (Chambers, 1993 and Scoones 1998 as cited by Natarajan *et al.*, Ibid). Sustainable livelihood became a popular concept in the 1990s while evolving into an approach and then into a framework by the publication of Ian Scoones in 1998 (Natarajan *et al.*, 2022). The author reported that the popularity of the framework happened after it was embraced by institutions of national and global governance such as DFID. In some cases, it is reported that the framework is more or less regarded as a methodology.

Having defined sustainable livelihood, the sustainable Livelihood Framework (SLF) is defined as a tool mostly represented schematically that has many factors and relationships affecting people's way of living. The importance of the framework is justified with the allocation of billions of dollars towards supporting the poor. The framework is very relevant as it encompasses the integrated rural development, sector-wide approaches and participatory approaches.

The framework presented as in Figure 2-7 is reported to have earned itself a main stay within the academic and applied field due to the relevance in helping the understanding of livelihood options, particularly of the poor.

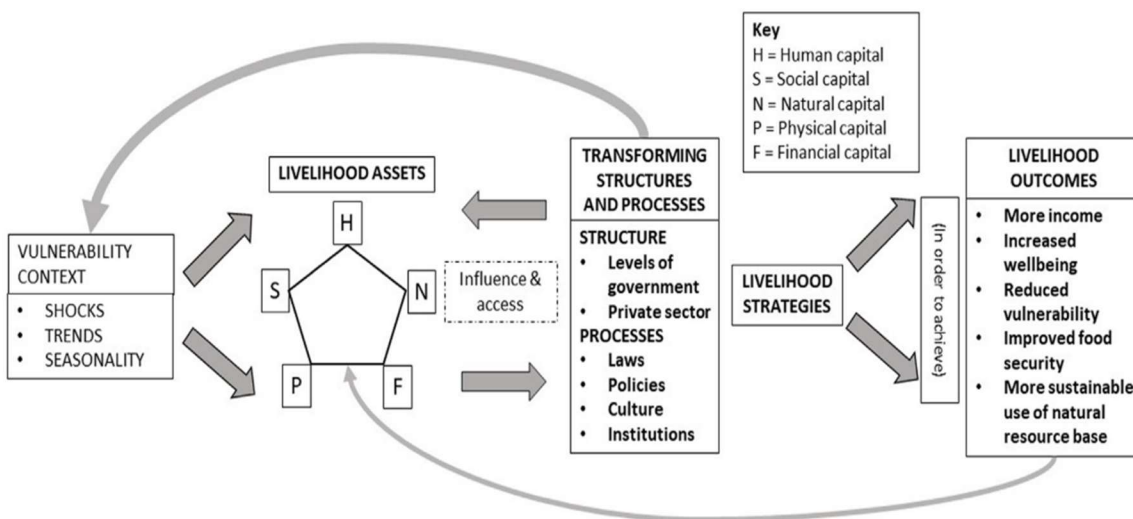


Figure 2-7. The Sustainable Livelihood Framework. (Source: Source: Natarajan et al. (2022:13)

The framework has vulnerability context on the left, which can be regarded as adversity if compared with community resilience. The mediating factors of resilience are represented as livelihood assets (human, social, natural, physical and financial capitals), transforming structures (level of government and private sector and the transforming processes (laws, policies, culture and institutions). The livelihood strategies can also be included within mediating factors. The framework provides only the positive livelihood outcomes, while resilience consists of both

negative and positive livelihood outcomes. SLF and resilience are aimed at bringing some interventions on the poor with some few, if any, differing approaches. However, SLF has the advantage in that it is not rigid as it provides liberty of policy makers and academicians to reshape it based on the available assets, structures and processes.

The SLF has important assets which are equally important to resilience building. Within human capital, the example of poor health is a negative condition towards a person's ability to pursue a resilient or sustainable livelihood, while skills and level of education are vital for the attainment of decent livelihood. A skilful and educated individual is more likely to adapt to climatic and other shocks as they are prerequisites if one is to be able to adopt new technologies. A male-headed household is more to adapt than a female-headed household as male farmers have, in many cases, biased access to many resources. Age and household sizes are the other factors that are important in adaptations. On financial capital, the extent of the people in the area having several sources of income leads to resilient livelihood. The people or households who have access to off-farm income are more likely to adapt because they are less dependent on climate-sensitive agriculture. The access to television and radios, which provide information about adaptation and sustainable livelihoods, fall within financial capital.

The study area is on the foot of Mulanje Mountain, which is an important natural asset that the people depend on for firewood, poles, source of food like mushroom and others. The road network, school blocks available, health facilities available, power system and water system within the community fall under the physical capital. The size of land per capita or per household, a very important physical infrastructure influencing the adaptation in rural settings, fall under both physical and natural resources. Within the social capital, there is need for community members to have easy access to market and advisory/extension services for them to be aware of new

technologies and adaptation strategies. Membership to various groups within and outside the community is also crucial in that such members have the privilege of benefiting the information and resources on various coping strategies. The other important feature of social capital is about cohesion among members of the same community as they are able to offer support to whoever is in distress.

The transformation structures and processes are key to the adaptation strategies. The laws, policies, culture of the people and the availability of active institutions are key for sustainable livelihood. The level and extent of government involvement and the involvement of the private sector are also key to the enhancement of sustainable livelihood of the local masses. The livelihood strategies that the people adopt are key to their sustainability and quality of rural lives. The understanding of all mediating processes at household or community level of study area provides a clear indicator on the extent of the resilience-building before the adversity and the recovery after the adversity. Since each community is unique in terms of endowment of its capitals, there is need to have the understanding of the capitals available based on a specific case; hence the study on resilience and sustainable livelihood requires the approach of a case study.

In terms of sustainable livelihood and resilience, Malawi's rural households are grouped into three (Malawi Government, 2017c) as below:

1. "Stepping Out" households: these are the households that have managed to move out of agriculture and entered into productive sectors of economy over time. For example, they have the household-head finding better-paid employment in local non-farm activities combining with agricultural activities or investing in SME. It can also be a 'migration step-out' to take advantage of opportunities in peri-urban and urban areas. These are the most

resilient households as they do not depend on the natural resources and are not affected by the biggest threat of climate change;

2. “Stepping up” households: the households that have labour, land, assets and capacity for surplus food production and/or commercial activity. These have the capability to move the livelihood ladder through diverse and high value agricultural activities. The surplus food production and the engagement in commercial activities give this group of households some enhancement of resilience; and
3. “Hanging in” households: these households have less land or no land of their own, no assets and no potential for market engagement. They may provide labour on borrowed land or survive on piecework. In this group the people are only engaged in agriculture as a safety net rather than a driver to have the household move up the livelihood ladder. The other danger with this group is that the households are living in the margin of destitution and the continued exposure to adversity such as climate change can lead to very dire situation.

In terms of enhancing the resilience of households and community, the overall aim is to have as many “hanging in” households climbing the livelihood ladder towards “stepping out” and “stepping up” households. An energy system like Bondo Mini-grid is an enabler for “stepping out” and “stepping up”. In order to achieve these, there is need to “identify the community’s assets, challenges and specific vulnerabilities and threats related ... potential adversities” (B. Pfefferbaum et al., 2015. p239). Community members and other organisations in the area are better placed to know more about the needed parameters in their locality, relationships and networks, and knowledge about their priorities; hence the preference of using participatory approach in the study. The stepping out, stepping in and hanging in are schematically represented in Figure 2-8.

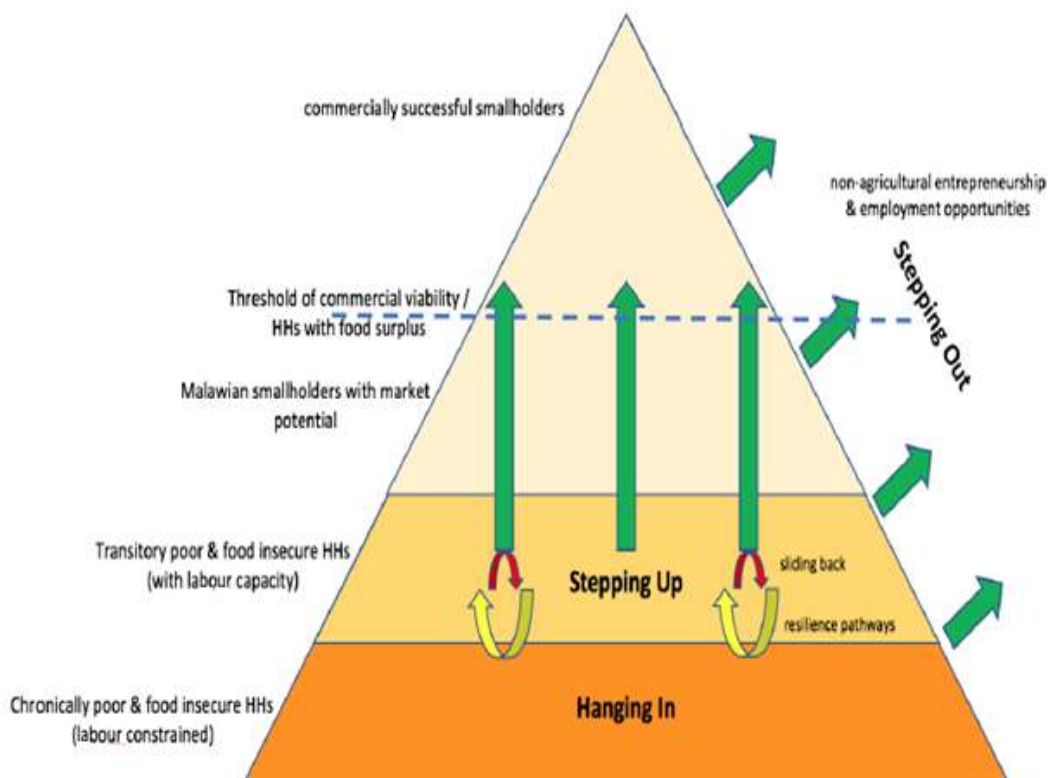


Figure 2-8. *Lifting Households Towards Resilience.* (Source: Malawi Government (2017c:25))

The effort that rural people are putting towards the interventions available to lift themselves up the resilience pathways are inadequate considering the severity and frequency of stressors. As presented in the Figure, there are more people within the ‘hanging in’ than those who have made the ‘stepping up and stepping in’. There are some households which had tried to step up but have they have been forced to slide back to ‘hanging in’ as shown in the Figure 2-8. Those ‘stepping out’ are reduced with many who graduated from lower levels sliding back to ‘stepping up’ and others falling even further to ‘hanging in’. This happens because of the severity of the adversities, the lacking capability of the community and the limited availability of the capitals.

There are several factors that impinge development efforts and resilience of communities that need to be dealt with. Household resilience is one important part of community resilience. Household

resilience is about net movement of households from “hanging in” to “stepping out” and “stepping up”. There is need for more households move up of the resilience ladder than those hanging in or sliding back, if the enhancement of community resilience is to be achieved. The participatory approach is the preferred way of understanding the enhancement of community resilience. In this study, the concept of resilience has been used within the development agenda and before disaster or disruption as a way of finding out how communities and households can have increases in incomes, assets, buffers and how they can be supported to have positive mindset.

2.6. Related work within Community Energy Resilience

The provision of electricity access to rural areas of developing countries has the ultimate goal of the attainment of all the three pillars of sustainable development – economic, social and environmental (Traeger *et al.*, 2012; Saing, 201; Aklin *et al.*, 2017; Bruderle, Attigah and Bodenbender, 2011 & Torero, 2014). However, the increasing of electricity access in rural areas on its own had been seen not helpful towards the achievement of these (Mainali and Silveira, 2011 & Torero, 2014). This is because rural communities are inherently challenged in several areas. Their dependence on rain-fed agriculture, which is impacted by climate change and seasonality means reduced incomes, food, and raw materials. Rural communities are also challenged with the underutilisation of resources; limited access to financial capital; lack of basic business skills and knowledge; and the underdeveloped infrastructure (Contejean and Verin, 2017). Rural people inherently face income insecurity as they have difficulties to create and run farming as business and/or non-farm businesses. Of the few who run own businesses are reportedly the self-employed entrepreneurs and they mainly imitate what they see in their villages or nearby. With such challenges, rural communities are most unlikely to be able to pay tariffs that reflect the full cost of

electrification (International Renewable Energy Agency, 2018), let alone buy electrical appliances that can improve their lives.

Various pieces of literature have been reviewed with none explicitly providing the understanding of the concept of community energy resilience. As a result, the related work has been split into two sub-sections – enhancement of energy-system resilience and the enhancement of community resilience with electricity. These are aimed at providing evidence of the options for the enhancement of community resilience with electricity access and enhancement of resilience of energy-systems that provide electricity to rural areas.

2.6.1. Enhancement of community resilience with electricity access

This section is providing evidence on how electricity can provide improvements of community/household wellbeing. It is all about providing evidence of how community resilience can be enhanced with electricity access. Several case studies on how the access to electricity is an important element in building the community resilience are explained in sub-sections that follow.

A. The positives of electricity access in Asian countries against Sub-Saharan Africa

It is reported that rural electrification provided weaker evidence on the impact in areas of health and education in Sub-Saharan countries of Rwanda, Benin, Burkina Faso, Mozambique, Senegal and Zambia. The positive correlation of electricity access was on the increased income that was observed in South Africa (Dinkelman, 2011 as cited by Saing 2017)). It is reported that electricity access in South Africa provided positive effects on female employment and an increase in working hours by both females and males. On the other hand Khandker et al 2012 as cited by Saing 2017) reported that electricity access provided positive outcomes in Asian countries of Bangladesh, Vietnam and India. Within the education sector, it reported that students stayed longer in schools,

and that the students were having increased study time and there was increased enrolment. Household's income and consumption were also on the increase. Notwithstanding the results of the research that revealed all these, electricity access provides positive impacts in all areas including Africa. Only that there had been fewer research work to document the positives, hence the potential of this research work filling some of gaps.

B. High-level political commitment in Ghana

High-level political commitment has shown that there can be many gains on expansion of rural electrification initiatives. Trotter (2016) reported the case of Ghana where rural electrification was championed at the presidential level. The author reports that the former president of Ghana, the late Jerry Rawlings, campaigned to become the president of the country with a promise of expanding rural electrification targeting rural electorate in 1992. After assuming power and in keeping his campaign pledge, rural electrification was intensified. It is reported that such a drive produced the necessary positives as the country registered an increase in rural electrification from 6 percent in 1990 to almost 50 percent in 2014 (Philipp A. Trotter, 2016). The urban electrification rate is reported to have increased from 75 percent to 85 percent during this time.

It is reported that the increase of rural electrification and urban electrification rates resulted into the country's per capita income increasing three folds between 1990 and 2000. This is mainly because electrification access was accompanied with complimentary programmes. One such programme was the Program for Economic and Sustainable Development (PSED) championed by the country's Ministry of Trade and Industries (Africa Renewable Energy Access Program, 2012). PSED promoted local development through the establishment of light industrial zones, business trainings. It is reported that the light industrial zones resulted into 550 companies being established and over 1970 people employed (Africa Renewable Energy Access Program, Ibid). Apart from

ministry of energy or utilities providing electricity connections, ministry of trade and industries brought its own programme on business trainings and support of businesses. Expansion of electricity and implementation of various incentives require support from several ministries and different stakeholders if sustainable development is to be realised. Of course such an approach requires so much investment from the central government which, other countries may not afford.

C. Complimentary to rural electrification in Zimbabwe

It is reported that the government of Zimbabwe prioritised rural electrification as part of rural infrastructure development after independence. Such a drive provided high priority on rural infrastructure development that included the rural electrification plan. A programme called Electricity End-user Infrastructure Development (EEUID) was implemented as Rural Electrification Fund (REF), an institutional establishment similar to Rural Electrification Agency (REA) as is called in many countries. It is reported that the REF in Zimbabwe was established as early as 2002 (Bruderle, Attigah and Bodenbender, 2011 & The World Bank (2012)). The authors reported that REF started to provide support to rural communities for the procurement of electrical appliances such as grinding mills, irrigation equipment and welding machines that had been identified by the business owners themselves. The appliances were provided to rural households on loan and the delivery was made by the same REF. The financing for such a programme was from central government through levy on sale of electricity which was 1 percent in 2002 and increased to 6 percent in 2007. The drawback of the provisions of loans was low repayment; hence, a commercial bank was engaged to manage the loan facility apart from training operators in basic business skills. With a commercial bank running the programme, applicants were asked to pay 35 percent as down payment for the equipment/appliances. Much as there are no documented results on the socio-economic gains that were made, but the dedication and changes that were being made

to produce intended results are worth learning from. The important message is that there was commitment from government in supporting REF through a levy from electricity sales. The other lesson is that if one strategy is seen not to produce intended results, timely changes are important based on best practices elsewhere. The involvement of banks for the provision of loans and provision of basic business training to the target beneficiaries are some of the changes worth emulating.

D. Complimentary of electrification in Brazil

Brazil implemented *luz para todos* (Light for all) programme from 2003 as part of universalization and increased usage of electricity (Da Silveira Bezerra *et al.*, 2017). Much as the programme was to fill the gap that had less than 50 percent of rural population and 97 percent of urban population having electricity access, the broader objective was to foster the socio-economic development and poverty reduction through free access to electricity infrastructure. All three modes of electrification of grid extension, decentralised grids and stand-alone system were done based on the economics and convenience. The electrical appliances were also provided to households. The author reported that by 2014 the programme had managed to connect 3.37 million, 68 percent more than the original target of 2 million families.

What is impressive is that there was realization on the importance of electricity access towards social and economic development targeting the less developed rural regions. In the achievement of the broader objectives, collaborations with universities and research centres were encouraged as part of the whole set-up. Research institutions were handy to provide directions on management models while respecting the cultural, economic and environmental aspects. Adult learning, educational opportunities for the youths, poverty reduction strategies, sustainable development and reduction of social inequality were key components of the programme. As a way of guaranteeing

continuity of electricity affordability for low-income households, cross-subsidies were implemented as a way of compensating local power producers to continue serving remote areas. Such comprehensive support is reported to have had positive impacts with families increasing their income by 250 percent due to increased productivity in farming and food processing (Da Silva Bezerra *et al.*, 2017).

The main lesson learnt is that the electricity access needs to be accompanied with the activities that can foster greater economic development. Another lesson is that rural communities require to be supported with affordable electricity, appliances and trainings including adult education. The encouragement of collaborations with various stakeholders, including research centres and universities, is another plus for such programmes. Universities and research centres are so important in documenting the failure and then proposing solutions, and reporting success for others to learn from. These are missing in many projects of expanding electricity access. The coordination is mostly missing and support to the communities through education, loans and subsidies is mostly no there. Of course, some countries such as Malawi may not afford such dedicated funding to the sector due to limited resources.

E. High level political commitment in Senegal

On the same high level political championing as was the case in Ghana, a case of electrification in Senegal is worth learning from. After securing power in 2000, the then president Abdoulaye Wade, championed the expansion of rural electrification (Mawhood and Gross, 2014 as cited by Trotter, 2016). There was increased dedication towards Rural Electrification Agency (Agence Sénégalaise d'Électrification Rurale, ASER), which was established in since 1998. Under the Senegalese Rural Electrification Action Plan which was called Plan d'Action Sénégalais d'Électrification Rurale (PASER), a programme that came into being in 2002, the country was divided into 18 concessions.

The private concessionaires were attracted to develop plans and tasked to make their own investments of at least 20 percent of the total investment cost, with the remaining 80 percent to come from PASER. This is part of initiatives of reducing barriers for electrification plans of the rural areas which are not economically feasible; hence shunned by the private investors. The other interesting element as reported by the same author was the courageous act of the government going against World Bank and IMF power reforms. It is reported that the president ordered the state to buy back the shares of the state-owned utility SENELEC which had previously been sold to a Canadian-French Consortium, thereby fully reversing privatisation. It is reported that this top level commitment led to rural electrification increasing from 5 percent in 1997 to around 30 percents in 2010 (Philipp A. Trotter, 2016). It can be concluded that the government support, more especially financial support provided to private concessionaires and top level championing of rural electrification made Senegal to have had the highest number of mini-grids in Africa, at 227 mini-grid, in 2019 (Bloomberg NEF, 2020).

It should also be reported that the electrification drive in Senegal was accompanied with innovative policies including the introduction of cross subsidies for the reduction of electricity tariffs. The rural electrification drive and the accompanied cross subsidies contributed to the threefold increase of GDP per capita in the country in the 2000s (Bloomberg NEF, 2020). Also, the country's GDP savings, averaging 16 percent, were reported to have been well above Sub-Saharan Africa's mean national GDP per capita levels. The drive of electricity access that had been championed at the very highest level and the availability of subsidies are important if results are to be produced within the shortest time available.

F. Complimentary to the rural electrification of Kenya

The case of having other stakeholders, other than the government, providing their own support to the electrification drive is reported in Kenya. In a bid to promote the productive use of electricity (PUE), customer education was intensively conducted and that partnerships between communities and providers/manufacturers of equipment, financial institutions and other stakeholders (Africa Renewable Energy Access Program, 2012) were encouraged and established. The examples provide evidence on the importance of complimentary like business training, partnerships with various stakeholders. Much as the gains are not reported, what is more important is that electricity was not prioritised on its own, but complimentary support were dedicated.

G. The differences on community resilience with electricity access on the borders of Kenya and Tanzania

The other case study worth learning from is that of the adjacent communities in the borders of Tanzania and Kenya (Contejean and Verin, 2017). It is reported that the demand for electricity was high on the Kenyan side than on the Tanzanian side. The huge demand on one was partly due to an already established rural middle-class society that was on the Kenyan side unlike on the Tanzanian side. This rural agricultural middle class prevalent was totally missing in Tanzania, even though they were such so close. It is reported that the Tanzanian rural inhabitants on the border were mostly smallholder farmers dependent on rain-fed agriculture with very little possibilities, except imitating what was happening within the village and nearby. The farming as business and the sprouting of non-farm business were almost non-existent on the Tanzanian side. On the other hand, it is reported that the Kenyan side had increased electricity consumption with traces of economic development due to electricity access being visible. This shows that the existence of human capital and attributes within the community can hinder or spur economic

growth. With the existence of middle class within the community that had been exposed to different technologies and progressive urban life provide fertile ground for increased consumption of electricity leading to economic and resilient livelihood of the community members. Mere subsistence farmers dependent on rainfed agriculture rarely take electricity as a driver for economic transformation.

2.6.2. Enhancement of energy-system resilience

This section is about providing evidence based on case studies as to how mini-grids can be sustained or have their resiliencies enhanced. This is done on the understanding that resilience of the mini-grids will lead to the enhanced resilience of the community. Two successful case studies of Uttar Pradesh and Tanzania, and the various options that can be implemented for the enhancement of mini-grid establishment are explained in the sub-sections that follow.

A. Mini-grids in Pradesh

One case study of how mini-grids can be enhanced is of Uttar Pradesh, India. Championed by Uttar Pradesh New and Renewable Energy Development Agency (UPNEDA), the institution adopted a *laissez-faire* environment towards mini-grids based on their Act 02 of 2003. It is reported that through the act, it was easy for the private operators to provide electricity in rural areas without tariff regulation or licensing requirements, except registration (World Bank, 2017a). No uniform tariffs were implemented by the mini-grids operators. It is reported that UPNEDA could voluntarily inspect or go to mini-grids based on customer complaint if the operator fails to meet safety standards. Technical and safety standards were enforced through simple grievance system where customers were lodging complaints to regulators or any other body if the operator was failing to meet service standard. In such a case, UPNEDA had the mandate to cancel or blacklist

any mini-grid operator that failed to meet the minimum safety standards. Several mini-grids in large village were allowed to exist directly alongside existing grid infrastructure.

Then there was the 2016 policy, which was offering 30 percent state subsidies to private developers to install mini-grids in remote and economically challenged areas. It is reported that such subsidies were provided on condition that the operators would provide less than 8 hours of electricity and monthly cap of tariffs of equivalent to 0.91 US\$ for loads of 50 W and US\$ 1.82 for loads of 100 W. Surprisingly, no private operators accepted state subsidies under the policy as tariff limitation were regarded to be too low for commercial viability. Regulations were simplified further with UPNEDA acting as a single-window clearance facility, liaising with the collaboration of other relevant state authorities so as to ease mini-grid's approval and clearance. Registrations of mini-grid establishments were also allowed to use online platform.

The favourable regulatory framework for rural mini-grids, with no tariff regulation and relaxed authorisation plus funding from central government through UPNEDA made mini-grids flourish in the state. With poor service from the main grid, it is reported that rural customers were forced to switch from main grid to mini-grids even though the tariffs of mini-grids were sometimes 20 times higher than main grid (World Bank, 2017a). It is reported that the establishment of mini-grids in the state only started in late 2000s but it had grown so fast that it was able to provide services to over 350,000 rural residents by 2015.

The lessons learnt are that regulations and licensing requirements need to be simple and enabling if the private sector is to join the sector. No tariff regulations are important, if the sustenance of mini-grids is to be achieved commercially. The *laissez-faire* approach can be allowed at the start of the projects with regulations following after many actors have been allowed into the sector. Government subsidies are equally important for the penetration of mini-grids into economically

challenged areas. Having a dedicated state institution providing a single-window clearance facility and use of online platform for registration are very much commendable in easing the licensing and clearance processes.

B. Mini-grids of Tanzania

Tanzania is regarded highly on provision of enabling environment for mini-grids; hence, offering many lessons. Simplified regulation made the country make positive strides in the sector. For example, small scale power producers with capacity of 1 MW are reportedly not required to apply for licenses from the regulator in the country (Contejean & Verin, 2017 & Energy Environment Partnership, 2018). Tanzanian's regulation specifies that energy projects generating less than 100kW required no tariff approval from the regulator (Contejean and Verin, 2017). Developers are encouraged to collaborate with community or customers over how much should be charged as tariffs. Energy developers with installed capacity of less than 100 kW of electricity were again allowed to sell electricity to the utility in Tanzania (Odarno *et al.*, 2017). Developers were allowed to sell electricity to the utility in US\$ to avoid loss of value with the local currency. It was by law that a utility must pay out the mini-grid operators the capital cost minus subsidy upon arrival of main grid. In addition, a mini-grid can also opt for conversion to Small Power Producers (SPP) or Small Power Distributors (SPD). The issues of dedicated funding towards mini-grid establishments and the sharing of cost for preparatory work of mini-grids are some of the incentives that were there to attract developers for the sector in the country.

It is also reported that in Rwanda, projects aimed at generating less than 500 kW do not require environmental clearance or licensing (Energy Environment Partnership (2018) while Malawi, projects above 50 kW are required to be licensed. The lessons are many and worth emulating for countries like Malawi.

C. Donor and/or State financing for mini-grids

Financing, both as capital cost and operating cost, continues to be the major challenge for mini-grid proliferation. This is because the systems for rural electrification rarely make economic sense as rural communities have limited urbanisation, sparsely populated, have low income and limited resources and equipment for investments (Traeger *et al.*, 2017). Bloomberg NEF (2020) reports that most mini-grids for rural electrification cannot survive on their own; hence require public, and donor funding. Outside financing is therefore an important component for provision of tailor-made instruments for de-risking private sector investments and addressing viability gaps (International Renewable Energy Agency, 2018). There are several cases that show the importances of donor and public financing pushing the proliferations of mini-grids in several countries of the world. There are also several approaches of financing options towards mini-grid support, which include de-risking project preparation phase, direct financing or credit lines, subsidies and performance based financing (International Renewable Energy Agency, 2018).

De-risking of rural energy projects through sharing of cost for feasibility studies, environmental impact assessment and licensing between the developer and public finances as was practiced in Nigeria and Tanzania is an important element (International Renewable Energy Agency, 2018). The developer can not be attracted to rural market by bearing all the costs hence de-risking can provide the much-needed motivation. Such initiative, among others, had been able to produce positive results in Tanzania. No wonder, Tanzania was one of the countries with the largest total installed capacity of mini-grids in Africa at over 158 MW of installed capacity in 2018 (Day and Kurdsiel, 2019). The country also boasts of having one of the highest number of mini-grid establishment at 209 mini-grids in 2019 (Bloomberg NEF, 2020).

Another initiative is the provision of dedicated financing such as credit line for off-grid electrification, including mini-grids, as was the case with Rwanda and Tanzania (International Renewable Energy Agency, 2018). Tanzania had a US\$23 million World Bank credit line, which was initiated in 2010 and managed by government owned Tanzania Investment Bank. The bank was tasked to provide on-lending to local commercial banks as 15-year low interest debt for developers to access up to 85percent of total investment on projects of 10 MW or less. Much as the huge amount of the credit line was not utilised by the termination year of 2016 for reasons not disclosed by the authors, the 7.2 MW that was added by the funding and the learning curve on the implementation of such projects can still be regarded as positive developments.

In Indonesia, a strong public financing component supported mini-grids development through subsidies and grants. Thereafter the ownership, operations and management of these mini-grids had to be transferred to local communities (International Renewable Energy Agency, 2018). With such an approach, it is reported that the speed of mini-grids establishment in the country was so rapid. A total of 583 mini-grids were installed in the country by 2019 and it is little wonder that Indonesia was ranked among the top ten countries in terms of numbers of installed mini-grids globally (Soni and Kawahara, 2020).

The development of rural mini-grids is accelerated even faster if central governments are actively involved. Blimpo and Cosgrove-davies (2019) reported that successful rural electrification and associated benefits are best achieved by government-led initiatives. (International Energy Agency, International Renewable Energy Agency, United Nations Statistics Division World Bank, *et al.*, 2020) reported, with the example of Bangladesh, as to how the government-owned infrastructure development company launched intensive customer awareness campaigns to address load-uptake challenges in mini-grids. It is reported that such awareness campaigns brought in new customers

and raised the per-capita electricity utilization. The increased load-factor resulted into increased cash-flow thereby providing the much-needed financial resourcefulness of rural energy systems.

D. The KeyMaker Model

The other approach of enhancing the resilience of mini-grid is the KeyMaker Model (Bloomberg NEF, 2020), also regarded as a business model under ‘Supplier-Offtaker Model’ (Energy Environmental Partnership, 2019). This is one of the ways of improving average revenue per user (ARPU). Under the model, the energy developer, or any other interested party, is engaged in procuring raw materials or products from the local community and use electricity from the mini-grid electricity to add value. The resulting products are sold to customers higher prices. Grinding, milling, oil extraction from plants, fruit processing, and freezing are some of the value-additions that can be considered within the model.

E. Actions toward the Productive Use of Electricity (PUE)

With many mini-grids having no options of anchor load nearby, productive use of electricity (PUE) aimed at stimulating the customer’s power consumption can be the option. Of course, even with the anchor load, PUE activities still need to be encouraged. PUE is defined as a set of activities that use energy/electricity in increasing income and productivity at household and community level (Bruderle et al., 2011 & Contejean & Verin, 2017). In some cases, the definition is extended in that PUE activities should provide taxation in the form of value added tax. Of course, the extension is tall order to be achieved in typical rural communities. Examples of PUE activities include agro-processing such as milling, light industry like carpentry, tailoring; welding and looming; and services sector such as bars, restaurants that need power for lighting, sound systems and refrigeration. Successful implementation of PUE is not cheap and easy as it requires addressing

several challenges and the involvement of several stakeholders. Access to finance and equipment, availability of good road networks and markets, provision of technical and business skills of local community are some of the issues for consideration within the implementation of PUE. Such a wide range of needs on the implementation of PUE cannot be left to the developer alone. Financing institutions, equipment manufacturers or sellers, academia, government departments and the community itself need to work hand in hand with the developer if PUE can be achieved in earnest.

The successful implementation of PUE activities as a way of maximising large sources of revenue for the electricity provider happened in Vietnam. Blimpo and Cosgrove-davies (2019) reported that funds were provided as capital costs for prioritising PUE. Electricity access was made as key development indicator for assessment authorities that were managing commune, districts and provinces. The areas that had huge potential of PUE were targeted as a way of showcasing the impact and also supporting companies to have increased income.

F. Political economy of rural electrification

For rural energy development to flourish, there should be a clearly defined institutional structure including rural electrification agencies and regulatory agencies (Franz *et al.*, 2014). In addition, there have to be clearly defined roles and responsibilities including coordination between various institutions that support rural electrification. For example, mini-grids can benefit from funding for the adaptation and mitigation of climate change, and with the case of Malawi such funding is channelled through Malawi Environmental Protection Agency (MEPA). Green Climate Fund (GCF) and Climate Investment Funds (CIF) is reported to provide huge funding (Rai *et al.*, 2015) which the agency can tap then work hand in hand with institution that support mini-grids as a way of supporting resilience building and adaptation of rural communities. The author reported that it takes the necessary enabling systems in place in areas of policy, planning and budgeting if

countries and the sectors are to access, govern and deliver on such funding. That means different sectors and actors, led by MEPA, have to push or pull in one direction in negotiating finance and influence the delivery.

Tanzania is reported to be good at that as the roles and responsibilities of the rural electrification agency, regulator, ministry and utilities for the mini-grid sector are collaborated. This is among the reasons that Tanzania is reported to have been getting over 40 percent of the EEP portfolios that had the coverage of the countries of Malawi, Rwanda, Uganda, Kenya, South Africa, Tanzania (Energy Environmental Partnership, 2019). It should also be noted that the countries that are serious with rural electrification have Rural Electrification Agencies (REA) institutionalised long time ago. REA, as an autonomous body under the Ministry of Energy is been regarded as the best practice on promoting and facilitating improved access to electricity access in rural areas. For example, the neighbouring countries of Tanzania, Zambia and Zimbabwe have had their REAs created in 2005, 2003, 2002 respectively. After 20 years, Malawi is still nowhere to have its REA created even though the country's policy gave a timeframe of 2018-2020 (Malawi Government, 2018b p56-57), which reads.

“To improve the management governance for Rural Electrification and Renewable Energy.....Establishing a Rural Electrification Agency as a semi-autonomous legal entity to manage the Rural Electrification Fund and Rural Electrification activities (in both grid extension and off-grid options) 2018-2020”

With the current arrangement without REA institutionalised, Rural Electrification Fund (REF) is reportedly to be prone to abuse with local press reporting different cases of abuse and corruption on the management of the rural electrification fund (Mzungu, 2021). The continued delay for the institutionalisation of REA is of great concern. Proper management of political economy is key on

attraction of foreign investment and proper utilisation of rural electrification fund and funds from central government for the support and expansion of rural electrification access.

The proliferation of mini-grids in Malawi can gain so much ground if the country can emulate how governments of Indonesia and Bangladesh supported mini-grid in their countries. The country can make progress if different arms of government such as the ministry of energy, the regulator, rural electrification agency, utilities, MEPA and MERA can be working together. There is also need for transparency and accountability on how each of the above is exercising its mandate so there is confidence for external financiers to be part of the initiatives. Decentralisation, especially institutionalisation of REA, is key so that what is collected as REF is utilised for the intended purposes, unlike where cases of abuse are being reported with current arrangement.

G. Accelerating mini-grid establishment with enabling regulation

Bloomberg NEF (2020) recommends that governments should strive to have single points of authority with powers to streamline the licensing and regulation process, relaxation of size of thresholds of installed power required for licensing, deregulation of tariffs and building robust sets of rules around grid arrival and protection of isolated mini-grids. For example, in Mali, the country's Rural Electrification Agency (REA) was given full oversight over mini-grid development. In Sierra Leone, a single license provided reportedly allows developers to generate, distribute and sell power, while in Tanzania as it has already been discussed, developers are allowed to obtain a single license for multiple specified sites (Bloomberg NEF, 2020). Governments and its ministries, departments and agencies are therefore called upon to set clear, pragmatic, simplified and consistent regulations that are best placed to attract developers.

Caprile and Matinga (2016) reported that the country's rural electrification act and rural electrification policy are only supportive of grid extension and solar home systems. As a result, mini-grids do not have the privilege of policy support and they are not supported, if any. As if this is not enough it is reported that electricity regulation act and the regulator treat mini-grids at the same level as large-scale generation system. The authors made the recommendations of reviewing rural electrification act and the energy regulation act so that mini-grids are fully recognised as a third option just like grid extensional and solar home systems.

2.7. Malawi: Economy, Electricity Sector and Vulnerability

The study was conducted in Bondo, which is a rural community in Mulanje District of Southern Malawi. Malawi, a country located in the south-east of Africa, has a total area of 118, 484 km² and an estimated population of 19.65 million as of 2021 (World Bank, 2022). It shares its borders with Mozambique, Tanzania and Zambia. Of the total area of the country, 20 per cent is water, with Lake Malawi covering an area of 22,490 km².

The country is relatively densely populated at 186 people per square kilometre and with high intercensal annual growth rate of 2.9 percent based on the data of the population and housing census of 2018 (Malawi Government, 2019c). The country is one of the poorest in the world ranked 173 of 188 on the United Nations Human Development Index (World Bank, 2019c). The national poverty rate was 50.7percent in 2019/20, which was a slight decline from 51.5percent in 2015/16. Using the international comparable poverty head count (US\$ 2.15 per capita per day) the poverty rate of Malawi stood at 70 percent in 2019, while the GDP per capita was only US\$ 394 in 2019 (World Bank, 2022). High levels of poverty and the huge increase of population growth are a hindrance towards resilience building or as ways of adaptation and mitigation strategies more especially at a local level.

Writing about Malawi is incomplete without pinpointing the landmark features of Lake Malawi and Mulanje Mountain. The eastern part of the country is dominated by the lake, which is the World's ninth and Africa's third largest lake. It is reported that the lake contains more fish species than any other fresh water body in the world. The lake is between 505 km and 603 km in length, about 87 km in width at its widest point, a total surface area of between 28,800 km² to 30,800 km² and the depth of 785 m at its deepest point (Weyl, Ribbink and Tweddle, 2010). Over 90 percent of the fish species in Lake Malawi are endemic to the lake, no wonder it is an attraction for the evolutionary biologists and conservationists (Thompson, 2013). Its attraction is for reasons of protection of endemic fish species and for tourists to the Lake Malawi National Park at the southern tip of the lake.

Lake Malawi National Park was a protected area under forest reserve since 1934 but got a status of a park on 24 November 1980. The park was also inscribed as a UNESCO Heritage Centre since 1984 (United Nations Environment Programme and World Conservation Monitoring Centre, 2022). Part of the same lake, which is on Mozambican side, called Lake Niassa, was officially declared a game reserve by the Government of Mozambique. This was done with the primary purpose of protecting endemic fish and other aquatic communities through monitoring illegal and overfishing, erosion and deforestation, managing fisheries and mitigating the impact of climate change (World Wide Fund, 2011). The lake is very important for livelihood provisions in so many areas such as the source of fish, recreation, indirect employment, and as a tourism attraction thereby benefitting millions of people in coastal and near places of the lake in Malawi, Tanzania and Mozambique.

2.7.1. The establishment of central government in Malawi

The central government in Malawi, in the similar manner that it is today, started when the deputy Consul-General, John Buchanan, declared the districts of Mulanje, Thyolo, Chiladzulu, Phalombe, parts of Blantyre, and Zomba as Shire Highland Protectorate (McCracken, 2012). It is reported that the declaration was made against the instructions of the British Foreign Office, the authority that had powers to do so. Buchanan was forced to make the declaration as a way of fending off the representatives of Portuguese East Africa, the Portuguese colony currently Mozambique, into making treaties with chiefs in the area to annex the land east of Lake Malawi and Shire Highlands to form part of Portuguese East Africa. It is reported that the colonial administration of the then Mozambique wanted to have the land under their jurisdiction and were attempting to make treaties with the Yao Chiefs, who were dominant within the areas South-east of Lake Malawi and Shire Highlands, and the declaration confirmed the area to be under British rule. The necessity of the area to be under the British was due to the many European traders and missionaries, especially from Scotland, who had settled in the area and they were lobbying for protection under the British command. Observing the need to have the land secured in the interest of the early European settlers, John Buchanan had little option except make declaration of a protectorate. After the declaration of Shire Highlands protectorate by Buchanan, the then Commissioner and Consul-General, Harry Johnson, declared the Nyasaland Districts Protectorate in 1889. Nyasaland district protectorate was the same Shire Highland Protectorate plus the expansion in other areas. Johnston also did the proclamation against the instructions of the British Foreign Office.

The lobbying by the settlers to have the Shire Highlands and the area west of Lake Malawi to be under British rule paid off with the Foreign Office endorsing the proclamation of the protectorate

in 1891. The wishes of the European settlers who had settled in Shire Highlands due to extensive travel and writings of Dr. David Livingstone during his Zambezi Expedition had been fulfilled.

McCracken (2012) reported that the British were first reluctant to have Nyasaland as its colony because the area was hard to reach from the Indian Ocean. Accessing the area required navigating the foreign waters of Portuguese East Africa and this was regarded as risky. It was only after the Anglo-Portuguese treaty of 1891 in which the Portuguese granted the concession of Chinde Channel to the British Government for 99 years that the British Foreign Office was swayed to ratify the declaration of a protectorate. Chinde Channel was a waterway that was deep enough for a ship deck and steamers for collecting cargo into and out of mainland through Zambezi River and into the navigable part of Shire River in Malawi. The protectorate was declared for a small section of land compared to what is currently Malawi and it had to take Johnston to consolidate and expand the area up to Songwe River. It should also be known that it was before the British Central Africa Protectorate in May 1891 that a number of European companies and settlers had acquired vast land of Shire Highlands, where tea is currently grown in estates. Being landlocked is still a challenge as access to the sea for imports and exports have to pass through ports in Mozambique, Tanzania or even South Africa.

2.7.2. Climatic conditions of Malawi

The country has a sub-tropical climate with three main seasons. Warm, wet season is from November to April during which 95 per cent of precipitation takes place. The Northern Highlands and the Sapitwa, the highest peak of Mulanje Mountain, receive the highest precipitation of about 2300 mm or more (Britannica, 2022). The lower grounds such as Lower Shire at the southern tip of Malawi receive the lowest precipitation ranging between 650 mm and 900 mm. A cool, dry season occurs between May and August, with temperatures ranging from 17 degrees Celsius to 27

degrees Celsius in low lying areas and 4 to 10 degrees Celsius in highlands. During this time, snow is common on Nyika Plateau in the Northern Region and on Mulanje Mountain in the Southern Region. The third season is hot, dry which is experienced between September to October with temperatures ranging from 25 to 37 degrees Celsius (World Bank, 2022; Britannica, Ibid). The different climatic conditions, coupled with different soils in the country provide the necessary conditions for the cultivation of various crops such as coffee, tea, tobacco among others.

2.7.3. The economy and sources of livelihoods of the people of Malawi

Malawi's economy is agro-based, with the sector supporting an estimated 85 percent of the population (Malawi Government, 2003; World Bank, 2022). The economy is dependent on tobacco, tea and cane sugar which together contribute over 70 per cent of export earnings. Other cash crops grown include coffee, cotton, macadamia nuts, pulses, and paprika chilies. The country has a relatively small manufacturing sector that had been declining; for example, the share of manufacturing to GDP declined from 17 per cent in 1994 to 10.9 per cent in 2002 (Malawi Government, 2003). Most of the country's mineral deposits are not commercially exploited except small scale mining of coal and quarrying of limestone for cement production. There is also small-scale mining of some precious stones happening in the country. Of course, exploration and assessment of minerals are continuing and some prospects of large-scale mining may take place in future. Subsistence fishing is done in rivers and lakes, with Lake Malawi contributing three-quarters of all fish caught in the country (Britannica, 2024). Other major fishing sources are the lakes of Malombe, Chilwa and Chiuta, plus the Shire River. It is reported that the volumes of fish caught had been on the decrease due to overfishing, fishing with use of nets that have mesh sizes smaller than those recommended by fisheries experts, and the disregard of the ban on fishing in breeding seasons.

One of the ways of adaptation strategies to climate change hazards is the combination of cropping and/or livestock production. It is reported that the country fall far much behind on livestock ownership with statistics of 2000-2002 indicating Malawi to have had ownership of just 8.9 tropical livestock units (TLU) per capita against 24.9 TLU per capita for Zambia, 45.1 PLU per capita for Zimbabwe and 157.5 TLU per capita for Botswana (Makoka, 2008). The author also reported that in 2004-5, only 43 percent of Malawians households had owned livestock. There is therefore need to encourage local people to get involved in animal farming as a way of increasing the numbers of TLU in the country apart from helping on recovery and resilient building.

2.7.4. Malawi's Electricity Sector

The country has low electricity generation capacity, low electricity consumption per capita and low electricity access rate. Inadequate electricity generation is regarded as the major stumbling block towards the realisation of social, economic and industrial development in the country (World Bank, 2025). The installed capacity of 441.55 MW as of 2022 (Electricity Generation Company (Malawi) Limited, 2021) is too little for the estimated population of 19.65 million as of 2021 (World Bank, 2022). The installed capacity is less than half of what was projected to be the demand of electricity at 949 MW for 2022 and also far much less than what was projected to be the available power of 811 MW for 2022 (Malawi Government, 2019b). The summary of generation and transmission lines plus some major load centres are as indicate in the Figure 2-9.

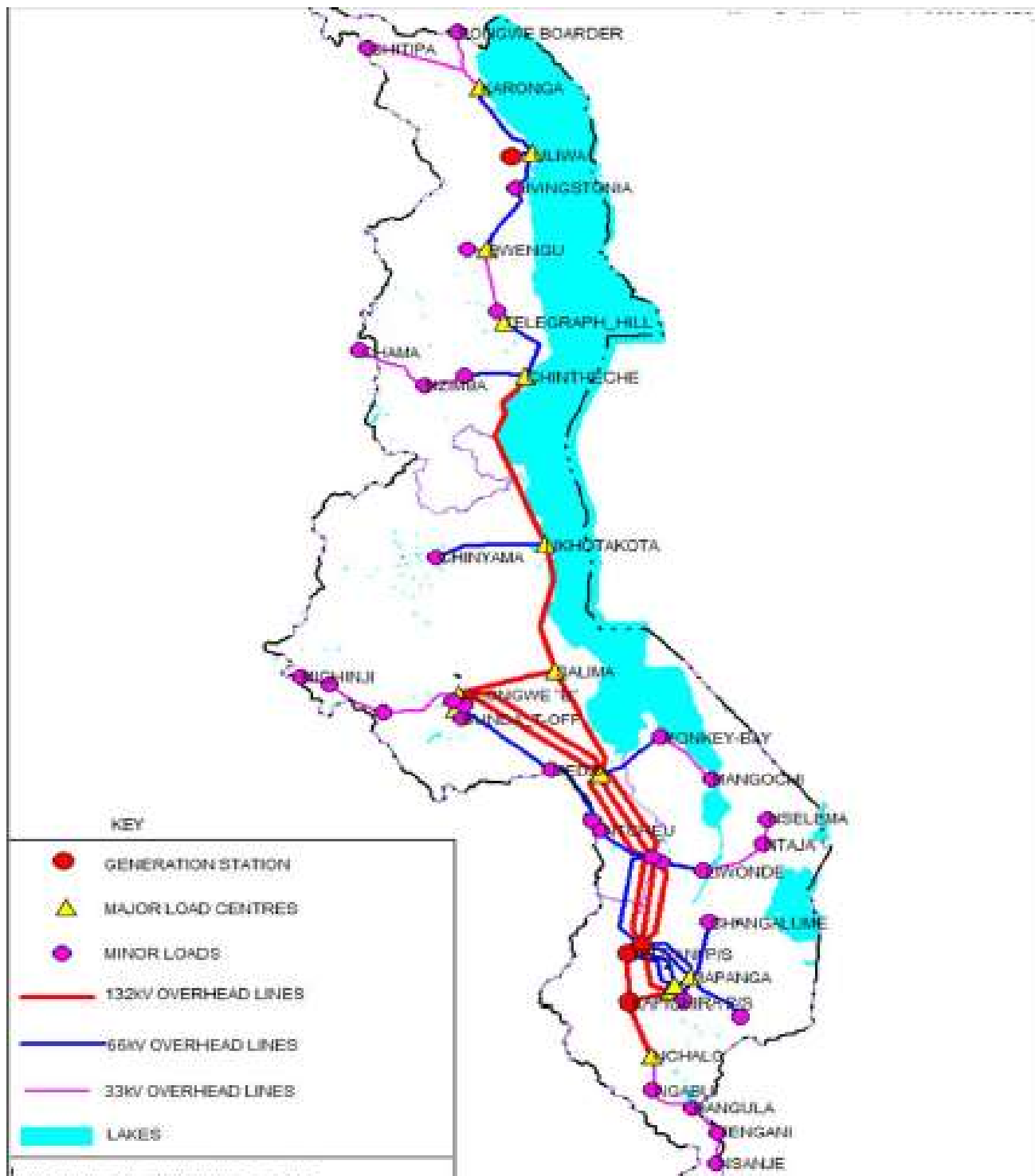


Figure 2-9. Map of Malawi showing ESCOM transmission lines, generation and load centres.

((Source: Electricity Supply Corporation of Malawi (ESCOM) (2013:7))

Except for the 4.5 MW Wovwe hydropower plant in the Northern Region, all the power is generated in the Southern Region on Shire River. The 132 kV lines transmit power northward as shown in the Figure. Three of these high voltage lines reach Blantyre and Lilongwe. Only one line which passes along the lake reaches the northern region up to Chintheche in Nkhata Bay. All other areas in the northern Malawi, including Mzuzu, are therefore served with 64 kV and 32 kV voltage lines as shown in the figure 2.9.

At 14.2 percent in 2021, Malawi had the lowest electricity access rates in SADC 2021 as in the Figure 2.10. The access rate peaked to 18 percent in 2018 but it reduced to 14.9 percent in 2020 (World Bank, 2025). There is huge discrepancy between urban electrification rate that was 57.5 percent in 2017 and dropped to 55 percent in 2020, against the rural electrification rate that was 11.4 per cent in 2018 but dropped to 6.6 percent in 2020 (World Bank, Ibid). The country's electricity access rate is far much lower than the average of 50.6 percent for the Sub-Saharan Africa in 2021 (World Bank, 2024), The electricity access rate in 2021 in Malawi against the countries in SADC is as in Figure 2-10.

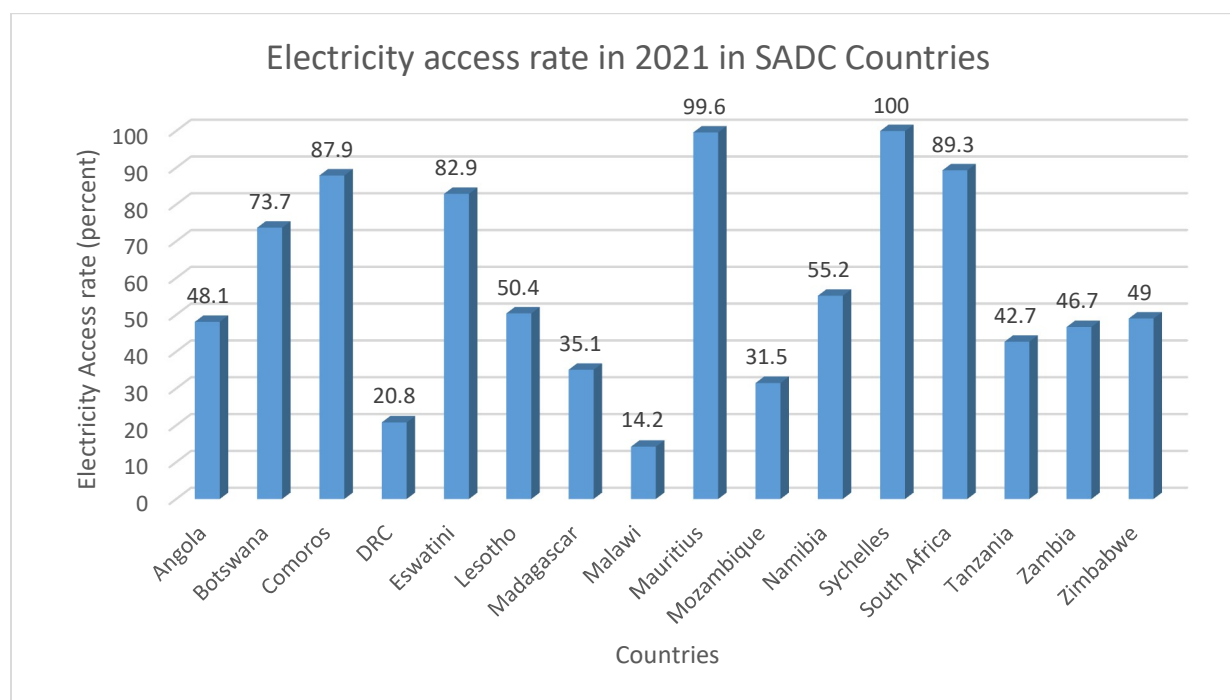


Figure 2-10. Comparison of electricity access rate in SADC Countries. (Source: Compiled from World Bank (2024))

The electricity access rate is not expected to have a huge leap as the population growth rate overshadows the connection rates. For example, ESCOM managed to connect only 35, 000 customers/households (or the increase of around 152,000 people based on household size of 4.4) within the fiscal year ending June 2018 against the annual intercensal growth rate of 2.9 percent or increase of around 400, 000 people in the same year (Malawi Government, 2019a & World Bank, 2019b).

In summary, low electricity generation capacity, low access rate, the risks of hydro-meteorological hazards and the concentration of generation power plants on one part of the country, Shire River, are the major challenges facing the power sector. Grid expansion is an important aspect, but the successful national strategies towards the universal access rate require the integration with mini-

grids and off-grid technologies (IEA *et al.*, 2020). The three approaches of grid, mini-grid and off-grid are considered in detail in the subsections that follow.

A. Overview of the National Grid

National grid in Malawi was first managed by the utility of ESCOM. until January 1, 2017. As one way of achieving improvements with the grid sector, government embarked on reforms in 2003. Malawi Energy Regulatory Authority (MERA) was established under the Energy Regulatory Act of 2004 as the energy sector-wide regulator. Then there was vertical unbundling of the then only utility, ESCOM, that led to the utility being stripped off its functions of power generation. The formation of a generation entity called Energy Generation Company (EGENCO) incorporated on September 7, 2016 and started its operations on January 1, 2017. EGENCO got the mandate for the generation of electricity; hence, it inherited all generation assets that were previously owned by ESCOM (EGENCO, 2021). Power Market Limited (PML), which was incorporated in 2018, assumed the responsibility for buying, selling, importation and exportation of electricity in Malawi (EGENCO, 2021). This restructuring of the power market was aimed at bringing efficiency within the sector apart from wooing the participation of the private sector as Independent Power Producers (IPPs). However, the incorporation of PML was short-lived as it was reversed with its functions going back to ESCOM in early 2023. The national installed capacity of electricity, which is under EGENCO (Electricity Generation Company (Malawi) Limited, 2021) is structured as in the Table 2-1.

Table 2-1. Installed and available electricity available in Malawi in 2023

<u>Site</u>	<u>No. of</u> <u>Stations</u>	<u>Total</u> <u>Capacity</u> <u>(MW)</u>	<u>Capacity</u> <u>Available</u> <u>(MW)</u>	<u>Energy</u> <u>Type</u>	<u>Comment</u>
Nkula	2	135.1	135.1	Hydro	
Tedzani	4	121.1	121.1	Hydro	
Kapichira	2	129.6	129.6	Hydro	The power plant was destroyed by Cyclone Anna on 24th January 2022 and put back on May 10, 2023
Wovwe	3	4.35	4.35	Hydro	
Thermals	30	53.22	53.22	Diesel	These are for standby or emergency power supply
TOTAL		442.22	442.22		

The contribution of IPPs has been very little, even though so many PPAs were signed (Kasalika, 2024; Africa Energy Portal, 2025). COVID-19 derailed some of the progress that should have been made. In early 2023 it was only Cedar Energy, Mulanje Hydro and Golomoti Solar PV that are contributing 3 MW, 8.2 MW and 17.5 MW respectively to the grid.

All the power plants under construction or active and their expected date that were set for commissioning as were compiled from various sources are as indicated in the Table 2-2.

Table 2-2. Major renewable energy projects under IPP in Malawi in 2022

Power project		Source	Capacity (MW)	Expected year of feeding into grid	Status as of March 2023
Salima Plant	Solar	Solar PV	40	2020	Active
Kanengo Plant	Solar	Solar PV	17.5	2020	Not yet
Golomoti Plant	Solar	Solar PV	17.5	2020	Not yet
Kanengo Solar Plant	Atlas	Solar PV	20	2020	Not yet
Gebis Waste to Energy	to	Biomass	21	2020	Not yet
Nkhota Solar Plant	Kota	Solar PV	21	2020	Not yet
Mulanje Cedar		Hydro	3.06		Active
Mulanje Hydro		Hydro	8.2		Active
TOTAL			148.26		

If all the planned installed capacity of 148.26 MW that was expected from IPPs were to be achieved, the country would have made huge progress in bridging the gap on electricity generation against electricity demanded. The delays, the missed commission dates and the stability of the grid with the addition of all or a bigger fraction of these especially the solar PV which have variable power generation are some of the issues that need to be looked into going into the future. Of course, the delays were inevitable with Covid-19 preventing progress of the work and importation of some equipment.

A. Challenges of the Grid Network in Malawi

Over 87 percent of the country's installed capacity is hydro-based on the single river of Shire in Southern Malawi. With the Southern Malawi being the region mostly prone to natural disasters, the hydro-meteorological hazards of floods, drought and the recent cyclones have had negative impact on generation systems resulting into reduced available power. The increase in severity and frequency of hydro-meteorological disasters in the country, with the example of drought in 2018 followed by Cyclone Idai in March 2019, which brought torrential rains to the Southern and to a smaller extent the Central Regions of Malawi, there is so much concerns on the available power on year and year basis. For example, Cyclone Idai brought so much devastation as the accompanying floods led to severe damage of two hydropower plants on Shire River. The damaged plants were taken offline thereby resulting in a loss of 270 MW out of 370 MW of the total hydropower installed capacity (ReliefWeb., 2019). Since all hydropower plants in the country are of run-of-rivers, available power is most of the times affected with both too much water through flooding in the rainy season and too little water during droughts.

Tropical Cyclone Ana had its own battering of the hydropower plants on 24th January 2022. Kapichira Hydropower plant had all its 129.6 MW of installed capacity not available to the grid because of flooding. Before the repairs of Kapichira were finished, Cyclone Freddy brought its own challenges from 12 March, 2023, causing the national blackout on 13 and 14 March 2023. The flooding on the power stations caused by Freddy brought instability on the system and as a protective measure the utility had to shut down the whole electrical network. Even without disasters of floods and droughts, the country continues to face scheduled load shedding due to siltation and trash brought by the human activities upstream.

It is reported that increasing electricity access and expanding generation capacity is being hampered by the weak financial capacities of utilities of ESCOM and EGENCO. This is because the average tariff of electricity of about US\$0.10/kWh is too low to meet the utility's cash-flow requirements and that the utilities do not have borrowing capacity to finance expansion drives (World Bank, 2019b). This is agreed by Caprile and Matinga (2015) who indicated that ESCOM's tariffs only cover the utility's operational costs, with investments in generation and network infrastructure financed by central government funding, donors and/or the rural electrification fund (REF). The minimum cost-reflective tariffs of most utilities in Africa is estimated to be well above US\$0.2/kWh (Energy Sector Management Assistance Program, 2019), which would be prohibitively expensive to the majority of Malawians. In addition, the energy infrastructural budgetary allocations from central government have always been insignificant while donor support to the sector is hardly available (Trotter, 2016). Between 2001 and 2006, donors contributed a meagre 6 percent towards electricity infrastructure in Sub-Saharan Africa countries against a whopping 81 percent that came from taxpayers and infrastructure users (Trotter, Idib). Such being the case, only countries that are able to achieve huge national savings are the only ones that make progress on increasing both the generation capacity and the access rates.

There are also challenges within the political economy in that utilities of most governments in Africa take utilities as vehicles for rewarding the ruling clique through corruption (Kende-Robb *et al.*, 2015), which is also true for Malawi based on several media publications (Gausi, 2022). Grid extension is regarded as a political tool with policy makers prioritising the extension of the grid to peri-urban areas for campaign to maximise their political support' This is because urban populations are more politically active and organised hence depriving them electricity access has a bearing on votes (Madriz-Vargas, Bruce and Watt, 2017). Soni & Kawahara (2020) adds that

areas that can economically be served by grid extension are slowly diminishing. As a result, there is need to seriously pay attention to off-grid systems of mini-grids and solar home systems (SHSs) as solutions in their own right or as complementary to grid extension as a way of acceleration the access to electricity.

B. Efforts in increasing capacity of available electricity in Malawi

The country's generation capacity in the country is so low to meet immediate and future demands. Some initiatives have been planned or implemented with the aim of increasing the country's generation capacity or available electricity. The government made agreements that led to several IPPs, mostly within Solar PV minus storage. The government of Malawi, International Financing Corporation, Électricité de France S.A., commonly known as EDF, and Scatec ASA signed a binding agreement to undertake the co-development of the 350 MW Mpatamanga Hydropower Project on 6 September 2022. The project will be implemented on shareholding split with EDF owning 27.5 percent, Scatec 14 percent and its venture partners owning 13.5 percent, government of Malawi owning 30 percent and IFC 15 percent (International Finance Corporation, 2022). It is reported that Mpatamanga HPP is planned to have a reservoir that is expected to provide an advantage for the expansion of the adjacent Kapichira HPP. With the reservoir and increased generation, the country will make progress on stability of the electrical system and expanded generation capacity.

The construction works for a 218 km 400 V interconnection line from Matambo substation in Mozambique to Phombeya substation in Malawi was in progress as of January 2024. The project was launched by the presidents of Malawi and Mozambique on November 23, 2021. The expectation is that the initiative will first put 50 MW for importation from Mozambique with room for upscaling to 120 MW in future (Mkandawire, 2024). On a smaller scale and distribution level,

the country is currently importing 3 MW from Mozambique through Mandimba to Mangochi and 20 MW from Chipata to Mchinji (Ministry of Energy, 2020a).

The other project that has been planned to increase the generation capacity is the Songwe River Basin Development Project. The project will be implemented by the two countries of Malawi and Tanzania with equal shares from the 180 MW upon full development. This is very important because it has several benefits, including the construction of multipurpose dam on the border of the two countries expected to be 115 m high and have a water storage capacity of 330 million m³ (African Development Bank, 2023). The broader benefits of the project include development of 3000 ha of irrigation scheme for each country, provision of portable water to 86,000 people, addressing the problem of environmental degradation of the basin and contributing to the adaptation to climate change, which adversely impacts food production of the households in the area. The challenge is that the development of this project, as a cross-border project, is so much dependent on the alignment of priorities and collaborations between countries involved. It is little wonder that much as collaboration works started before 2001, there is no tangible development as of early 2024.

C. Efforts in increasing electricity access rate in Malawi

Malawi has implemented some projects lately with the aim of expanding electricity access, including Ndawala Project and Malawi Electricity Access Project (MEAP). Ndawala was initiated after observing that the grid expansion to rural trading centres through Malawi Rural Electrification Programme (MAREP) did not result to corresponding increase of household connections. Households are failing to get connected due to the affordability of the connection fees, let alone internal wiring costs. Under the project, each target household was being assisted with wiring services and connection fee through a soft loan of MWK55,000 (Approx. US\$54 in

May 2022). To benefit from the initiative, a household had to pay a commitment fee of MWK5,000 (Approx. US\$ 4.9 in 2022) with the loan being repaid through 40 percent deductions from every unit of electricity purchased by the household (Ministry of Energy, 2020b). The only drawback is that the project was planned to support only 12,982 households.

The Malawi Electricity Access Project (MEAP) is implemented by ESCOM with technical and financial support from the World Bank. As per the project document (World Bank, 2019, p17), the aim was for the “elimination of connection barriers due to unaffordable internal wiring costs” through providing ready boards to low-income households that cannot afford internal wiring costs” The project was planned to support 280,000 out of 1.1 million households by 2024 that are within 500 m of existing transformers. The beneficiary households were required to pay a standard connection charge of MWK25,000 (US\$24 in 2022) representing 31 percent of the total subsidised connection cost of MWK79,000 (Approx. US\$79 in 2022). The balance was to be repaid through deductions made from each electricity purchases by the households (Borgstein *et al.*, 2019).

Ramping up Ndawala, MEAP and free connection campaign can provide a huge leap in expanding electricity coverage to the 70-80 percent of the 1.1 million households living within 500 m, or 1.5 million households living within 1 km of existing transformers (Borgstein *et al.*, 2019). Expanding the two initiatives so that all the 1.5 million households living within 1 km of the existing transformers was estimated to increase electricity access rate to around 38 percent. Such requires huge financing and that without concrete and dedicated activities complementing the provision of electricity, the impact of electricity access to local development and the foothold on reduction of poverty remains elusive. Also, without the immediate increase of the generation capacity and improvements on regular and unexpected maintenance of the network can only result in poor electricity provision characterised by an increase in blackouts and regulated load-shedding.

D. Untapped potential of energy for electricity generation in the country

The country has so much potential on various sources of energy for possible developments. On solar energy resources, the country is well endowed with an average of 3000 hours of sunshine per year which can be developed at various levels across the country. The country has some sites with good potential for wind farm development at small- and large-scale levels. Caprile and Matinga (2018) reported that the country has a good number of areas with mean wind speed of 5 m/s at 10 m height. The area which is so much promising on wind power development has the overall potential for the generation of 150 MW (EnergyCentral, 2022) in Northern Malawi. There is also so much untapped hydropower potential available in several sites across the country as in the Figure 2-11.

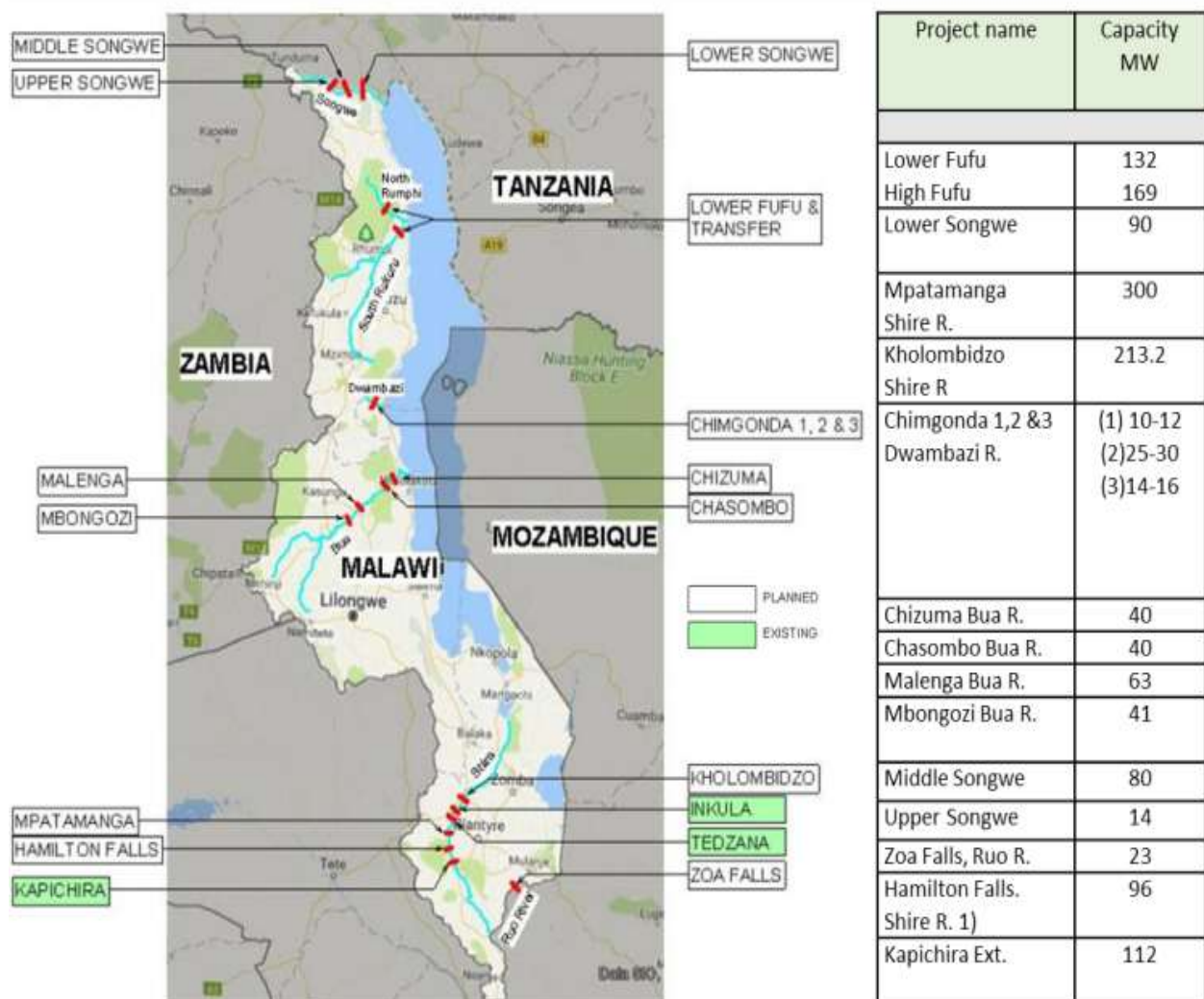


Figure 2-11. Major sources of existing and untapped hydropower sites. (Source: Tipping, 2021; Africa Energy Portal, 2025)

The map shows that there is huge hydropower potential that is untapped and spread across the country. As has already been explained, what is missing is the investments to develop some of these energy sources. Geothermal potential is also available with several known sites within the country.

B. Overview of mini-Grid sector

Mini-grids are defined as *‘electric power generation and distribution systems that provide electricity to just a few customers in a remote settlement of bringing power to hundreds of thousand customers in a town or city. They can either be fully isolated from the main grid or connected to it, but they are also able to intentionally isolate themselves from the grid’* (ESMAP (2019) as cited by Day and Kurdsiel, 2019: 2). With proper design, good resource and technology, mini-grids provide quality services of electricity as national grid.

Much as there seems to be no consensus on the sizes of mini-grids, some put it that mini-grids involve electricity generation of 10 kW to 10 MW (Etongo and Naidu, 2022; Franz *et al.*, 2014), while Odarno et al. (2017) is of the view that any system less than 10 MW can be regarded as a mini-grid. Etongo & Naidu (2022) further explains that any system with less than 10 kW or a customer base of 20-100 should be regarded as a micro mini-grid. Whatever the definition, mini-grids or micro mini-grids have a significant role in expanding the electricity success and increasing the overall installed capacity in a country.

The deployment of mini-grids has been on the increase globally. Countries that have large numbers of mini-grids include Afghanistan (4980) and Myanmar (3,988) (Bloomberg NEF, 2020). In Malawi mini-grids are regarded as the most viable option to deliver electricity to rural areas that are located more than 5 km from the MV line and have population densities of more than 250 inhabitants per square km (MEGA, 2016). This condition means more than 4.5 million people, representing 27 percent of the people who are without electricity access currently need to be served by mini-grids (Malawi Government, 2017a; MEGA, 2016).

Mini-grids have the advantages that they are the speedier option and, in some cases, more cost-effective option of providing electricity for rural communities than grid extension (Luc, Bordeleau

and Young, 2015 & Odarno *et al.*, 2017). The IEA estimates for universal access to electricity by 2030 have shown that over 40 percent of the people in Africa and South Asia that do not have connections can be conveniently and cost-effectively be served through mini-grids (Caprile and Matinga, 2015; DFID, no date; Luc, Bordeleau and Young, 2015). Moreover, the dire financial positions of utilities of developing countries and the fact that the areas that can be easily be served by grid are steadily diminishing (Bloomberg NEF, 2020), make mini-grids popular choices.

Over SHS, mini-grids have the advantage as they provide motive power which has greater transformational potential within the economic, social and environmental sectors of rural areas (Traeger *et al.*, 2017; Alliance for Rural Electrification, 2018). A report by DFID (no date) contends that much as grid expansion and SHS are required to accelerate further, it is the mini-grid sector that is the most off-track to meet its share of the IEA projections towards the achievement of universal access to electricity by 2030.

It is widely observed that there has been very little literature on the mini-grid establishment and lessons learnt. Odarno *et al.* (2015) recommended the need for increased actions in populating literature in the sector. Such literature should include building up knowledge about mini-grid experiences as a way of understanding what makes mini-grids fail or succeed. Information such as the available energy resources, the different funding sources, the many operation models, and various business models should be readily available. Such information should be available to all including local authorities. There is also calls for collaborations, not only with traditional players, but also with universities, and research centres in exploring various areas including implementation of mini-grids within cultural, economic and environmental aspects of a particular area (Da Silveira Bezerra *et al.*, 2017).

Alot more is expected to be done to reach the targets of the people to be served with electricity from mini-grids in Malawi, including policy and regulation changes, financing flexibilities and effective coordination among different stakeholders. There is also need to review and make amendments to the Rural Electrification Act 2004 and Electricity Act 2004 for the inclusion of mini-grid as a third viable option alongside standalone home system and grid extension (Malawi Energy Regulatory Authority, 2020). This is because current regulations and policies require mini-grid operators to comply with regulations meant for large grid-connected systems (Caprile and Matinga, 2018). Such requirements lead to delays for approvals and higher costs for clearances and approvals.

The country has several bottlenecks hindering the proliferation of mini-grids. Figure 2-12 is the result of a survey that was conducted for the 17 countries on the average cost incurred to obtain permits for mini-grid's establishment

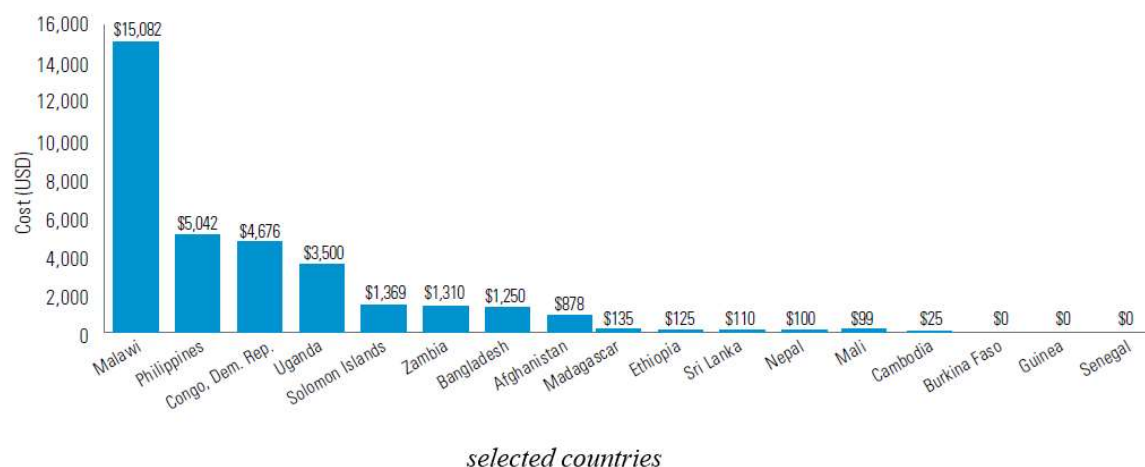


Figure 2-12. Total cost of obtaining permits to set up a mini-grid facility in the 17 surveyed countries. (Source: RISE database, World Bank as cited by Banerjee, Moreno, Sinton, Primiani, et al. (2017; 179))

From the figure, it is very clear that paperwork requirements to obtain a generation permit was found to be the highest in Malawi at an equivalent of US\$15,082, while it costed close to zero in Burkina Faso, Guinea and Senegal. Similarly, a comparison was made for the time it takes to secure a generation license as in Figure 2-13.

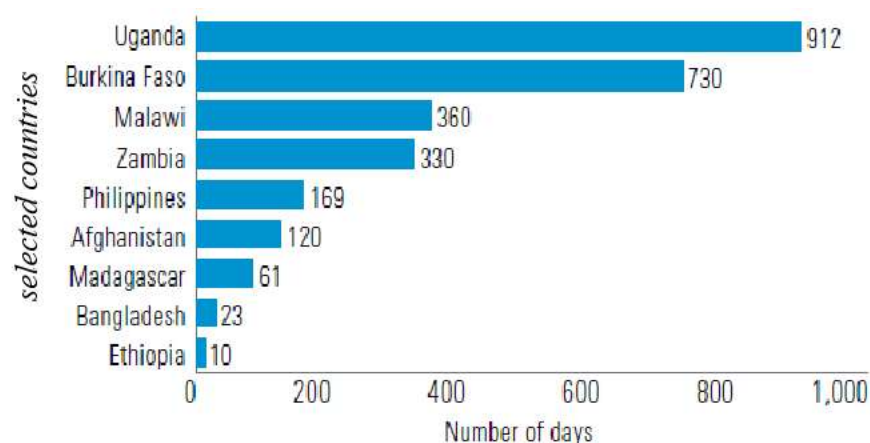


Figure 2-13. Comparison of days before securing a generation license in selected countries.

(Source: RISE database, World Bank as cited by Banerjee et al. (2017;177))

From figure, it is in Uganda that a developers wait for a longer time estimated to be 912 days to have generation license secured. In Malawi, the developer waits for 360 days to have the generation license issued, while it takes a mere 10 days for the developer to obtain a generation license in Ethiopia. The country is rated average in terms of number of days for a potential developer to secure environmental clearance of the six countries as in Figure 2-14.

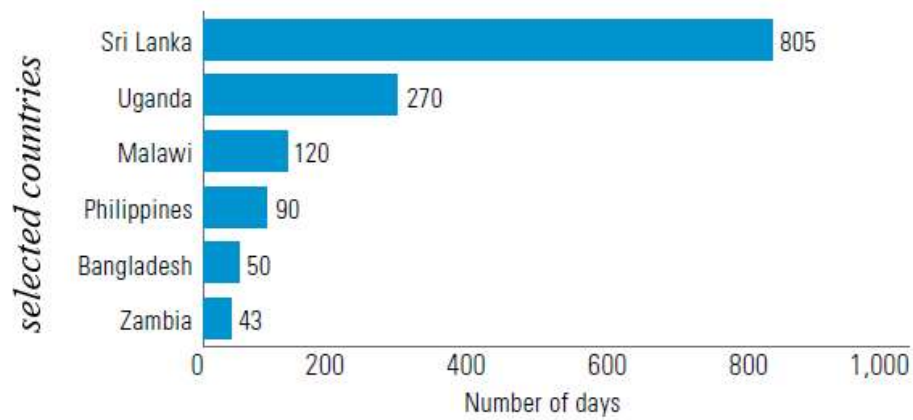


Figure 2-14. Comparison of days before securing environmental clearance in selected countries.

(Source: RISE database, World Bank as cited by Banerjee et al. (2017;177)).

In terms of obtaining an environmental clearance, it takes 120 days to have the document issued in Malawi, while in neighbouring Zambia it only takes 43 days. The above data provide evidence as to why the country's energy environment for mini-grids is unfavourable and complicated for mini-grids. The unfavourable regulatory environment in the country suppresses the growth of the sector in that developers will choose to make investments in other countries that have favourable regulatory environment.

Excluding mini-grids run by utilities and those very small and mostly called energy kiosk, the country has only three mini-grids worth mentioning (V. Mwale *et al.*, 2024) as summarized in the

Table 2-3. Major mini-grid establishments in Malawi in 2023

Name of project	Partners	Energy Source	Connections estimates in 2023	Installed capacity	Start Date
Bondo (Mulanje)	UNDP/GEF, SgurrEnergy Scottish Gov	Hydro	1700	220 kW	2014
Chipopoma (Rumphi)	Naomi Opprieht, UNDP/GEF, Ministry of Energy	Hydro	150	50 kW	2018
Sitolo Village (Mchinji)	UNDP/GEF, DoEA	Solar PV	800	80 kW	2018

As can be seen in the Table 2-3, the installed capacity and the number of households served by these mini-grids are just too small if compared to the projections of 4.5 million people or around 1.1 million households (Malawi Government, 2017a) who can conveniently and cost-effectively be provided with electricity access by mini-grids. Rough calculations reveal that less than 4200 households are benefitting electricity from mini-grids. For comparison's sake, there are four mini-grids in the country with total installed capacity of 1.65 MW, while the neighbouring country of Tanzania had 158 MW of installed capacity in 2018 (Day and Kurdsiel, 2019) and a total of 209 mini-grids in 2019 (Bloomberg NEF, 2020).

C. Overview of Solar Home Systems (SHSs) sector

Solar Home System are decentralised power systems that provide power mostly for lighting for few hours of a night and/or charging phones. These are a well suited and efficient form of providing power to scattered homes that have minimal power needs. SHSs are so popular for rural and peri-urban areas of Malawi because of the huge percentage of the people in these areas that cannot access grid or mini-grid electricity. The other reasons for their popularity include the decreasing prices of solar components, abundance of solar resource in the country and the unaffordability of large independent power system for those not within the grid or mini-grid perimeter (Walwyn and Hanlin, 2022; Africa Clean Energy Technical Assistance Facility, 2021). The popular systems in Africa are those within the range of 5 Watts and 50 Watts peak and so far an estimate of 22 million components of these are sold within Sub-Saharan Africa in each year (Walwyn and Hanlin, Ibid). Of the 18 percent electricity access rate in Malawi in 2018, around 6.5 percent was contributed by SHSs (Africa Clean Energy Technical Assistance Facility, 2021).

The challenge with SHSs is that they provide very basic power mostly for lighting and/or charging phones. Such power does not provide motive power for improving productivity and income for the people hence it has little contributions to the socio-economic development and transformation of households, communities and the country. Street lighting, irrigation, carpentry, cooling and refrigeration, heating, welding, entertainment including powering smaller appliances in salons and barber shops cannot be achieved with SHSs. However, they are very useful on smaller extent of energy transitions in that they replace of kerosene, candles and biomass, hence the reduction of some forms of emissions. The use of SHSs results to reduced emissions and reduced impact to health.

2.7.5. Vulnerability Context in Malawi at Macro level

Since colonial days, the economic outlook of Malawi had been of mixed fortune with some hope here and there followed by despair in most cases. It should be reported that the British were reluctant to add the land of Malawi to be among its colonial territories as it did not want to have huge burdens of providing financial support with the increase of colonies that did not have exploitable minerals (McCracken, 2012). The land had no exploitable minerals except that it had a sizeable number of European settlers, mostly from Scotland, who were swayed to come and settle in the Shire Highlands by the extensive writings of Dr. David Livingstone. Early European settlers were attracted by the cool weather, rich soils and abundant sources of water of Shire Highlands. In this section, the economic outlook of the country before and after independence are discussed to provide some background of vulnerability context of the country at macro-level. This is aimed at providing a background to the economic development of the country. A strong economy is relevant for provision of relevant and quality infrastructure such as roads, power systems and the network, markets, schools, hospitals, airports for the enhancement of sustainable and resilient livelihoods of citizens. Poor economy leaves citizens suffer or strive by themselves.

2.7.6. The economic outlook of Malawi before Independence

Malawi, was officially declared as a protectorate under British rule in 1891. Economically, it was benefitting from Britain with grants in aid totalling £54,354 in 1891-1896 (McCracken, 2012). The author reported that the aid continued to flow into the country at an average of £30,000 a year in 1904-1912, a time that most of British aid was reportedly being phased out from most of her colonies in Africa. This aid from Britain is reportedly to have represented 72 percent of the external money that the country was receiving and it was not enough for large scale investment, especially for railway and improvement of harbour facilities for transportation of goods. With no exploitable

mines, the protectorate is reported to have started with the exportation of ivory which raked in £18,253 thus accounting for 80 percent of total exports in 1893 (McCracken, Ibid). It is also reported that to access ivory, elephants were hunted as far as Luangwa Valley in Zambia. However, this was short-lived as the government introduced high taxes and custom duties that made the ivory trade dwindle; hence, its contribution towards exports reduced to 59 percent in 1896. The decline continued such that in 1900, the total export from the trade reduced to a meagre £2, 500 because the hunting of elephants during that time was regarded as a rich man's sport with the high taxes and import duties. The transportation of ivory to the ports and other places was done by the natives as shown in the Figure 2-15.



Figure 2-15. African Lakes Company ivory store with carriers, c.1889, photographed by Frank Moir, joint manager of the ALC. (Source: (McCracken (2012:82))

McCracken (2012) reported that the decline of ivory trade and its contribution to export earnings was not felt much as coffee was slowly becoming a prominent product for export. The export of coffee was valued at £2,996 in 1893 and jumped to £22,413 in 1898 and continued to increase such that it reached a whopping £66,245 in 1900, contributing to 79 percent of export earnings in the year. Coffee was planted in estates by European settlers with Africans providing the needed labour and benefitting employment. Such a promise and the resulting export earnings made the governor of a protectorate proclaim that ‘as yet the solitary instance of a successful agricultural

colony within tropical Africa” (McCracken, 2012:82). There were huge expectations of coffee becoming the main exchange earner for the country with the economy expected to make huge leaps out of it.

The expectations of coffee making a backbone of export earnings were short-lived with a sharp decrease of prices of coffee on the international market from 100 shilling per cwt in 1897 to 55 shillings per cwt in 1901. Hundredweight or CWT was a measurement used to define the quantities of certain commodities being bought and sold. Steel, cattle, oil, seeds, and grains are examples of products that were measured using the hundredweight. The conversion is 1 cwt being equivalent to 45.4 kg in Canada and US and 50.8 kg in Great Britain (Investopedia, 2023). Such a decline of price was attributed to huge supply of coffee on international market by Brazil coupled with a decline of the quality of coffee from Malawi. The quality of coffee from the country is reportedly to have declined by to pests’ infestations and unchecked weeds. The downward fall of the price of the commodity continued to an extent of the product earning £14,751 in 1902 a decline of 76 percent over the previous year. Such a decline was of a very huge concern. The short-lived promise due to the heavy fall of the coffee industry is summarised in the editorial of Central African Times, “We have failed to attract the attention of capitalists from other parts. We have failed likewise to produce any capitalists of our own” McCracken, Ibid:82).

With reduced aid from the colonial office and then gloomy outlook of the export market due to the false promise of coffee as an export product, there was little hope of building any other export product. There was no consensus of the alternative export product after the coffee had failed. Several coffee estates were therefore abandoned and some were sold out. With not so much as dependable export product, the options were limited except to try several products such as growing tea in Mulanje, tobacco in Blantyre and cotton in the Lower Shire. There were others who were

against estate farming and instead providing support to peasant farming. The other group was for the idea of exporting labour to more advanced economies of South Africa, Northern Rhodesia and Southern Rhodesia. The people from the protectorate were to work in mines of the countries. All in all, the picture for building a product or service for the export market was gloomy, with no concrete path moving forward.

Much as labour migration had been there as early as 1880s, it was done on unofficial basis. It became official as the colonial government got involved with labour recruitment for Transvaal mines at a wage of 30 shillings per person per month. The monthly wage is reported to have been over eight times higher than what peasant farmers could get paid if they were to be employed within the protectorate. From the export of labour, the colonial government was benefiting 10 shillings per month per labourer. The other important factor was that three-quarters of the wages were paid back in Nyasaland at the end of each contract. Such an arrangement provided a huge contribution towards income for the management of the affairs of the protectorate. Just like coffee, labour migration had huge challenges that forced the colonial government to move out of it. There were heavy fatalities of migrant workers due to intense heat while in the mines and the harsh winters outside the mines. The extreme cold experience for the many not used to it led to pneumonia and related illness. The mortality was so huge that the death rate was comparable to deaths during the First World War (McCracken, 2012). This forced the colonial government to send letters to all government officials within the protectorate for the end of labour recruitment. Of course, informal migration of labour continued as was before. Again, this was a huge setback for the much-needed export earnings for investments in infrastructure developments and the situation of having no dependable product for export continued into the independent Malawi.

2.7.7. The economic outlook of Malawi after independence

The country's growth rates after independence have generally been low and volatile, with only two periods of relatively high growth rates as summarised in Table 2-4.

Table 2-4. Historical economic growth rates of Malawi averaged 5 years and suggested reasons

Half Decade	Average GDP (percent)	Major factors causing the decline or the rise
1960-1964	4.6	Large scale estate farming and unwavering donor support
1965-1969	5.8	Large scale estate farming, labour migration to South Africa, Zimbabwe and Zambia, unwavering donor support even from Apartheid South Africa
1970-1974	6.4	Large scale estate farming, labour migration to South Africa, Zimbabwe and Zambia, unwavering donor support even from Apartheid South Africa
1975-1979	5.8	Large scale estate farming, labour migration to South Africa, Zimbabwe and Zambia, unwavering donor support even from Apartheid South Africa
1980-1984	2.1	Oil shocks of 1979, influx of Mozambican refugees, Civil war in Mozambique and fiscal indiscipline
1985-1989	2.6	Fiscal indiscipline, wavering donor support
1990-1994	0.6	Fiscal indiscipline, wavering donor support, drought
1995-1999	7	Fiscal indiscipline, wavering donor support
2000-2004	2.3	Massive misappropriation of public funds, extensive fiscal indiscipline and weather shocks
2005-2009	6.9	Good performance, donor support and scraping off of international debts
2010-2014	4.3	Inconsistence of policies, massive misappropriation of public funds, Debt cancellation under the Highly Indebted Power Countries Initiative
2015-2018	3.6	Inconsistence of policies, massive misappropriation of public funds

Compiled from: (Kayuni, 2011; Booth et al., 2006; Sen and Chikunda, 2002 & (World Bank, 2018)

It should be noted that growth rates of less than 6 percent (Moyo, 2009; Sen and Chikunda, 2002) and not sustained over a long period of time are reported to have minimal foothold in uplifting the masses out of poverty. It should also be noted that the economic growth rates in Malawi are being eroded by higher population growth rates averaged 2.9 percent per annum. The data in the table give a picture of low growth rates with very low expectations on transformation of the rural and urban masses. It only on three out of 12 occasions that the country registered growth rates of over 6 percent and these had not been sustained over a long time. It also provides a picture of how the past has been shaped and at the same time considering how the current status has been shaped over time.

The volatile, and mostly low, growth rates and the reasons provided means the country could not make savings for huge infrastructure development such as railway, power systems, road network, markets, investments towards quality health and education services, airport. Investments into these would have provided the needed foundations for subsequent socio-economic development for the uplifting of people from poverty. Of course, there had been hope in 1970-1974 and then 2004-2009, but such growth had not been sustained due to internal factors and exogenous shocks such as oil shocks of 1979 over which the international development policies had no control over them. What is so prominent on the economic development is that the country had been a beneficiary of aid. The impact and role of international aid and how this has had its footing on poverty levels apart from the contribution in the energy sector provide the next discussion points.

Moyo (2009) had provided extensive explanation of the history of international aid starting with the establishment and role of the World Bank, IMF, and Marshal Plan. The European Recovery Program (ERP), more commonly known as the Marshall Plan was a program of U.S. assistance to Europe during the period of 1948-1951. The Marshall Plan— launched in a speech delivered by

Secretary of State George Marshall on June 5, 1947—is considered by many to have been the most effective ever of U.S. foreign aid programs. An effort to prevent the economic deterioration of post-war Europe, expansion of communism, and stagnation of world trade, the Plan sought to stimulate European production, promote adoption of policies leading to stable economies, and take measures to increase trade among European countries and between Europe and the rest of the world. Since its conclusion, some members of congress and others have agreed to have same format of Marchal Plan in helping poor countries like Malawi.

Thompson (2013) reported that development aid has had a shifting focus with the aid before 1970s targeting large infrastructure development modelled along Marshal Plan. It is explained that this was done based on the notion that large infrastructure provides an enabling environment for successive stages of increased economic development. This era saw the building of huge infrastructure in developing countries such as roads, power plants, railway, water and sewerage, and airports. Many of the power stations in Malawi and road network can be traced to have been developed during this era. Much as most of the donor support for infrastructure development was in the form of grants, some were loans. While some countries were putting the aid/loans to good use, others failed as the ruling cliques of such governments were continuously diverting the support for own personal benefits. There were no reprisals or conditions imposed on such ruling cliques that were abusing the aid or grants because of the sensitivity of the cold war. What was more important for the rich countries then was the maximisation of loyalty from any country for each of the political divide.

Moyo (2009) explained that the oil embargo of 1973 brought a shift of aid and loans from the Marshal Plan towards pro-poor services such as projects in agriculture and rural development, social services (housing, education and health), mass inoculation programmes, adult literacy

campaigns as well as food rations for the malnourished. With oil as a strategic commodity, the oil embargo brought increased prices of oil, which in turn resulted into undesirable impact of increased prices of other products and services. Developing countries like Malawi had their people feeling the blunt as there were lack of food and other life-sustaining commodities and services. To avert the sufferings, Malawi just like other developing countries, was in need of urgent interventions for easing the suffering of her population. This is the reason that the Marshal plan of funding large infrastructure projects had to be abandoned. As such, loans and grants were provided towards pro-poor services as a way of easing the suffering of the masses. Along the way developing countries had little choices, except to continue borrowing hence accumulating unsustainable debts.

The 1979 oil spike precipitated by the Iraq-Iran war together with the accumulation of debts by poor countries and the corruption in some countries brought their own shocks and stresses. As a way of restructuring debts, which were becoming unsustainable, IMF and World Bank had to make interventions in the form of Structural Adjustment Programmes (SAPs). SAPs brought strict conditions for poor countries to secure future loans and interest rates were lowered on subsequent loans for the countries that met the conditions of SAPs. The facility, later called Structural Adjustment Facility, was criticized by some as it was regarded as a ploy. Many saw it that the lending institutions were deliberately providing prescription to heavily indebted nations including Malawi, so that the countries can be incentivised to get more loans which were to help them pay the previous loans back to IMF and World Bank. Others considered this as neo-liberal thinking as the conditions were about reducing government interventions in the economy, increasing market competition, focusing on increased exports, and making significant budgetary cuts on social, health, and education programs. With these there were decreased wages, higher costs of health

care and education, higher food prices, increased school fees and the fees paid for government services, restraints on credits for small business owners, and the end of subsidised goods and services. Thompson (2013) reported that much as some significant economic development did occur out of structural adjustment initiatives, it became very clear that the policies were a burden to many of the already marginalised groups of the society.

The failures of SAPs forced governments to liberalise their economies modelled along the Asian Tigers that were making progress with their liberalised economies. Under this approach, World Bank and IMF were encouraging countries like Malawi to embrace free market policies in return for cash for economic stabilisation. Under the same, previously nationalized industries were forced to privatise, trade was liberalised and civil service was forced to reduce (Moyo, 2009). With time, there was refinement of the approaches including the need for active participation of civil society and at a local level, there were calls for the active participation of local people through the use of methods such as Rapid Rural Appraisal (RRA) and the Participatory Rural Appraisal (PRA) among others. Both RRA and PRA require active participation of rural masses in decision making of the issues that affect their lives. The need for active involvement of civil society and the rural participatory approaches is aimed at incorporating the different needs and perspectives at state and local level.

Much as there had been so many interventions, poverty has remained high with vulnerability of the local people continue to worsen by climatic and economic shocks and stresses. There is acknowledgement that reduction of poverty or reducing vulnerability or the increasing resilience at macro level (state or country level) is proving a huge problem due to inadequate government resources and fragility of the economy. This is because the economy of Malawi has its huge

dependence on rain-fed agriculture. Of course, the intervention at macro-level is of huge importance and needs to be provided where conditions are conducive.

The reasons why some countries like Malawi are very poor and do not make progress in moving themselves out of the thicket of poverty require some deep reflections. Acemoglu and Robinson (2014) tried to come up with reasons through theories such as Geography Theory, Culture Theory and Ignorance Theory. While all the theories mentioned have some grain of truth, many authors are in support of the geography theory in that countries in tropical regions are a haven for some deadly insects such as mosquitoes, houseflies and tsetse flies, and the deadly diseases such as malaria, tuberculosis and HIV/Aids. The infestation of insects that spread deadly diseases makes development harder to achieve as states spend their huge revenue on drugs in hospitals and the community members have own backlash in terms of spending their productive time in sick beds or taking care of the sick. Then there are also other reasons such as the one provided by (Booth *et al.*, 2006) called neopatrimonialism.

(Booth *et al.* (2006) defined the term of neopatrimonialism as the patronage system in which power is concentrated in the hands of a single dominant figure – often but not always, the president. Such concentration of power is reported to neutralise the independence and effectiveness of state institutions, other political parties, parliament, the judiciary, and the security services. The authors added that such a system has very weak checks and accountability of the executive and is not developmental in nature. A closer look at Malawi and how power hence resources are distributed in all the regimes since independence supports the notion of neopatrimonialism and indeed it is affecting the development agenda and progress in the country. Resources are diverted and filling of critical positions in different sectors are done out of regionalism and cronyism hence affecting the development of the country.

Sachs (2006) brought forth another thought-provoking thinking on sources of poverty and vulnerability at local and state levels of developing countries. These are called poverty trap and fiscal trap. The two provide an interesting viewpoint and is very pertinent to this study. The poverty trap is about poor people not having the ability, by themselves, to get out of poverty. This is because they do not have assets, incomes and access to modern energy that have the potential to help them move out of poverty. The fiscal trap is similar to the poverty trap only that in this context, the emphasis is on government and not individuals. Government has a critical role in making or facilitating investments towards education, health, power etc. However, some governments do not have the financial means to do so. The author is of the opinion that fiscal trap is contributed by the impoverished people in a particular country hence taxation is not feasible or the leadership is inept, corrupt and incapacitated. In addition, some countries may be heavily indebted, hence the tax collected goes into servicing the debts. Such can be attributed to Malawi with poor people being so poor that they cannot help themselves to move out of poverty hence poverty trap. The political environment and leadership in Malawi can be defined within the lens of the characteristics of fiscal trap as explained.

Circumventing the poverty trap and fiscal trap requires external support and some progressive thinking and mindset change at both levels. Even if the country can have a windfall of resources, if the leadership is inept, corrupt and incapacitated, there can be no progress. Such are among the reasons that the country had and continue to be dependent on development assistance from multi-lateral agencies such as EU, IMF, African Development Bank and World Bank and bilateral donors which include UK, Germany, Norway, USA, Canada, Denmark, and Sweden for different projects and programmes of achieving poverty reduction and sustainable economic development. However, there has been very little progress on the objectives that call for the local people to be engaged in

order to influence the change in their attitude together with some interventions if they are to move out of the trap of poverty.

2.7.8. Vulnerability Context in Malawi at Micro-Level

The Malawi Government (2019a) reported that the Fifth Intergovernmental Panel for Climate Change (IPCC) Assessment Report AR5 identified Malawi as a country at high risk to the adverse effects of climate change. Floods, droughts and changes of temperatures are the major hazards affecting the country and these have been on the increase recently due to climate change. The risks are mostly due to the country's location within the Great African Rift Valley. Apart from climatic change related hazards, other main stressors include economic shocks (inflation, interest rates, and exchange rates), exogenous shocks, high population growth, land degradation, poor soils, earthquakes and landslides (Malawi Government, 2018b). Cyclones have been common over the recent past as they happen almost annually.

The extreme climatic, economic and man-induced hazards are having negative impacts on people's lives, their livelihoods and infrastructural development. Over the recent past, these hazards have been happening one after the other, which has made the country's poor and vulnerable plunging deeper into extreme poverty with no room for recovery or building their resilience. For example, the country experienced floods in 2014-15 growing season, droughts in 2015-16 growing season, drought in 2018, Cyclone Idai in March 2019, Cyclone Ana in 2022 and Cyclone Freddy in 2023. With over 90 percent of Malawians dependent on climate-sensitive sectors of agriculture, forestry and fisheries, and with inherent limited resources and capacities coupled with their living in climate-sensitive settings (Trocaire, 2006 & Rasul and Sharma, 2016), the results are dire. Recovery and resilience building can hardly be achieved with such frequent occurrence of hazards in huge magnitudes.

It is reported that around 1.5 million people are affected by drought each year and the number increases in drier years, while floods affect at least 100,000 each year (World Bank, 2019a). The impact of floods and droughts are predominantly in the Southern Region. The floods of 2014-2015, which is regarded as the worst flooding in 50 years, had an estimated 195,000 animals killed or washed away, 200 people killed, 200,000 people displaced and a total damage estimated at US\$400 million (World Bank, Ibid). The drought of 2015-16, regarded as the worst drought in 35 years, brought huge damage whose recovery was estimated at US\$335 million (World Bank, Ibid). Cyclone Idai of March 2019, which brought heavy rains of 250 mm and the strong winds within 24 hours, caused severe floods that affected 975,000 people, with 86,976 displaced, 60 killed, and 672 injured. In addition, it was reported that 288,371 houses were partially or completely destroyed. Other infrastructure such as roads, bridges, power lines, irrigation infrastructure including mature crops were affected. Power supply was interrupted for two days across the country by the cyclone (Bedi and King, 2020 & Government of Malawi, 2019).

The country also experienced Cyclone Ana from Indian Ocean which made a landfall on 24 January 2022. Ana affected 20 of the 28 districts in Malawi with Phalombe, Chikwawa, Mulanje, Chiladzulu and Zomba Districts, being the most heavily affected. With 250 mm of rainfall within 24 hours, the damage left 32 people dead, 147 injured, 414,000 people affected and 76,000 people displaced, and 71,716 hectares of cropped land affected (United Nations - Malawi, 2022). The flooding due to cyclones also caused extensive damage to Kapichira Power Station whose all-total installed capacity of 129 MW was lost from the grid.

The occurrence of cyclones seems to have taken a yearly pattern in Malawi as after Cyclone Ana of 2022, Cyclone Freddy hit the country in 2023. Cyclone Freddy, which developed in the Indian Ocean, is regarded to be the worst cyclone the country has ever faced. The cyclone resulted into

torrential rains falling in the Southern Malawi thereby bringing multiple flooding in Blantyre, Mulanje and Thyolo on 12th March 2023 (Malawi Government, 2023a). It was reported that on 13th March 2023, the cyclone had caused flash floods and landslides in Blantyre, Chiladzulu, Mulanje and Phalombe districts. The cyclone brought havoc as 2, 267, 458 people were affected, 679 people killed, over 530 people went missing, 260, 681 houses destroyed and over 2, 178 people were injured. The infrastructure that were damaged included roads, school blocks, health facilities, bridges, water sources , powerlines, and irrigation systems (Malawi Government, 2023b). In agriculture and livelihoods, the cyclone resulted into an estimated total of 202, 095.2 hectares of cropped area that belonged to 467, 958 households either completely washed away or just submerged. The crops that got affected included maize, groundnuts, soybeans, tobacco, sesame, rice and cotton. An estimated total of 1.4 million combined livestock belonging to 104, 565 livestock-keepers were either killed or injured by the impact of the cyclone (Malawi Government, Ibid).

The vulnerable rural masses are also affected by the exogenous shocks that happen from time to time. Exogenous shocks are the unexpected or unpredictable events that occur outside the country or industry but their impact are heavily felt within the country and industry (Magalasi, 2021). The recent ones are the COVID pandemic and the Russian-Ukraine conflict. The COVID-19 pandemic brought challenges of rising food prices and the general decrease of living standards due to the restrictions that were implemented worldwide as a way of containing the spread of the disease. Before the recovery from the pandemic, the Russia-Ukraine conflict started on 24th February 2022. The conflict brought huge price increases on essential commodities such as fertilizer, fuel, wheat, sunflower oil and seeds, and other food related products (United Nations Development Programme, 2023). This is because Russia and Ukraine are the major producers of grains and

fertilizer which were exported to various regions of the world. In summary, the hydro-meteorological shocks coupled with exogenous shocks are causing untold miseries to many. What is even more worrisome is that these are happening yearly or one after the other leaving no room for Malawians, just like others in developing countries, for recovery. Much as that is the case, efforts on building the resilience of local people need to be intensified with new approaches, including provision of modern energy such as electricity.

2.8. Mulanje District

The study area of Bondo Community is located in Mulanje District hence the need to have the characterisation of the socio-economic, cultural and demographic data of the district. Mulanje District, located in the Southern Malawi as in the Figure 2-16, is named after Mulanje Mountain, which is the mountain to the eastern part of the district. With a land size of 2005 km², the district is densely populated at 341 people per square kilometre and a total population of 684, 107 based on the population and housing census of 2018 (Malawi Government, 2019c). The total land area of the district is distributed as follows; 24 percent covered with Mulanje Mountain, 31 percent covered by the tea estates and 45 percent is for arable and housing. The average household size of land of 0.6 hectares is very low (Malawi Government, 2017b).



Figure 2-16. Map showing Mulanje District with Mulanje Mountain stretching into nearby Phalombe District. (Source: ReliefWeb (2023))

The district is dominated by the Lomwe tribe, an ethnic group that was over 82 percent of the total population of 2018 (Malawi Government, 2019c). However, the most widely spoken language is Chichewa (Malawi Government, 2017b). The Lomwes follow a matrilineal system of marriage (locally called *chikamwini*). Under this system of marriage, land is acquired through marriage and the husband lives in a wife's village. The husband has no kinship connections in the village with the children and land belonging to the wife. It is reported that the arrangement makes the husband to have very little influence on decision-making; hence, little inclination to invest on the land and in his children (Malawi Government, 2019a). It could be due to the system and its impact of marriage that the district is reported to have huge numbers of female headed households at 125, 910 and child-headed household at 14, 820 of the total households of 185, 251 households. Such disparity can be attributable to the custom of matrilineal arrangement as husbands have little powers hence easy to move away on any slight misunderstanding.

Just like at a country level, the majority of the people in the district are involved in subsistence farming with the main cash crops grown being tea, tobacco, pigeon peas, rice sweet potatoes, pineapples, tomatoes, bananas and sunflower. The once vibrant banana-industry and the whole of its value chain that included farmers themselves, middle men, transporters and sellers in the district and many parts of the southern region of the country, including the country's second biggest city of Blantyre, fell down in late 90s. This was due to the notorious banana bunchy top disease whose containment brought an enforcement of all farmers in the district, including the nearby Thyolo District, to have all banana plants uprooted and burnt. Much as replanting with disease resistant varieties is encouraged with support of the government and World Bank; the industry is failing to reach the heights it was before the disease. Much of the bananas consumed in the district and other

places are therefore coming from the nearby Mozambique. The district has also experienced reduced tobacco farming due to lower prices because of the anti-smoking campaign worldwide.

The tea estates in the district play a huge role in providing employment to over 30,000 people based on the figures of Malawi Government (2019b). However, there has been a huge reduction of employment opportunities over the recent past as some critical areas that employed so many people like the application of fertilizer and pesticides have been replaced with use of an aeroplane. On a positive note, the district is reported to have had an increase in the number of tourists like 5171 international tourists in 2013 from 700 tourist in 2004 (Malawi Government, 2017b). Smallholder farming of tea and the farming of pineapples are the main livelihood options for many on the south eastern slopes of the district, including Bondo Community.

2.8.1. The History of the people of Mulanje and the land issue

The area around Mulanje and Thyolo was first occupied by the Mang'anja and later by the invading Yao (McCracken, 2012). The Europeans came and settled in the area in the 1800s with the establishment of coffee, tea and tobacco plantations. When the Mang'anja were dispersed by the hostile Yao, who were trading in slaves, the Lomwe people trekked from Mozambique to settle in the area. The settlement of European in the area resulted to the abolishment of slave trade that was carried out by the Yao. To continue with slave trading, the Yao had no choice but moved out of the Shire Highlands towards Lake Malawi. With no threats of slave trading, the Lomwe people continued to trek from Mozambique and settled without the worry of being captured to be sold as slaves. They also had the benefit of employment by working in estates of the Europeans. This is the reason that the predominant tribe currently occupying the Shire Highlands is the Lomwe growing their crops and providing labour in the estates.

McCracken (2012) reported that the expansion of estate agriculture in the Shire Highlands grew rapidly before 1891 when the vast land was granted to or bought by European settlers from the local chiefs. Much as Johnston was tasked to review the claims for issuance of Certificate of Claims under freehold after the declaration of the protectorate, much of the land remained under European owners despite questionable evidence in many cases. The availability of land for local people continues to be a contentious issue since then and complicated further by high population growth. It should also be recollected that the displacement of people from Mozambique due to the civil war between 1976 and 1992, resulted into many people flocking into Malawi. Some of these could not go back after the war due to many reasons such as marriages. These provide the reasoning as to why the districts within Shire Highlands are the most densely populated in the country. The population densities of Chiladzulu, Thyolo, Mulanje, Phalombe and Zomba were 469, 433, 341, 325 and 316 people per square kilometre against the country's 186 people per square kilometre (Malawi Government, Ibid). The continued increase of the population in the area, just like elsewhere in Malawi, has made the land issue bringing conflicts. No wonder it is reported that Mulanje no longer have virgin land (Malawi Government, 2017b). The encroachment of the Mulanje Mountain Forest Reserve and much of the available land belonging to estate owners continue to be a challenge as local people fail to get enough land for their subsistence farming.

2.8.2. Vulnerability in Mulanje District

Much as the presence of Mulanje Mountain and tea estates are a huge blessing on the socio-economic front; the district is lagging behind in so many human development indicators. The vulnerability of the people in the district is mostly attributed to the scarcity of land as it is the most critical productive resource and, for many, especially for the rural masses, it is the sole source of livelihood (Chinsinga, 2008). The scarcity of land in the district should be understood not on the

pretext of vast land being occupied by tea plantations in estates but by the unsustainable population growth over the years. The household land holding size that was 0.6 in 2016 was not the same when Europeans settled in the Shire Highland in the 1880s. It has come to this far because of population grown and will keep on dwindling. Such size of land per household is not enough for food production and cash crops for income generation for the whole year. As has been put by Chinsinga (Ibid), such a small land is only helping as a cushion or as a safety net that should be there as a base, while people's income is generated elsewhere. This is to say that such a small amount of land cannot push household out of poverty. The way forward is to have households empowered so they can have other reliable sources of livelihoods. Related to low land holding capacity are soil erosion, land degradation and soil exhaustion.

Due to the use of land year in year out for the same crops, there is depletion of chemical composition of healthy soil. A healthy balance of the nutrients and soil composition is lost leading to crops failing to have the needed nourishment for their healthy growth. Such is leading to ever-dwindling yields every year. With limited amount of land that has limited balance of the nutrients and soli composition, it becomes so difficult to have the options of helping the people in the district build their own resilient livelihood options. With such challenges non-farm livelihood options need to be intensified so that as many people as possible should move away from farming. Without this and the continued increase of the population, the vulnerability of the people in the district will continue posing greater challenges to the conservation effort of Mulanje Mountain Forest Reserve and bringing conflict with estate owners.

The district has huge potential for fish farming owing to huge water sources from perennial rivers and streams from the mountain and the higher temperature ranges of 22.4 and 35 degrees Celsius (Malawi Government, 2017b). However, not much of this potential for dietary, income and

livelihood diversification is exploited. The low production of fish from fish farming is due to the drying of fish ponds due to erratic rains, inadequate resources for extension services, illegal harvesting and theft of fish, and lack of quality fingerlings used by farmers (Malawi Government, Ibid). Fish farming has the potential for the diversification of livelihoods in the district if the local people can be well supported. A lot more is required to unlock this potential for livelihood diversification of the people in the district.

Comparatively, the district has lower socio-economic parameters if compared with data at region and country levels as in the Table 2-5.

Table 2-5. Comparative characteristics of the population of Mulanje District against southern region and national data

Characteristics of the population	District	Southern Region	Malawi
Poverty incidence (NSO 2012), in percent	65.3	63.3	50.7
Incidence of ultra-poverty (NSO 2012), in percent	33.6	29.5	24.5
Children mortality rate, in people	78 per 1000		59 per 1000
Access to electricity in 2016, in percent	7.9		10.7
HIV/Aids prevalence, in percent	20.6		8.8
Population density in 2018, in peoples per km²	341	244	186
Literacy rate in 2018	69	67	68

Sources: Compiled from (Malawi Government, 2017b & Malawi Government, 2019b)

As can be observed from the table, the human demographic data at the district level is fairing unfavourably in comparison to country and regional data. It is only the literacy level that the district performs better than the regional and country data. Scarcity of land for agriculture production by the local people, climate change, illiteracy and low analytical skills, high fertility rate and high prevalence of diseases more especially HIV/Aids, are the major causes of vulnerability in the district. High demand of fuel wood and land pressure are not helping on land restoration; hence, there is continued increase in deforestation and encroachment of Mulanje Mountain Forest Reserve.

2.8.3. Mulanje Mountain

Mulanje, as a district, is mostly on a flat plateau but all of a sudden, a mountain is seen to have risen abruptly from the surrounding as can be observed in Figure 2-17. Mulanje Mountain, also known as Mulanje Massif, is a prominent feature in the district. It is a granite inselberg and one of the largest inselbergs in Africa, apart from being the largest peak in South-Central Africa. As a monadnock or relatively isolated mountain, it covers an area of 650 km² with over 20 peaks protruding at 2500 m above sea level, thereby leaving a very small stretch of land between itself and the republic of Mozambique (WWF, 2013 as cited by Thompson, 2013).

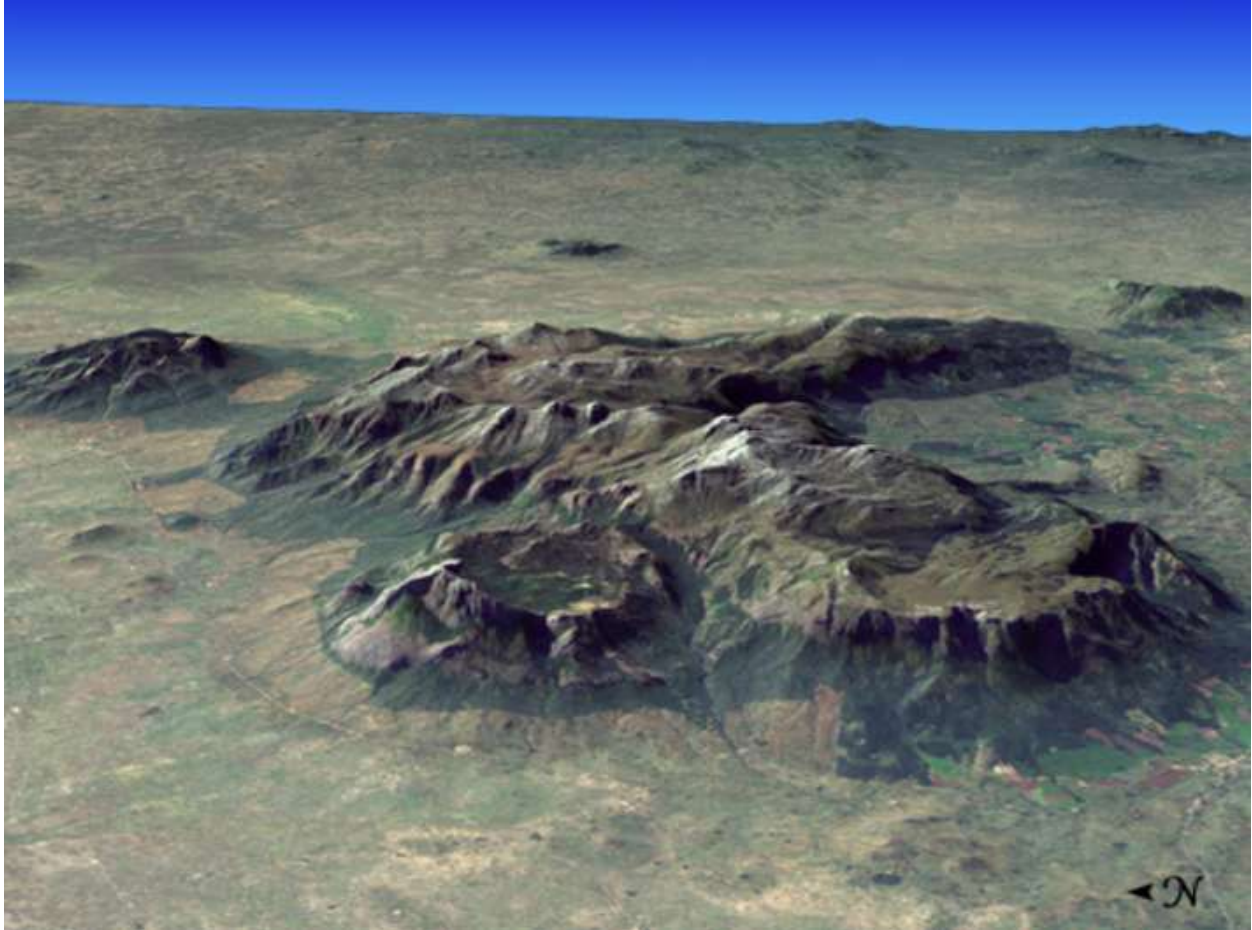


Figure 2-17. Landsat image of Mulanje Mountain. (Source: (Nasa Earth Observatory, 2004))

As can be observed in the figure, the mountain has several peaks such as Manene, Chinzama, and Chambe while the highest peak at 3002 m above sea level is called *Sapitwa*. *Sapitwa* means “the place where one is not supposed to go”. The mountain is completely surrounded by villages with smallholder farmers cultivating on customary land and the large estates of tea as in Figure 2-18.



Figure 2-18. Mulanje Mountain with tea plantation on flatland. (Source: (Malawi Info Directory, no date))

The mountain brings unique characteristics in that its high-altitude intercepts moist south-east winds from the Indian Ocean with huge amounts of precipitation on the mountain and surrounding areas. The precipitation received is in the ranges of 2000 mm to 3000 mm depending on direction, altitude and aspect, while the summit of the mountain receives precipitation in excess of 4000 mm per annum (Borgstein, 2017 & Wisborg and Jumbe, 2010). High amount of rainfall coupled with unique rock feature of the mountain provide a very important catchment area for fresh water through nine main perennial rivers of Ruo, Lujeri, Likurezi, Lichenya, Likhubula, Muloza, Sombani and Nandiwo, apart from the various streams. This makes the mountain an important source of fresh water for the districts of Mulanje and Phalombe, including the city of Blantyre, which is about 65 km away. The rivers provide huge potential for irrigation and power generation. So far three power plants have been installed – Mulanje Hydro Limited with 8.2 MW on rivers of

Ruo and Ndidza, Cedar Energy with 3 MW on Muloza River and Bondo Mini-grid of 220 kW which is planned to be upgraded to 6.5 MW on Lichenya River. With mean runoff of the rivers from the mountain estimated at 51.63 m³/s (Taulo, Mkandawire and Gondwe, 2008), the potential of the rivers for increased power generation with both storage and run-off type of hydropower systems remain so huge.

Mulanje Mountain has national and global environmental significance for its richness in biodiversity (Development Alternatives Inc, 2006). Due to the steep slope, high rainfall and isolated plateau on high altitude, the mountain with its forest reserve, has many varieties of species including 1300 plant species, 250 butterflies, 180 birds, 55 reptiles and 32 amphibians (MMCT, 2008 as cited by Wisborg and Jumbe, 2010). Of these species, 40 plant species are endemic, 8 endemic butterflies and 8 near-endemic birds. World Wildlife Fund, 2013 as cited by Thompson (2013) added that the other endemic species found on the mountain are 2 dwarf chameleon, two geckos, one skink, one lizard, one frog sub-specie, one squeaker frog and one ridged frog. Numerous snake species and additional gecko species, greater hamster, rat and sub-specie of monkey found on the mountain are regarded as near-endemic. Wisborg and Jumbe (2010) reported that the mountain was also a home to large animals such as eland, but only blue duiker, bushbuck, red duiker and klipspringer, which are able to hide in the steep slopes are remaining. Such a variety of species makes the mountain unique and very attractive to biological conservationist and evolutionists, among others.

The other aspect of Mulanje Mountain is presence of the endangered Mulanje Cedar. The tree species *Widdringtonia whytei*, endemic to Mulanje Mountain, first noted by Scottish missionary Robert Cleland in 1888 and then described by Whyte in 1893, was named Cedar by Rendle in 1894 (Bayliss *et al.*, 2007). The tree was declared a national tree of Malawi by the then president of

Malawi, the late Dr. Hastings Banda, in 1984. Valued for its fine timber, attractive fragrance and pest-resistant sap, the tree species has undergone a huge decline due to illegal logging and wild fires. Several efforts are in place to protect the cedar and other unique species of the mountain, one of which is the application that was made in 2000 for the inclusion of Forest Reserve into the World Network of Biosphere Programme. The application that was submitted to UNESCO for World Heritage Site status was reportedly unsuccessful, but if successful, it would have meant better protection of the mountain's ecosystem as the UN would have had the legal mandate to take legal action if the ecosystem is threatened (Bayliss *et al.*, Ibid).

The uniqueness of the mountain can be appreciated through the many recognitions by various designated institutions as follows (Wisborg and Jumbe, 2010).

1. Mulanje Mountain Forest Reserve (declared in 1927 by the then colonial government);
2. Mulanje Mountain Global Biosphere Reserve (MMGBC) (declared in 1999 UNESCO);
3. Recognised by World Wildlife Fund (WWF) as one of 200 ecoregions of particular importance for biodiversity conservation and an Afromontane Regional Centre of Endemism;
4. Recognised by International Union for Conservation of Nature (IUCN) as an International Centre of Plant Diversity;
5. Recognised by Conservation International as an Eastern Afro-Montane Biodiversity Hotspot; and
6. World Heritage Site (application prepared by MMCT and a consultant).

2.8.4. Community based Rural Land Development Programme (CBRLDP)

There are huge disparities on access of land as some households or districts in Malawi have limited access to land, while others have large land, some of which is not used (Malawi Government, 2009 as cited by Stevens and Luwanda, 2015). The author mentioned that the country had in excess of 2.6 million hectares, representing 28 percent of total of idle land on one part of the country while the other part had a huge deficit. Land availability is so critical in the Southern Region more especially the Shire Highlands that out of the 6 most densely populated districts in the country, five come from the region as in the Table 2-6.

Table 2-6. Population densities of some districts in Malawi in 2008

ITEM NO	DISTRICT	POPULATION DENSITY (Peoples/km ² in 2018)
1	Likoma	726
2	Chiladzulu	469
3	Thyolo	433
4	Mulanje	341
5	Phalombe	325
6	Zomba	316
7	Machinga	205
8	Mangochi	171

Source: Malawi Government (2019c)

Much as Likoma District has the highest population density, it is an island on Lake Malawi whose dependency is fishing, tourism and as a hub of trade between Malawi and the places in Mozambique that are close to it. The district is unique and should not be compared with mainland districts. The rest of the districts that have high population density in the Table 2-6 are found in the Shire Highlands. Mulanje is one of such districts. The last two rows in the table have districts

which have the advantage of low population density and have the bigger part of their population close to fishing areas of Lake Malawi, Lake Malombe and Shire River. These districts have vast sparsely land outside fishing areas mostly idle. Taking of the idle land, a pilot phase of the programme called Community based Rural Land Development Programme (CBRLDP) of resettlement of people from Mulanje and Thyolo to Mangochi and Machinga Districts started. Funded by World Bank with a budget of US\$37.9 million, the programme was about planned to resettle 15,000 landless and/or land-poor families from Mulanje and Thyolo to the idle land of Mangochi and Machinga (Chinsinga, 2008; Stevens Luwanda, 2015 & Sharp, 2015). This was one way of solving land issue in Mulanje and Thyolo so that households that had small land holding capacity could have larger land sizes for increased crop production for both food and income.

It is reported that CBRLDP was the first land reform that involved land distribution in Africa and the first of its kind that involved funding from World Bank (Sharp, 2015). The programme was envisaged to contribute to increased productivity and increased income among marginalised poor that had little access to land. Chinsinga (2008) reported that the initiative was implemented as a pilot phase with a view to provide lessons for possible upscaling across the country. The beneficiary families were first asked to assemble in groups of 20-30 and they had to elect a representative while in their original districts. Then they were provided with funds to move and purchase land of 2-hectare plots per household on the defunct tobacco estates of Machinga and Mangochi. The purchase and distribution of land was reported to have followed strict notion of ‘willing buyer and willing seller’. This means there was no force on either the buyer or the seller for the transactions to take place.

Much as the programme succeeded in providing the necessary funds and land redistribution, it faced unprecedented challenges. The sharing of resources with new comers was not totally accepted by the receiving communities. The settlers were also required to conform to the local authority such as traditional authorities and group village heads (Sharp, 2015), which were different from them. These brought some conflicts hence the project could not continue. A summary on the differences between the settlers and receiving communities are summarised in the Table 2-7.

Table 2-7. A summary of differences between the settlers and receiving communities

Districts	Mulanje	Thyolo	Machinga	Mangochi
Sending/receiving	Sending	Sending	Receiving	receiving
Infrastructure	Good	Good	Very poor	poor
Environmental characteristics	Lush green forest	Lush green forest	Dry sandy soils	Dry sandy soils
Livelihoods	Tea: factory, cash crops, piecework and tourism	Tea: factory, cash crops, piecework and tourism	Fishing, farming, pastoralism, piecework	Fishing. Farming and piecework
Ethnic groups	Lomwe	Lomwe	Yao	Yao
Religion	Christianity	Christianity	Muslim	Muslim
Kinship	Matrilineal	Matrilineal	Matrilineal	Matrilineal

Source: (Sharp, 2015:7)

As Table 2-7 depicts, the only commonality of the resettled communities and the host communities is the kinship or system of marriage. These characteristics matter if a community is to function as one. The stark differences in religion, ethnicity and the livelihood options provided fertile grounds for conflicts and skirmishes. For example, Lomwes enjoy pork and they do pig rearing, while the

selling and consumption of pork among Yaos, who are mostly Muslims has resulted in skirmishes in the district of Mangochi. With the challenges and the likelihood of conflicts, if people from one area are resettled to another area, the programme had never been upscaled as was planned. The preferences of the people are to be resettled within own neighbourhood or district with many demographic characteristics similar, but this cannot solve the land issue.

2.8.5. Economic potential of the district

There are several economic potentials within the district of Mulanje. Apart from its richness in biodiversity, Mulanje Mountain has been discovered to contain some reserves of bauxite, whose mining activities were estimated to have the potential period of 40 years. The huge reserves of bauxite were found on plateaux of Lichenya and Linje at altitude of 2000 m above sea level (Malawi Government, 2017b). Much as the bauxite was estimated to be within the lens of 2150 ha, only 460 ha of land or forest reserve was estimated to be affected by the mining activities. The feasibility study on the techno-economic evaluation of the bauxite was done in 1993 by MET-CHEM Canada with funding from African Development Bank (Malunga, 1999). The impact of the mining activities to the environment was considered to be minimal as the ore is observed to be soft and friable hence no blasting and with thickness of the ore estimated at 4 m to 5 m mining, benches would not to be used (Malunga, Ibid). With projection of the then increase in aluminium prices by 3 per cent in 1994/95 and a stable price increase of 2 per cent per annum on the world market, the prospects were positive. Not much is known since then, but Bayliss *et al* (2007) reported that in December 2005, the Malawi Government entered into a discussions with Gondo Resources Management so as to have mining activities started by 2011. The author reported that the subsequent estimates of mining activities were reduced to 25 years from the previous estimates of 40 years. It is not known whether the mining project will be started or not.

Mulanje and the whole part of Shire Highlands was so much adored by Dr. David Livingstone through his writings after his Zambezi expeditions between 1858 and 1866. Due to the elevated land over low swampy country, Shire Highlands was observed not only to have cooler climate but the presence of perennial rivers meant the farms could be irrigated all the year round. It is for this that Dr. David Livingstone proclaimed that the area's benign climate and fertile soils would make ideal opportunity for the promotion of Christianity and commerce (Palmer, 2021). As a result of Livingstone's writing several Anglican and Presbyterian missionaries and traders came and established themselves in the area in the 1860s and 1870s (Palmer, Ibid). A number of European missionaries, traders and others purchased huge stretches of land from local chiefs. Such is the origin of estate farming in the district. Estate farming is a source of employment and foreign exchange earner from tea exports. Smallholder farmers are involved in tea farming with the harvest sold to tea estates mostly Lujeri Tea Estate.

The attraction of local and international tourists is another potential sector that the district has. The international tourists are attracted with the rich biodiversity of the mountain, beautiful scenery of the tea overgrowth on the foot of the mountain, and hiking of the mountain. In the dry season of July to October, one sees many international hikers trekking into the area so they can reach the Sapitwa, also called the island in the sky. Local people are benefiting from helping tourists in reaching several areas of the interests on the mountain as tour guides. Businesses are also benefitting. Mulanje District is therefore, so much endowed with physical and natural resources, which if put into good use can have huge impact on lifting the people from poverty.

2.9. Related work on co-design

The two examples of co-design, one in Mozambique and the other one in Uganda, are worth learning from. In Mozambique, it was about the implementation of a small-scale project as a way of empowering a social minority group to actively participate in community's Information and Communication Technologies for Development (ICT4D). The outcome was the need for the development of course content, the offering of training and encompassing the course content (Cumbula, Sabiescu and Cantoni, 2017). In Uganda, it was about community's support of rural water management. Pay Me For Water (PM4W) as a platform of sustainable financial management for the enhancement of accountability and management of the water was conceived and implemented (Ssozi-Mugarura, Blake and Rivett, 2017). In both cases, co-design started with workshops that brought together stakeholders at a national level and then various localised workshops. The participants in co-design process in Mozambique were not provided with any form of remuneration while in Uganda the participants were provided with some form of remuneration as a way of reciprocity. This on the understanding that researchers benefit from co-design through publications or stipends while community participants often contribute unpaid labour and time.

2.10. Theoretical perspectives

Practice and academia are agreeing that the provision of electricity access to the rural and marginalised poor is a game-changer in realising economic and transformational development (Garniati, Owen and Kruijsen, 2014; Clemens *et al.*, 2010; Bruderle, Attigah and Bodenbender, 2011; Sustainable Energy for All, 2024). World bank (2017) summed it better by reporting that electricity is an essential part of modern life and its importance is manifested in its linkage to the wider development agenda and the interconnection to 125 (74%) of all the 169 SDG targets.

However, the expected positive outcomes for the rural masses who had been given the access have been elusive in many rural electrification projects (Mayer-Tasch, Mohua and Reiche, 2013; World Bank, 2023; Abeberese, 2024). There is a glaring missing link of turning electricity access into diversification of rural livelihoods and economic transformation.

Many rural communities that have been provided electricity access register low consumptions in electricity to realise the resilient and socio-economic development from electricity access. This is because community members of rural settings are affected with unaffordability and unwillingness to purchase electrical appliances and electricity units, which result into low electricity sales and low load factors. These in turn affect the technical and financial sustainability of rural electrification projects including mini-grids. With these, many mini-grids for rural electrification have failed to survive beyond their pilot phases both within Malawi and in many other developing countries (Luc, Bordeleau and Young, 2015).

The underlining reasons for the departure from theory to practice require understanding at different levels including policy, technical, participatory approaches. There is need to have the understanding of the different ways of improving the sustainability/resilience of mini-grids for rural electrification and resilience building of rural communities with electricity access. The interlinkage of energy-system resilience and community resilience are interconnected or interlinked hence the study of sustainability or resilience of electrical systems can be better be understood together with resilience building and resilient livelihood options of local rural communities. This study is bringing forth the various ways of enhancement of community energy resilience, that is the enhancement of the resilience of the rural energy systems such as mini-grids and the building of the resilience of community's livelihood options.

2.11. Conceptual Framework

Conceptual Framework, also called Analytical Framework (Ngulube et al., 2004), is a necessary component of a dissertation that utilises a qualitative methodology (Statistics Solutions, 2023). It is reported to be the spine and soul of all qualitative research. As a spine, the conceptual framework is a structure or logical masterplan which a researcher believes can best explain the natural progression of the phenomenon to be studied (Adom, Hussain and Joe, 2018). As a soul, conceptual framework contains concepts, expectations, beliefs and theories that support and inform research. A conceptual framework also provides an argument as to why the study is significant and relevant.

The construction of a conceptual framework is based on constructivist theory as a result it is dependent on the knowledge and understanding of the researcher. That means conceptual framework is presented differently by different researchers and with different materials that are included (Luft et al., 2022; Gardiner & Kroth, 2014; Adom et al., 2018; Leshem & Trafford, 2007). Much as that is the case, the recommendation is that the framework is required to be craftily arranged and self-explanatory to the readers. There are several suggestions over what has to be included in the framework some of which include researcher's method of study, data to be collected, the theories to be applied, the methodology to use, the methods, procedures and instruments, data analysis, implementation of findings. The list goes on to include definition of the topic, elements of the topic, methods of approaching the study, findings, and recommendations and conclusion. The inclusion of all the listed can be a huge task apart from bringing confusions and crowding of the schematic diagram. The many parameters mentioned and without agreements among the authors mean the construction of the conceptual framework remains the onus of the researcher, hence constructivist theory.

Researchers are also given the liberty to use existing framework(s) or the existing framework modified to suit the nature of their research work (Garside, 2020; Adom et al., 2018). Shikalepo (2020) recommends that a conceptual framework should be placed as a last section of literature review because it is intended to summarise the main points of the chapter. Conceptual framework is mostly constructed as a diagram with use of flow charts between key concepts, constructs and/or variables, and their relationships (Ngulube, Mathipa and Gumbo, 2004). Alongside diagrammatic representation Adom, Hussain and Joe, (2018) recommends that the framework should be accompanied with explanations for it to be understood clearly. With the guidance provided, the conceptual framework on harnessing community energy is presented as Figure 2-19.

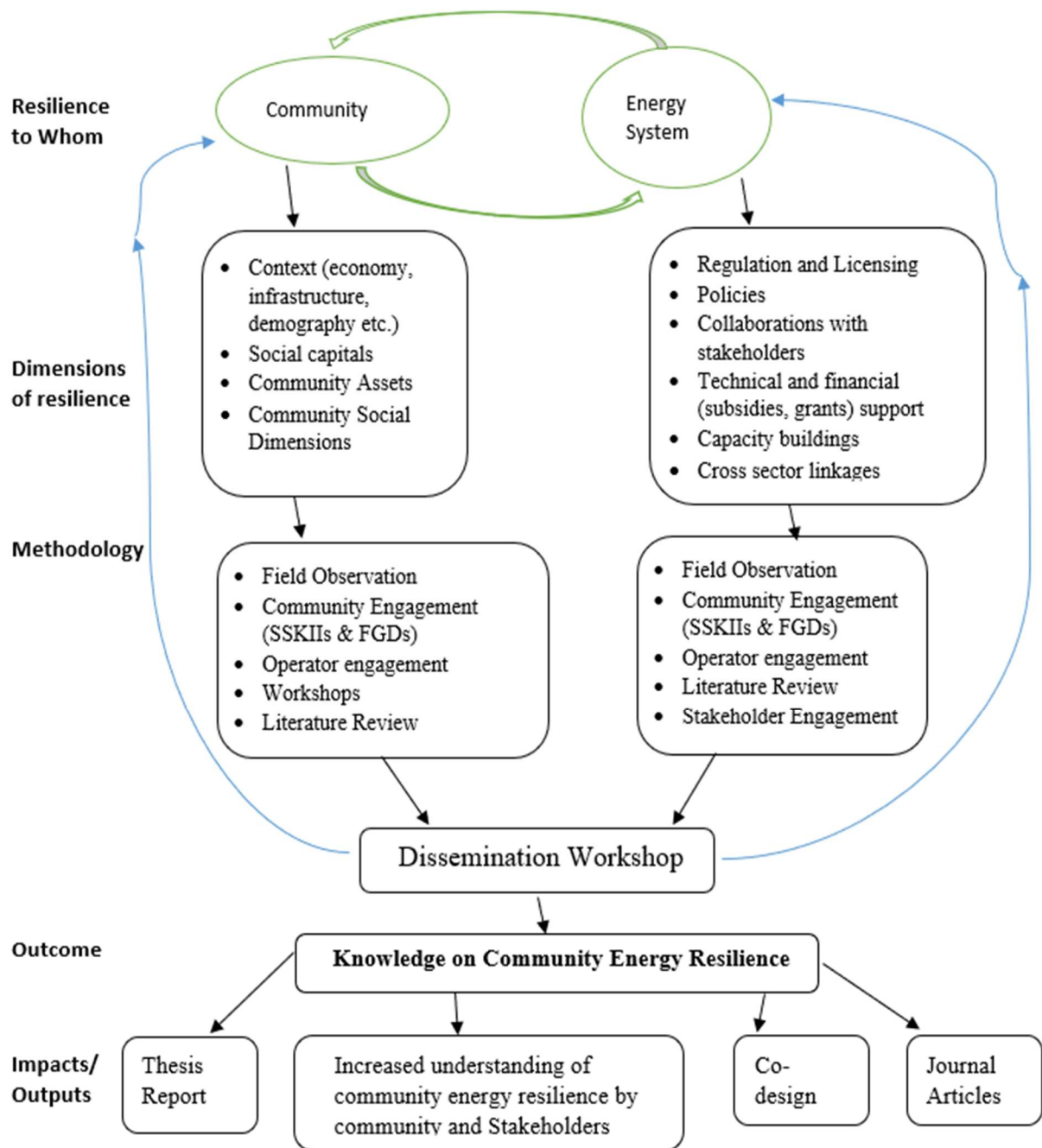


Figure 2-19. Conceptual Framework for the enhancement of Community Energy Resilience.

The framework as in Figure 2-19 has so many linkages on community resilience and energy system resilience. The starting point is a loop between community resilience and energy system resilience. This provides the need for nexus approach as the two concepts are intertwined. The study on the enhancement of the resilience of community should simultaneously be achieved with the enhancement of the resilience of energy system. Community resilience has dimensions such as community asset and social capital, which provide some form of measures of resilience. The dimensions for the resilience of energy systems such as regulations, capacity building and licensing have been included. The framework has also included methodological approach recommended for use in understanding the resilience of community and the resilience of energy system. Field visits, Semi-Structured Key Informant Interviews (SSKII) and Focus Group Discussions (FGD) are the research methods to use in understanding the resilience of community. Study tours on mini-grid establishment, interviews, workshops and observations are some of the research methods to use in understanding the resilience of energy systems. The outcome of the whole process is on understanding the concept of community energy resilience, that is, the understanding the resilience of energy systems together with understanding the resilience of the community. From this research work, thesis report, journal articles, a co-design as a product/service implemented and the increased understanding of the concept of community energy resilience are the expected outputs or outcomes.

CHAPTER 3: MATERIALS AND METHODS

3.1. Introduction

This chapter outlines justification for the approach of the study and methods used. Furthermore, the chapter provides the descriptions of data collection methods, which consists of focus group discussions, semi-structured key informant interviews, observations, co-design process, field visits and meetings. Data collection and data analysis are part of the section. Ethical considerations and limitations of the study have also been included within the chapter.

3.2. Research Design and approaches

Research design and approaches adopted in conducting the research are important aspect to provide the understanding and even question the scientific nature or acceptable techniques as to how data was collected, handled and analysed. It helps to critically evaluate the reliability and validity of research outcomes. There are three research approaches of qualitative, quantitative and mixed that a researcher can choose from based on his/her study. Qualitative research is necessary where “little information exists in a topic, when variables are unknown or when the relevant theory base is inadequate or missing” (Leedy and Ormrod, 2021:258). Such being the case, this study employed the qualitative research approach. This is on the understanding that the topic of harnessing resilience of the energy system and harnessing the resilience of the community has so many unknown dimensions and layers; hence the expected results were indeed multifaceted. The study had several unknown variables and it was expected to explain the varied results. The approach chosen has the advantage of providing the human side of the issue under study with participants expected to have contradictory behaviours, beliefs, opinions, emotions and

relationships that come with differences in ages, norms, socio-economic status, gender roles, ethnicity, and religion (Mack *et al.*, 2005).

The six commonly used qualitative research designs are case study or idiographic research, ethnographical study, phenomenological study, grounded theory study, narrative enquiry and content analysis (Leedy and Ormrod, 2021). I will not labour myself into providing details of all the research designs, except the case study, which was adopted in the study. Case study is defined as an in-depth or intensive study about a person, a group of people or a unit, a project, a policy, a programme, an institution, a community or a system in real-world context (Mohajan, 2018 & Heale and Twycross, 2017). This type of research design is reported to have its origin in sociology but is currently valuable for use in other practice-oriented fields including social and life sciences (Mohajan, Ibid). The study about Bondo community is unique and exceptional because of the features and characteristics it has; hence, it could better be understood using the approach of a case study. The three main common qualitative research methods (Mack *et al.*, 2005) of observation, focus group discussion and interviews were used. The data collection methods used in the study have been extensively discussed in the subsequent section.

3.3. Data Collection Methods

The type of case study that was used in this study is Community Based Qualitative Research (CBQR), which has been extensively discussed in section 2.4, due to the nature of research problems, the approach and expected outcomes. The qualitative research methods or the data collection methods that were used in the study include Focus Group Discussions (FGDs), Semi-Skilled Key Informant Interviews (SSKII), meetings, workshops, observations, and field visits to other two mini-grids within the country. For proper understanding of the methods used, activities

that were carried out are presented in chronological order. Ethical approval was duly applied and granted by Mzuzu University Research Ethics Committee. The discussions were recorded which had the advantage of capturing all information that had been spoken and the researcher was able to concentrate on the discussion at hand other than taking down notes.

The first step was the development of research tool as in Appendix 1 which was followed by the fieldwork. The first task of fieldwork required the identification of research assistants for the support and these were identified within the district of study. A half-day preparatory workshop was conducted with the aim of orientation and improvement, translation into local language and reflection on the research tool. With the support and active involvement of Mr. Arnold Kadziponye of MEGA and four research assistants, the preparation of the research tool was successfully done and mock FGDs and SSKIs were conducted thereafter. Mock FGDs and SSKIs were so important so as to check on the flow and timing of the discussions, while making improvements where needed. This preparatory workshop was conducted on 29th November 2021 at Fanizo Lodge within Mulanje District.

3.3.1. Focus Group Discussions (FGDs)

By the time of conducting the study, 17 villages had electricity connection from Bondo Mini-grid. These villages are of different sizes and have different number of households, and the FGDs were carried at village level so as to have an understanding or a consensus at a village level. FGDs targeted participants and respondents of all the villages that had electricity connection and a representation of those that were not connected and all the 17 villages were engaged. Each village was regarded as a stratum and random sampling was used to come up with participants. In addition

to stratified random sampling, purposive sampling was used to have a variety of members in each group of FGDs as follows:

1. Members at a village level were grouped into three –households perceived to be of high income, middle income and low income. In each of these groups, random sampling was used to come up with two participants from each;
2. Three participants who were not connected to the grid at village level were identified randomly; and
3. Deliberate efforts were taken so that among those chosen there was a minimum of 40 percent representation of either gender and 40 percent was for participants aged 30 and below.

In total, 17 FGDs and the number of participants, their gender and duration for each FGD is in Appendix 2. The number of participants in each FGD was not far away from the ideal numbers of 3 to 14 participants that had been observed to work well in a focus group discussion (Bloor and Frankland, 2001). The targeted participants were mobilised and asked to gather at a convenient place within their respective villages with members of the research teams making travels to meet them. With 5 research personnel, that is one researcher and 4 research assistants, each one was facilitating one focus group discussion in the morning and moved to another village for a second focus group discussion in the afternoon.

A total of 10 FGDs were conducted on 30th November 2021. Being the first day, a debriefing meeting was conducted in the evening of the day to share on successes, challenges and ways of making improvements for the subsequent focus group discussions. So far, there were no major challenges, except on the guide that required participants to make suggestions over what should be implemented within the village or community. The suggested intervention required to come

from the participants themselves and implementation required to be conducted in conjunction with MEGA, researcher and participants themselves. It was not easy for participants to open up as they had been used to having the problem defined by funders while the role of the community was for support. Way forward was to make probes and provide guides on what will be expected over the idea they were to give out.

The sitting plan within FGD was done in a way that participants and the researcher were sitting in a round-table format so as to get maximum attention from each other and that the participants should have equal level of importance during engagement, unlike the classroom format. Smart phones were used to capture voice data of the discussions.

All members, including women, were taking part in the discussion. Much as village heads were not invited in the discussions so as to reduce powerplay, some were joining uninvited. To avoid embarrassment and showing respect of their authority, they were allowed to take part. Much as there were village heads in three of the discussions, it was a free discussion with little powerplay observed. In some cases, women were at the forefront in a discussion, while in other cases men were the most active. All in all, encouragements were made so that everyone on the group was able to contribute. The FGDs took place during the COVID-19 pandemic and much as face masks and sanitisers were available, participants refused to use them with a belief that the nearby mountain protected all the people around from harm including COVID-19. Such is the reason that participants were not putting on the masks and no sanitisers were used as part of prevention measures. The remaining 7 FDGs were conducted on 1st December 2021. A summary on the numbers and gender of participants of FGDs at village level are included as Appendix 2. The Semi-Structured Key Informant Interviews (SSKIIs) started on 1st December 2021.

3.3.2. Semi-Structured Key Informant Interviews (SSKIs)

Purposive sampling was adopted in the identification of respondents for the Semi-Structured Key Informant Interviews (SSKIs). Two participants per village and 34 interviews in total were planned. Gatekeepers and opinion leaders/formers such as teachers, village heads, health personnel and religious leaders were targeted and identified with the help of MEGA officials. The type of respondents was chosen within the Bondo Community so they could provide the much-needed in-depth information for enrichment and as a supplement to the FGDs. Smart phones were used in capturing voice data. SSKIs took place from 1st December to 3rd December, 2021. Interviewees were identified and agreed as to where to meet in their respective villages. A total of 16 SSKIs of the 34 targeted were conducted. The total number could not be reached because some target interviewees could not present themselves at the agreed time and place. Interview fatigue could be the reason.

3.3.3. Co-design workshops

The co-design activities carried out in this study had been modelled on the five-stages of Setup, Discover, Define, Develop and Deliver (Abrams, Man and Mcleod, 2019), which have been comprehensively explained in section 2.3.6. In the “Set-up” stage, resources were mobilised and participants were identified from the community and other stakeholders. The next phase of ‘Discover’ was in the form of solicitation of co-design ideas, or co-creation, from community members through SSKIs and FGDs. The SSKIs and FGDs had a section that required participants to suggest ideas that would be implemented by the community themselves in collaboration with MEGA officials and the researcher. It should be emphasised that the ideas solicited needed to have the twin purposes of enhancing energy system resilience and improving lives at household, village

and/or community levels. The ideas generated were subjected to further discussion and scrutiny through three workshops, or co-design workshops as part of “Discover” and “Define”. The activities for solicitation of co-design ideas that started with SSKIs and FGDs and continued with the workshops. The compositions and discussion points of the workshops are explained in the sub-sections that follow.

A. First Co-Design Workshop

The first co-design workshop took place on December 6, 2021 in the boardroom of Mulanje Mountain Conservation Trust (MMCT). An attendance of the 18 participants for the workshop, which included a representative from Mulanje District Council, councillor, business people religious leaders, health personnel, village heads, teachers and MEGA representatives. During the workshop, a brief introduction was made on the purpose of the workshop. A list of ideas and the frequencies that were generated during FGDs and SSKIs were presented for deliberations. The participants were also asked to add whatever ideas they had. Participants were also informed that the study had a budget of an equivalent of £10,000.00 for the actual implementation of any feasible idea. Thereafter, the members were asked to rank the first five ideas that fitted within the budget and the objective of the study.

No payment was made to participants apart from the money to carter for their meals, snacks and transport reimbursement. Since the activity happened during COVID-19 pandemic, food was avoided, participants were provided with face masks, sanitisers and necessary social distancing was emphasised as part of the preventive measures.

B. Second Co-design Workshop

There was need to have refinement of co-design idea(s) that came out from the first workshop and reconsider those from FGDs and SSKIIS. The second workshop had seven participants so as to provide enough time for detailed discussion of the idea to be implemented. The workshop was held on May 13, 2022 at Fanizo Lodge in the same Mulanje District.

C. The third workshop

The third and final workshop was conducted on November 29, 2022 at Fanizo Lodge. It was conducted to continue with the refinement of the ideas and agree on the implementation plan. Drinks and snacks were provided. This workshop had 18 participants and as usual the majority were community members, three representatives from MEGA and three researchers.

3.3.4. Meetings

Several meetings were conducted with officials of MEGA as a way of understanding the operations of MEGA in terms of connections, tariffs, funding and roles of regulator, Ministry of Energy among other stakeholders. I was also privileged to be part of the meeting that was organised by Civil Society Network on Climate Change (CISONECC) at the powerhouse of Bondo 3. The meeting was not planned, but it just coincided with my visit to the power plant. Village heads and members of CISONECC were in attendance and short notes on the discussions were taken. Another meeting with two personnel of MEGA and a representative from Virunga Power was conducted on 13th November 2022 and deliberations were recorded as short notes.

3.3.5. Field Observations

The researcher made several visits to the study site. So far, visits of different durations were made in May 2019, February 2020, February 2021, November/December 2021, May 2022, August 2022 and November 2022 and on each, general observations and the changes happening within the community were always recorded. Field notes were written from observations.

3.3.6. Field visits to other mini-grid establishments in Malawi

In order to have a clear picture and make comparison on the terrain under which mini-grids are operating in the country, the mini-grids of Chipopoma Hydro System of 50 kW in the Northern Malawi and 80 kW-Sitolo PV in Central Malawi were visited. Chipopoma hydropower system was visited several times, either as part of this research work or normal work of research as an academic member of staff of Mzuzu University. As of May, 2022, the system was providing electricity to 85 households, one maize mill and some grocery shops. I also visited Sitolo PV System on June 20-21, 2022. During the visits of the power plants, briefings were conducted with the personnel who are managing the system and members of village electricity Committee. Several visits had also been made to Kasangazi micro-grid in Mzimba district as part of this research work or normal activities as an academic member of Mzuzu University. Field notes were taken of the various observations made during the field visits and the discussion points.

3.4. Reliability and validity of data collected

As in many qualitative research, the reliability and trustworthy of data collected was achieved through data triangulation. The guide for FGDs was used to come up with questions for SSKIs and other community engagements of co-design workshops and meetings.

In qualitative research, sample sizes are of little importance. Data saturation is key (Aldiabat and Navenec, 2018). It is believed that enough data was collected to fully understand the concept of the study of community energy resilience of Bondo Community. It is believed that there were no any new insights and new discovery that could have been collected with continued data collection.

3.5. Data analysis

The voice recordings from SSKIIIs, FGD and all three co-design workshops were translated and transcribed. Transcription was done verbatim so as to provide credence through avoidance of bias introduced through selective data extraction, which is reported to be common among researchers who may have vested interest in having particular themes or research questions in mind. Through listening and observation, notes were prepared as part of raw data. The process of data analysis done was following the steps as summarised in the Figure 3-1.

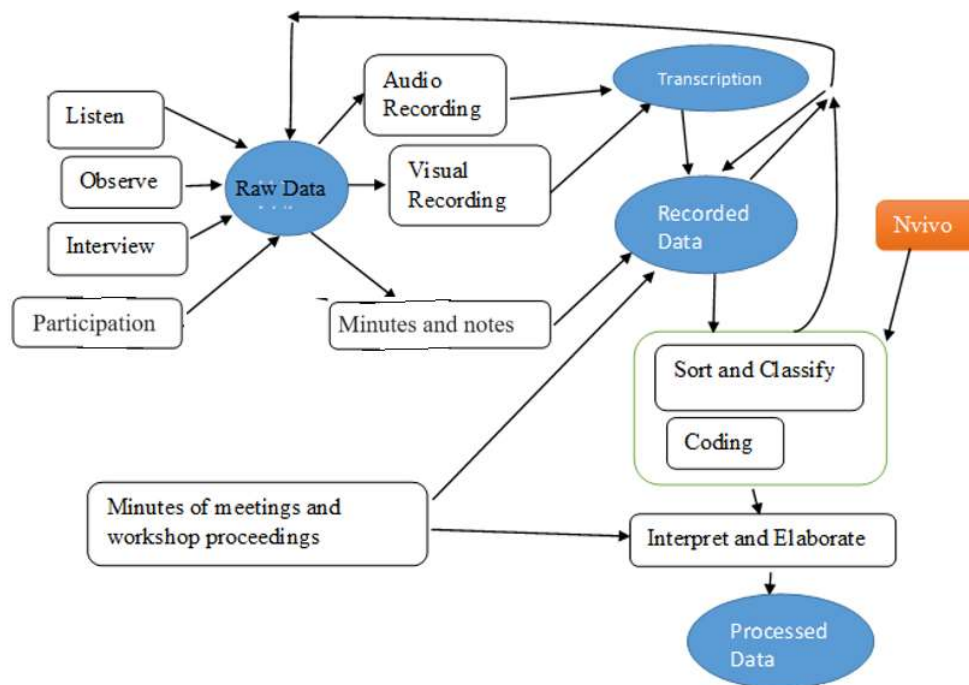


Figure 3-1. A schematic diagram showing a summary of how data was analysed.

Transcribed data, notes, and minutes of meetings were exported to NVIVO (2020) Student Licence. NVIVO is a software for organising, analysing and visualising of qualitative data. The first step in the use of NVIVO was to have the raw data imported into the software. After this, coding started. Mainly, structural coding was done in which texts that were related to research questions or research objectives (Belotto, 2018) were used. Thematic analysis, which is about developing codes and then finding relationships among similar codes which are then combined to come up with categories and then built into themes (Kim, 2015), was used. Themes are important in that they provide description of phenomena that are regarded to be important to a study by the researcher (Fuller *et al.*, 2008). It should be noted that some categories and themes were noted even during transcribing, classification and coding. In addition to thematic analysis, narrative analysis was used. Narrative analysis is defined as the excavation of meaningful stories such as to “how people make sense of what happened and what effect or what people make sense of what happened and to what effect” (Bryman, 2012: 582). Since thematic analysis had been used together with narrative analysis, the overall analysis used is called narrative thematic analysis (Butina, 2015). Much as there is no standard format of reporting the data, the study borrows the approach that was used by Butina (Ibid) in that the themes that have been observed are presented and supported with several quotes. The inclusion of the quotes is so important as they provide credence and evidence of the findings.

3.6. Limitations of the study

There were several limitations to the study with some that require explaining and documenting. The first is that the findings relied on respondents’ responses based on the situation at the time of engagement, which may have changed. The data was collected during the COVID-19 pandemic and then the challenges brought about by the Russia-Ukraine war may have changed the picture.

This is because the war brought increase of prices of the petroleum, grain and others. Such case indicates the data collected may not be accurate enough thereafter.

The second limitation was that the collection of data was done when the energy supplier had challenges with synchronisation of all three power plants. With only one plant in operation, blackouts were a major concern. It was reported that the delays to have the synchronisation of the power plants was due to lack of funds, but, by March 2022, this was done. This drastically reduced incidences of blackout thereafter. Regardless, the captured sentiments included in the report are reflecting the time when blackouts were so frequent. As such, the treatment of some findings should be taken with caution, and these may have affected the other areas of the findings.

The data collected is for Bondo Community and needs to be treated as such, except where it is general data. If such data reflects other communities, it should be treated as mere coincidence. Therefore, generalisation and application of the data from this research should be done upon verification of all parameters. The collected data may be affected by the sampling method used. The criteria of selecting the respondents which was done as per advice from MEGA officials as per plan was not verified. Some respondent/participants had the view that the objective of the study was to identify beneficiaries for an intervention; hence, some more people joining and even those not meeting the criteria may have been part of participants and/or respondents. All the same, the discussions and salient points provided so many insights into the researched area.

Research fatigue or over-researching of respondents was noted especially during SSKIIIs. It is little wonder that only 16 of the target 34 respondents turned up for the interviews. Follow-up and rephrasing of some question as a way of verification of facts was regarded to boring and bringing annoyance to the respondents. The interview of all targeted respondents may have brought different views on the findings. The community members also voiced the concern that they had

participated in several interviews and FGDs and needed the assurance over what this would bring. Such may have brought some lack of seriousness on responses and discussion points during the engagement.

3.7. Ethical Consideration

During the collection of data, all effort was made so that any harm or potential harm on the part of respondents and participants who were involved in the study was eliminated and where difficult, isolated and minimised. Respect for the dignity of research participants was prioritised. The study was conducted in a way of avoidance of risks to participants, respondents, researchers and the research assistants. The major risk during the conduction of community engagement was COVID-19 and so many precautionary measures were taken. Of course, resistance and perceptions of the community members proved difficult to have all measures taken. It was relieving that subsequent visits and community engagement had revealed that everything went well as there had been nothing reported on risks and hazards brought by the engagements.

Since the study involved human participants, ethical approval from Mzuzu University Research Ethics Committee (MZUNIREC) was sought and granted. A copy of the approval is included as appendix 3. Permission from village heads and other authority within the research site were always sought and given before any activity was carried out. In summary, the following points were strictly observed and adhered to throughout the preparation and conduction of FGDs, SSKIs:

1. Relevant authority in their areas of jurisdiction was notified of the planned activities that were to happen;
2. Before communities' engagement, participants and/or respondents were provided with explanation of the purpose of research;

3. The researchers introduced themselves and provided all information about the research;
4. Respondents/interviewees were told of the handling, usage and storage of data collected to ensure the anonymity of participants;
5. Respondents were told that they had no obligation to answer any of the questions if they did not wish to do so. They were also told that they had rights to withdraw from the engagement at any point;
6. The use of smartphones phones for voice recording of SSKIs and FGDs were clearly explained and consented to before their use; and
7. Written consent form was signed by each respondent or participant as a way of proof for acceptance to be part of the study.

CHAPTER 4: RESULTS

4.1. Introduction

This chapter presents and discusses the results of the study that was conducted at Bondo Community in Mulanje, Southern Malawi. It presents the findings from narrative thematic analysis with use of NVIVO and field notes that documented the observations made. The chapter starts with descriptions of the stressors affecting Bondo Community. This is because there is need to have the knowledge of the frequency, magnitude and type of stressors that the community is subjected to before considering the various options of enhancing the resiliencies of the community and resilience of the energy system. There are sections of the various themes that were generated from research objectives or research questions. These include the enhancement of energy-systems' resilience and the enhancement of community resilience. The section that considers the nexus approach of building the resilience of community resilience and building of energy-system resilience has been included as harnessing community energy resilience. The other themes that had been emerged during the data analysis include electricity by grid or mini-grid – not an easy path, community resilience-at a crossroads of mini-grid and biodiversity and energy, water and biodiversity nexus.

4.2. Benefits of electricity in Bondo Community

Rural electrification in Malawi is not easy as the formal way is grid extension with use of energy levy under a program of MAREP. Here, rural trading centres are chosen and grid is extended to such places. With huge demand and politics at play, the extension to Bondo had never happened until the idea of a mini-grid was hatched in 2007. It was reported that it was in 2014 that the bulb was first lit by the mini-grid electricity. There had been several benefits with the arrival of

electricity some of which are summarised with the testimonies from participants and respondents, and coded as CD for Co-design, SSKII for Semi-Structured Key Informant Interviews, FGD as Focus Group Discussion

Primary schools such as Kabichi and Mabanja could hardly attract teachers before electricity with only 4-5 teachers for all grades from 1 to 8 in total. After electricity, the number of teachers at Kabichi rose to 24 (CD-001)

When I joined a local school the pass rate was 60% but jumped to 85% in 2016, mainly due to electricity. The pass rate increased further to 100% in 2017. This in line with the government's target that primary schools be able to achieve not less than a 90% pass rate. Teachers were indeed refusing to join schools around the area before I joined due to unavailability of electricity and I was compelled because it is my home village, and I needed to contribute (CD-002)

We were walking around 8 km to access maize mills, which is not the case after electricity as electricity maize mills are within the locality (CD-003)

In health, pregnant women were required to bring candles during delivery at Bondo Clinic, which has not been the case after electricity. There had also been an increase in personnel, good lighting and refrigeration leading to improved services (CD-004)

Video shows, barber shops and soft drinks being refrigerated are some businesses that have come with electricity (CD-005)

Reduced energy bills from K15,000 per month for charcoal to K8,000 with electricity if used for cooking, lighting, phone charging and powering radios and TVs (CD-006)

With electricity there has been improvement at the clinic as some medicines are stored at the clinic unlike previously when such medicines were stored at the district headquarters, more than 8 km away (CD-007)

As can be observed not much in terms of productive use of electricity, resilience building and diversity of livelihoods were mentioned.

4.3. Vulnerability and early warning systems in Bondo Community

Knowledge on the magnitude, frequency and types of adversities that a community may be exposed to provides the idea of the mediating factors. The mediating factors inform the necessary action that should be engaged by both the community members and the external support. The understanding of various adversities, nodes and child nodes to do with adversities or common stressors affecting the community were created within the NVIVO software. All the responses or deliberations about stressors or adversities were coded into these nodes. In total, there were 31 different stressors that were mentioned and all of these have been included as appendix 4. The Figure 4-1. Compilation of the main stressors affecting Bondo area. N = 91. below shows the stressors that were mentioned three or more times by participants both during FGDs and SSKIs.

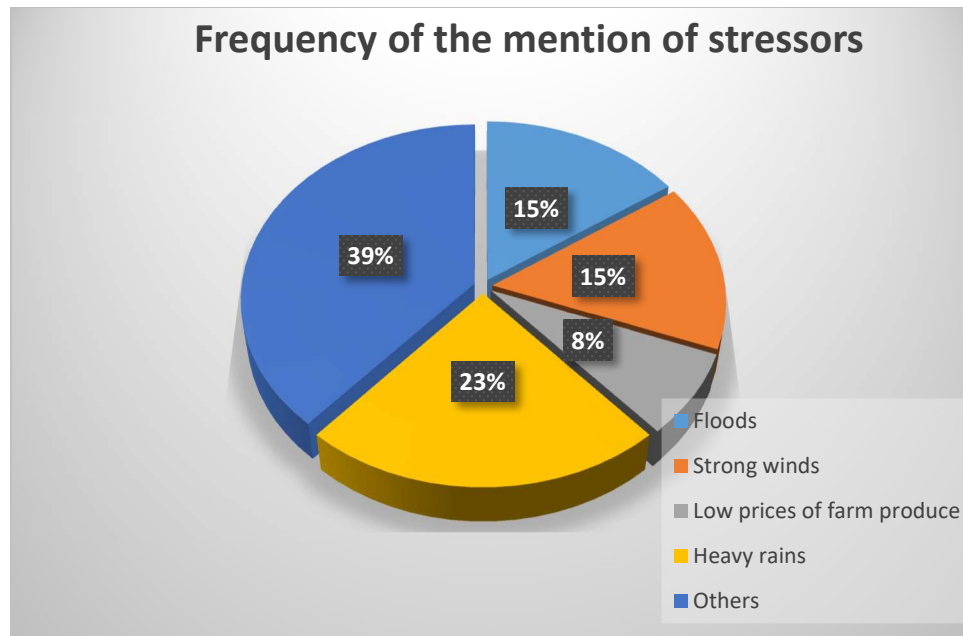


Figure 4-1. Compilation of the main stressors affecting Bondo area. N = 91.

So far, the major stressors that were mentioned by the participants were floods, low prices of farm produce especially of tea and pineapples, strong winds and heavy rains as shown in the Figure 4-1. All the stressors that were mentioned once or two times such as farming being seasonal, high interest rates for loans, unavailability of institutions for provision of loans, frequent blackouts, climate change, and poverty, had been lumped into others. Then there were other factors that were mentioned to have a bearing in preventing the members of the community from diversifying away from farming which include no market place, lack of capital, high interests on loans, and blackouts. Drought or dry spell was mentioned only once which can be attributable to the fact that the area is on the wind-ward side of the mountain. The intercepted moist air from the Indian Ocean is continuously bringing rains, which becomes heavy and windy in some cases. Observations from field visits within the community and the discussions had shown that the cyclones Idai and Anna had no major impacts in the area. This is confirmed by no mentioned of any of the cyclones and

their impacts within the community's engagement. It was also noted that households are not affected so much by floods and heavy winds as trees of eucalyptus and avocado pear which are plentiful in the area provide the necessary windbreak. The other factors are houses are built on the upper ground on ridges with water safely flowing to the lower grounds of troughs as in Figure 2-1. The type of soils and climatic conditions in the area are helpful for the growth of tea, bananas and pineapples, which have the added advantage for the prevention of flooding and loss of top soil.

4.4. Early warning systems in the community

Participants were asked to mention the early warning indicators that they know or engage to help them in predicting the various stressors. Several issues were mentioned but with many, if not all of them lacking scientific background. The indicators that were frequently mentioned during focus group discussions.

If the summer or dry season is shorter, rainfall will be less; hence dry spells (FGD 001).

If the summer or dry season is longer, the rainfall to come will be destructive (FGD-002).

Delayed rains symbolise possible drought (FGD-003).

When rivers do not dry out during the dry season, there will be too much rain (FDG-004)

Hot weather means heavy rains to come (FDG-005).

As observed, all the indicators listed above do not have a scientific basis; hence their reliability are questionable. Of course, there were some instances where participants mentioned that their prediction was dependent on radios and TVs. Much as this is a very effective way, it can be challenged as the number of people owning radios and TVs is small in a rural setting like Bondo is too low. Based on the 2018 census the percentage of the households which owned radios in the

Southern Region of Malawi was 39.7 while those owned Televisions was 12.2 (Malawi Government, 2019c). With Bondo community being rural area, the ownership of the radios and TVs is even lower than the figures above.

4.5. Enhancement of the resilience of community/households

In this section, some of the options for enhancing the community resilience for a rural community are explained. Some of the ways require the use of electricity, while others do not. The opportunities and barriers towards any of the options are provided. During the community engagement, members were tasked to provide the various stressors as it is after the understanding of adversity that affect particular households or communities that one is able to consider what mediating factors to implement. These mediating factors should be able to support the communities in resilient building based on the types, frequency and severity of the adversities. The income, assets and livelihood options of the community members need not to be affected even in times of adversity. There were several factors that were mentioned during the community engagement and some of them are (1) improved farming with regular presence of agricultural extension workers; (2) planting of trees and caring for the natural trees that are already available; (3) the need for government interventions price increases of basic products of farm inputs and food items; (4) need for acquisition of radios and TVs for early warning messages; (5) the planting of vetiver grass for controlling the flow of water; (6) help from several NGOs as it is only Red Cross and Sukumbidzi Trust that come forward in times of need; (7) there is need for veterinary services in the area; and (8) need for reduced blackouts, increased electricity generation and make connections, not only to houses that have done wiring, but all.

Much as the factors mentioned are important for enhancing the resilience of the community and households, a bigger picture needs to be painted. The discussions on building the resilience of the community are extensively covered in the next chapter.

4.6. Enhancement of the resilience of Bondo Hydropower system

Bondo Mini-grid, just like any other electricity provider, is expected to be functional all the time and able to expand depending on the energy demand. During field work, the perspectives of community, employees of MEGA and other stakeholders plus observations and literature reviews were used in coming up with how to make Bondo Mini-grid in particular and mini-grids in Malawi in general resilient. The starting point was the perspectives of the Bondo community in which their different opinions were grouped as the node of enhancing the resilience of Bondo. The other node was about the contributions of community towards electrical system and suggestions of making electricity system resilient. A total of 110 suggestions were made with some as what the community should do or is doing and also what the energy provider should do or just advice to the energy provider.

The suggested ideas and their frequency of being mentioned from the community's engagement were compiled and presented as in Figure 4.2.

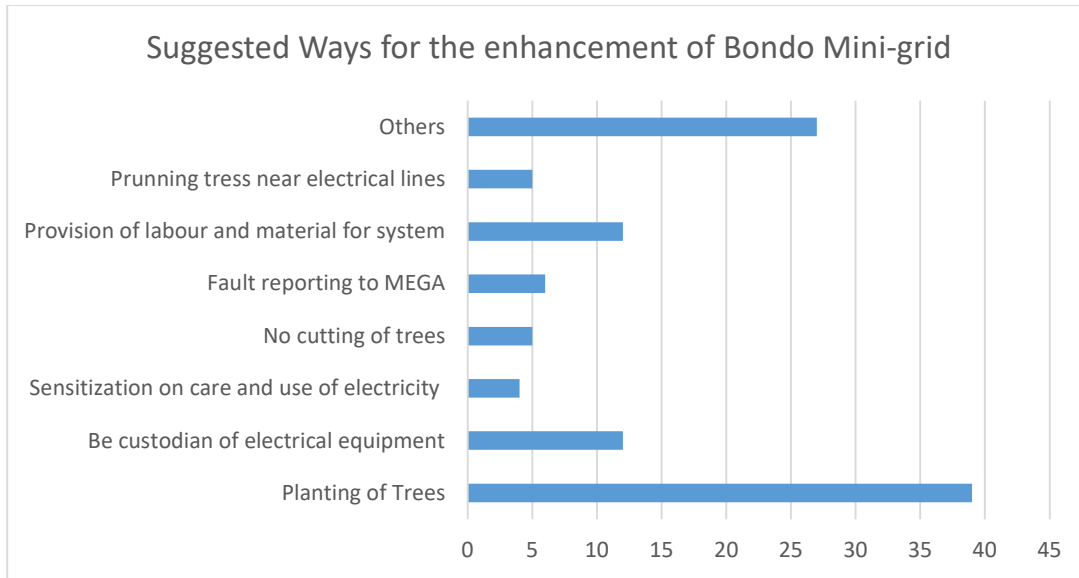


Figure 4.2. The community's suggested ways of enhancement of the resilience of Bondo Mini-grid.

The caring of the catchment area of Lichenya River through planting of trees featured so much as in the figure below. Being a hydropower system, the preservation and improvement of the catchment area of the river is indeed a good way of ensuring continued support of the electricity system. From the responses, it was shown that the whole Bondo Community was sensitised and there is so much knowledge in caring of electrical equipment of the mini-grid. There is so much knowledge on people's contribution towards the mini-grid such as prompt reporting of faults like falling poles and low hanging poles, safety and protection of transformers, the safe usage of electricity, and no cutting down of trees within the community, more especially the catchment area of the river among many others. Sensitisation, much as it was mentioned, has been done and continues to be done so that community members know what is expected of them in supporting the mini-grid. It is encouraging that there have been few reports of vandalism of electrical

equipment, if any, and that MEGA technical staff who are residing in the community become handy to respond to the faults when they arise.

Community members appreciate the electricity provided and this is evidenced in what the three villages of Mlima, Kudyere and Namainja are doing. The members of each of these villages are able to mobilise themselves in putting together some funds. The households in each of the villages were able to contribute K500.00 per month as was reported in December 2021. The money mobilised is used for paying watchmen for manning transformers at night. This is because they see the transformers being critical part of electricity delivery in their areas hence need not to be tampered with or vandalised. Such initiatives were separately reported to be done in each of the three villages. Much as some households were not contributing for one reason or the other, the commitment with the initiatives to continue in these villages. Of course, there were calls for MEGA's intervention to help on the enforcement of the initiative so that many villagers in respective villages, if not all, as others were deliberately not contributing. Such initiative is very encouraging and shows how rural poor are able to help on system resilience.

It should also be noted that the provision of labour and materials was done during the construction of Bondo 1. This time, contractors are engaged for the works on the system or labour in exchange of wages had been put in place. In summary, the mentioned strategies for the enhancement of the energy system that were mentioned by the community were compiled. Those that were mentioned three or more times include the following: (1) the provision of revolving funds for buying the appliances so there can be increased; buying of electricity units; (2) household should be switching off appliances when not in use; (3) MEGA should be able to timely respond to faults; (4) avoiding illegal connection and punishing those involved in illegal connections; (5) need for setting up of small factories for processing tea; (6) no washing of clothes and utensils on canal waters to avoid

dirtying of the water for power production; (7) children need not to play around electrical components like transformers and electrical poles; (8) prohibiting the cultivation of river banks; (9) restricting the movement in the catchment areas; (10) training of MEGA staff in all areas of electricity delivery; and (11) avoiding the disposal of trash in rivers.

The suggestions provided, whether as advice to MEGA or what is required of the community members themselves, provide true reflections of the contributions from the community on the sustainability of the hydropower system. It was reported that so many of these are put into place and that there had been huge improvements on the service delivery. Others such as the need for revolving fund and factories for processing of tea and pineapples require external support if they to be implemented.

The main contribution of the community is to take care of the equipment of MEGA and also help in conservation of the catchment area of Bondo. With support of seedlings from Sukambidzi Trust and Lujeri tea estates, more trees are planted each year and taken care of. However, there are some issues defeating the caring of trees as was observed from co-design workshop.

There are also challenges with changes of offices within the forestry department. Personnel get transferred so often. MMCT helped construct roadblock to curb the movement of trucks loaded with timber and poles, but trucks are let to pass by forestry personnel (CD-008).

As chiefs, we volunteer to protect the trees but the outdated laws of forest prevent us from enforcing or working better. We can catch a person logging tress and take him/her to the police only to have the person released within days after paying a fine, mainly in a region of K30,000 (US\$28.5 in 2021). The person may even be a danger to us and boast to have come out scot-free. We need to review forest laws (CD-009).

These were also reported by Borgstein (2017) some chiefs connive with villages and business people from other places on collection of timber and poles. It is encouraging that not much of the destruction are happening within Bondo courtesy of extensive work by MMCT, but I had witnessed open sale of timber from MMFR in other parts of the mountain.

4.7. Enhancement of the community energy resilience

During the community engagement, members of the community were asked to make suggestions as to what should be done together with the energy provider, community members themselves and the researcher, which should have positive impact to both the mini-grid and livelihoods of the community members. The ideas were the same as those listed in 4.6. Of course, there were some responses from focus group discussions.

Do not know. (FDG-006)

Tell us what you want to do in the community, and we will support you (FDG-007)

Buy a maize mill for us and run it as a business..... revolving fund (FDG-008)

Such was expected as community members have been used to be told of the intervention hatched elsewhere with their role of support. Conceiving ideas and taking active role on their implementation was new for them and it required more explanation and probing.

4.8. Management of the Load Factor and future plans of Bondo Mini-grid

The interactions with representatives of MEGA and representative of Virunga Power revealed that that the energy system was operating at 40 kW as off- peak load between 9 pm to 5 am and maximum peak of 110 kW between 5 pm to 9 pm. Blackouts that were a huge concern as during previous community engagement in November /December 2021 during SSKIs and FGDs were

no longer there after successful synchronisation of all three power plants. The demand of electricity by the community was so low such that it was mostly Bondo 3 that was in use with Bondo 1 coming in when energy demand increases during peak hours. Bondo 2 was rarely added to the system except when Bondo 1 or Bondo 3 were undergoing repairs and maintenance.

As an interim measure, the plans by MEGA with support from Virunga Power was to have the system boosted so as to have peak power increased from 220 kW to 400 kW with the incorporation of battery storage. This was mainly to accommodate maize mills so as many as possible could be operating at a time. Long term plan was to upgrade the system with the expansion of water reservoir at Bondo 2 so as to upgrade the generation system to 6.5 MW. Of the total power planned, 4 MW was to be sold to the national grid while 2.5 MW was to be dedicated for community use. Of course, there had been delays to have any of the two plans implemented and it is not known if they will be done as planned or not.

4.9. Co-design as outcome within the community energy resilience

One of the important components of the study was community engagement from the origination to the implementation of co-design. The concept was new for the community hence had to take several stages for a proper understanding. The process required community members or representatives together with researcher and representatives of MEGA to suggest ideas and then prioritise one idea that require implementation with collaboration. Representatives from the community, MEGA staff and the researcher were together required to come up with something tangible from conceptualisation to implementation. The intervention was to benefit community through increased incomes, asset build-up, improvement in health, education and environment while at the same time it should benefit the energy supplier through increased electricity sales and

general care of the whole electrical system and its catchment area. Several ideas came out from the FGDs and SSKIs as summarised in Appendix 5 and these were discussed at the three workshops so as to come up with one that required implementation.

4.9.1. Canning Factory

The compiled list of ideas generated from SSKIs and FGDs were brought for discussion to a stakeholder meeting or co-design session that took place on 6th December 2021 in the boardroom of MMCT. This meeting had representatives of Bondo community, officials from Mulanje District Council, religious leaders, researchers, MEGA employees. The objective of the meeting was to scrutinize the ideas that came from the community through SSKIs and FGDs. Participants were also at liberty to add other ideas where applicable. Emphasis was made that the suggested ideas needed to have benefits of livelihood improvement or improvement of standard of living of community members while at the same time fostering the delivery of electricity by Bondo mini-grid. The only limitation was on budget as the co-design needed to be within an equivalent of £10,000.00. Provision of clean cooking devices and establishment of factory for processing fruits dominated the discussions. At last, it was a factory of Juice making that was unanimously agreed. Participants were very enthusiastic with the idea with other members going online to search the cost of juice-making machines, where some were costing the equivalent €6,000.00.

It was also learnt at the meeting that UNDP engaged Bondo community to form a cooperative for the same idea of setting up a factory for processing fruits. A committee was put in place with land already identified. Of course, there were some disagreements and heated debate in that some members were preventing those that were in a committee supported by UNDP not to be part of the initiative under discussion. Through moderation and assurances, the meeting went smoothly and

all agreed to the idea of factory for processing of fruits more especially pineapples. The district had a factory before for the processing fruits but was disbanded and people still had it into their minds. Much as it was known that the establishment of a factory of such nature requires so much work and resources, members were not discouraged and they deliberated freely and expressing optimism over such an idea.

4.9.2. Electric cooking with hot plates

Considering that co- design is recommended to be an interactive process, another meeting was organised on 13th March 2022. This meeting had fewer representation of seven members, one representation from a local NGO, two representatives of MEGA, researcher, and three representatives from Bondo Community, with the aim of scrutinising the ideas that came from all previous engagements of SSKLL, FGDs and first workshop. The meeting also had the chance to conceive its own ideas. It was agreed to first come up with 10 priority areas, before going into discussion and choosing one idea for implementation. The ten ideas that participants agreed to be very feasible were: (1) maize mill installation as business; (2) electric cooking for boosting electricity usage and clean cooking; (3) raring of broiler chicken as business in groups or individuals; (4) sun-drying or preservation of foodstuffs using electricity; (5) fish farming using heated water from dump load; (6) bakery business for making scones, bread and other confectionaries; (7) wine making from pineapples; (8) distribution of energy server bulbs; (9) Mushroom production as business; and (10) welding and metal workshop.

Participants debated on the merits and demerits of each idea and how they were closely aligning to the main objective of providing benefits to both energy system and community or households within the community. Of the ten ideas, three ideas of electric cooking or e-cooking, mushroom

production and bakery business were the most popular. Electric cooking was chosen as the most feasible idea for implementation. It was also learnt that there was a similar project of supporting community members with e-cooking. The existing project supported 20 households with each household benefiting hotplate of one plate or element rated 1500 W, two pots and one wonder box. The wonder box is used for heat retention of cooked food. As a research work, the project involved measurement of time-series power data on entry into the house and power to the hotplate.

Considering that only 20 households benefited from the project in question, the idea of e-cooking was still supported as a way of expansion of the initiative. The participants also agreed to make some improvements over what was implemented before. As a way of improvements, members agreed that the hot plates with two elements/coil/cooking areas be procured together with two pots. It was proposed that the hot plates should be procured from African Build that supplied the previous hot plates. It was agreed that each hotplate, with 2 elements rated 1000 W each, be accompanied by 4-litre pot and 2-litre pot. The 4-litre pots and 2-litre pots were chosen to imitate the simultaneous cooking of *nsima*, the staple food in Malawi, in a bigger pot and the relish. This is because the traditional cooking involves cooking *nsima* in a bigger pot while relish is cooked in a smaller port. From the budgeted funds, it was estimated that 100 sets could be procured.

4.9.3. Electric cooking with pressure cookers

The third workshop took place on December 2, 2022 which had the three researchers, four employees of MEGA, and fourteen representatives of the Bondo Community as evidenced by the attendance list of Appendix 6. The agenda of this meeting included validation of electric cooking project and/or the conception of any other ideas worth implementation. The participants learnt more about the previous e-cooking project, including the report that the increase in power usage

with the intervention of 20 electric cookers did not exceed 5 kW per day. It was also learnt that there were plans by MEGA to distribute 100 sets of hot plates to the members of the community as the other intervention. The participants still resolved that they maintain e-cooking initiative, but with use of pressure cookers. Pressure cookers were chosen to provide variety of electric cooking and that pressure cookers provide the advantages of efficiencies and fast cooking of rice and beans among other foods. With the new arrangement, there was no need to procure pots and also agreed not to procure wonder boxes. The participants agreed that from the budget around 100 pressure cookers can be procured which would be distributed randomly to 5 households per village of the 17 villages that were involved. The remaining 15 were agreed to be distributed according to the sizes of the villages in terms of numbers of households. The meeting also recommended that more support on other modes of cooking such as baking, popcorn making, and deep frying need to be explored in future.

CHAPTER 5: DISCUSSIONS

5.1. Introduction

Electricity is a powerful tool for the enhancement of community energy resilience. However, the enhancement of the energy systems for electricity delivery in rural and vulnerable communities remain a challenge. So too is the challenge of the enhancement of resilience of rural community with electricity access. The challenges are exacerbated by various shocks and stressors mostly climate change, economic and exogenous shocks. A proper balance is required if the enhancement of the energy system is to have positive impacts on the wellbeing of the community. In this chapter, I discuss the various options that need to be considered for the enhancement of the resilience of both energy system and community in a nexus approach. The discussions of the various options for the enhancement of community energy resilience, whether directly or indirectly, are the first to be discussed within the chapter.

5.2. Major causes of vulnerability of Bondo community

There were so many so many factors that responsible for the vulnerability of Bondo Community that came out of community engagement. I feel the major causes were not mentioned or mentioned in passing and these are discussed as below

5.2.1. Shortage of land and land degradation.

One of the major sources of vulnerability of Bondo community just like in all the districts in Shire Highlands, is the scarcity of land for agricultural production. However, during the discussion, there was no mention of it, and my opinion is that the people are used to this and they are not exposed much to see the differences with other parts of the country where households have vast land. It is

understood that the increase of land-holding capacity for the rural poor has the potential of opening up economic activities and foster rural development. However, the high population density and high population growth in Malawi in general, and Mulanje in particular, continue to lead to dramatic decline of land-holding capacity per household (Chinsinga, 2008). With a small piece of land in Mulanje, which is 0.6 hectares per household (Malawi Government, 2017b), food production for the whole year with the country's household averaged 4.4 individuals (Malawi Government, 2019c) is impossible. This is before any thoughts of the possibility of the households that will need extra land for producing cash crops. The scarcity of land in the study area is providing little room for the people to produce enough for their consumption and sale.

The average land holding size is currently at 0.6 ha and this is not enough for agriculture. Such severe land pressure results in food insecurity, land related disputes and gender based violence because most land disputes affect women culturally due to the matrilineal socio-cultural practices prevalent in the district. (Malawi Government, Ibid. 27).

This proclamation provides credence as to how critical the issue of land and its scarcity and how it is affecting the people in the district. Farming activities to meet basic requirements at household level cannot be done due of low landholding capacity per household. The other source of vulnerability that is related to the land issue is the poor and overutilisation of land due to small-land holding capacity by households. There is degradation as the land has no chance to naturally regenerate and replenish by itself. Then there is population growth which is contributing to further diminishing of the amount of land a household can possess. The scarcity of land in Mulanje and Thyolo has been a long-standing issue which was failed to be solved by the pilot project of the Community Based Land Development Programme (CBRLDP) which started in 2004. CBRLDP

had clear mandate of ‘a transparent, legal and resource-supported approach to land redistribution’ (World Bank, 2009:2). The programme has already been discussed in section 2.8.4.

5.2.2. Maize as a staple food not doing well in the area

Bondo community and surrounding areas, being on the higher slopes of Mulanje Mountain, are colder than the foot of the mountain. One does not need to have a thermometer as mere touching of the water at the intake of Bondo 2 is enough. The pipes carrying water for community’s uses and the penstock carrying water from Bondo 2 intake uphill the foot of the mountain is covered with condensed water from the air. Maize, as a tropical and subtropical plant, is reportedly to be highly sensitive to low temperatures. Of course, poor soil was mentioned once during community engagement on the basis that soils and temperatures within Bondo are not conducive for the growth of maize. Bondo is in the Traditional Authority (TA) Mabuka, which has clay soils (Malawi Government, 2017b). During many of the visits made to the community and surrounding areas showed attempts by farmers to grow maize but all maize fields that were observed had stunted maize plants. The stems were small and there was no evidence of cob development. As has been stated, maize crops cannot grow well in the areas due to the clay soils, very heavy rainfall and low temperature ranges. The plant does better within the temperatures of 22-28 Degrees Celsius and it is susceptible to temperature stress below 12 degrees Celsius (Ma, Tan and Zhao, 2022). The low temperatures reduce “seed emergence and seedling establishment, leading to leaf wilting and chlorosis. Severe cold damage can result in rotten seeds, necrosed leaves and even plant death” (Ma, Tan and Zhao, Ibid:1).

5.2.3. The decline of the banana industry

The declined banana industry was not mentioned directly as one of the stressors in the district. Mulanje District was one of the districts that was producing abundant bananas in the country. The banana is a very important fruit that provided income and nutrients, hence supporting livelihoods for many people in the district. However, Banana Bunchy Top Disease, which is regarded as the most devastating virus disease of bananas, hit the industry in the country since 1997 (Mikwamba, Dessein and Kambewa, 2020). The containment of the disease required the uprooting and burning of all banana plants irrespective of whether they were affected or not. The most badly affected district was Thyolo but all the major producing districts of Mulanje, Salima, Nkhota Kota and Salima were also affected. The loss of the bananas industry has had a huge impact on the people of Mulanje District, including Bondo Community. The extracts from FGDs as below attests to this:

- *Previously we were able growing bananas but they are scarce now (FDG-009]*
- *We were forced to uproot all banana plants due to outbreak of disease, which could also break the winds (FDG-010)*
- *We were making profits out of selling bananas (FDG-011)*
- *Bananas are imported from nearby Mozambique (SSKII-001)*

Such are some of the testimonies as to how important the banana industry was. Banana was so important as it was providing farmers and others with alternatives, especially during the dry season when tea could not sprout out hence no provision of labour through harvesting. It was an important industry as several players such as transporters, vendors and the people in the nearby city of Blantyre were benefiting cash and food. So many sellers and transporters have had their livelihoods disturbed with the decline of the banana industry. Much as there are efforts to revive the industry,

like trainings and provision of disease-resistant banana suckers, not much progress is being made as most of the banana sold in the district continues to be imported from Mozambique. Community members cannot have the energy and zeal for the revival of banana farming after what they had gone through of being forced to uproot healthy together with sick banana plants. The experience of being forced to uproot all the plants that provided so much to the community and households cannot be easy. The full revival will be so difficult, more especially that the land that was previously used for banana farming had been converted to other equally important uses.

5.2.4. Economic and exogenous shocks

Malawians are heavily impacted with economic shocks of inflation, interest rates and exchange rates (Malawi Government (2018c)). The economic shocks are to do with general increases of goods with time, including the increases of farm produce and farm inputs. The economic shocks are so difficult to be comprehended by the rural communities to the extent of being mentioned by the local community as their impacts are not easy to be observed in a stable economy. It is only when these shocks are accompanied with exogenous shocks that the community would notice. Field work was done during the COVID-19 pandemic and it was surprising that there were no mention of the pandemic and the negative impact it had on the economy. With reduced travel, social distancing and working from home as measures for the containment of the disease, it is clear that there was reduced productivity all over. For Malawi's case, the pandemic had the effects as in Figure 5-1

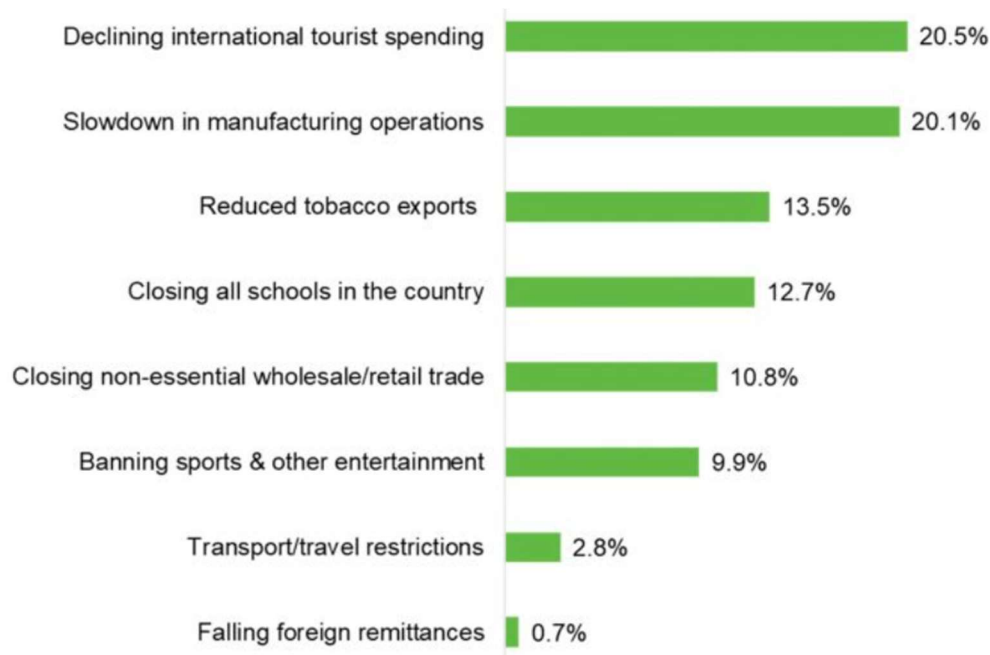


Figure 5-1. A diagram showing the impacts of COVID-19 to the various sector of Malawi's economy. (Source: Baulch, Botha and Pauw, (2020:7))

As it can be seen from the Figure 5-1, several sectors of the economy were affected that resulted in manufacturing slowing down, reduced tobacco exports, which could also have been true for tea, closing of some wholesale and retail trade and falling of forex remittances. These affected communities in Malawi, whether directly or indirectly. Before the world was to recover from the pandemic, the Russia-Ukraine war brought its own challenges that led to huge price increases on strategic commodities of grain, fertilizer and petroleum. Such back-to-back shocks of huge magnitude have brought negative impacts on the lives and livelihood options. If the impacts of Ukraine-Russian conflict are included, the prices of various products have doubled if not tripled, while the incomes of many Malawians have stagnated if not reduced. As has been stated, rural communities do not comprehend such issues hence that is why none had been mentioned during the various engagements.

Economic and exogenous shocks have huge impacts on a year basis due to the macro and micro vulnerability. There is need to build the resilience of the people and communities so that they are able to withstand, prepare and recover from the expected and unexpected economic shocks, including the exogenous shocks.

5.2.5. The Cycle of Poverty

The high levels of poverty in the area and the district as a whole are the other issues of concern. Poverty may be regarded as the outcome of stressors, but it can also be regarded as the stressor in that households cannot live decent lives because they are trapped within the poverty circle. It is a sort of ‘hanging in’ scenario with labour, land, assets and any other resource used for bare survival. Without external support and intervention, the people are expected to plunge even further into the jaws of poverty. The high poverty level in the district is therefore one of the major challenges. It is a more of a cycle of poverty trap as moving out of poverty is a tall order and that this poverty is passed on from one generation to the other. The high poverty levels have resulted in increase in the number of households within the “hanging in” while those “stepping out” or “stepping up” are very few and reducing.

5.3. Opportunities and barriers for enhancing the resilience of Bondo Community

The various options for resilience building of community resilience are explain in details. The reasons why some of these have limitations for implementation within the community have been explained in the sub-sections that follow.

5.3.1. Opportunities/barriers in animal farming in Bondo

Animal farming is one important activity for bringing income, food and prestige to local communities. But Bondo community does not have cattle, goat and sheep, with the exception of pigs which were sighted only on one occasion. Livestock are important assets that can be sold out to cushion the impacts of both man-made and natural stressors. A person who owns livestock may also opt to sell some for support during lean times apart from payment of school fees for the children and even to raise capital for business. The lack of livestock in Bondo community reduces one important option for resilience building at both household and community level. Bondo is on the foot of the mountain with undulating terrain, low land holding capacity and many areas covered with shrubs of tea and pineapple plants. Such is making it difficult to get involved in livestock and that even the thinking of supporting community with animal farming is seen not feasible. The area has no land for grazing. Piggery and poultry are the options in the area as these do not need grazing land, but surprisingly they are rare too. As the people of the area are predominantly Christians and of Lomwes tribe, the majority eat pork and its products hence providing enough incentives for piggery. Poultry farming should also be encouraged even at subsistence scale as these have been observed to provide the needed cushioning during times of needs. Travelling on main M1 road in the Central Region, one comes across several points where people mostly boys are selling chickens. Such may be seen to be not an important aspect, but very helpful as relish and cushioning rural families in lean times.

5.3.2. Opportunities/barriers with bee-keeping

While going uphill towards Bondo 2, I saw six beehives in a forest of blue gum trees. Asking my guide on beekeeping in the area, my guide got surprised as he had not taken note of beekeeping in

the area let alone seen beehives. He saw the beehives for the first time hence could not provide explanation on their existence. In other words, there is no beekeeping in the area; hence no honey for food and for sale. The only plausible reason is that most of the land is covered with tea shrubs and pineapple plants, which do not provide flowers and nectar for collection by the bees. Upland, there are mostly trees which do not flower. Much as it is mentioned that MMCT supports communities with beekeeping, this should be done on the other parts within Mulanje and not in Bondo. I was therefore not surprised to see all the beehives removed in my subsequent visits as the venture may not have produced intended results. The enquiry on why all the beehives was removed provided no answer, except the plausible reasons that bees are rare in the area or not were attracted. The other reason for lack of beekeeping in the area is the humid condition and cool temperatures induced by the mountain. Bees can hardly thrive in humid conditions and the cool weather (Total Transformation Agribusiness (PTY) LTD, 2012) as is the case with the area. This means beekeeping is not a feasible livelihood option in the area as the weather conditions influenced by the mountain not good enough.

5.3.3. Opportunities/barriers in fish farming

Much as the area has so much water from the mountain, there is no single activity on fish farming. There is a reservoir, uphill of Lichenya River as an intake of Bondo 2 from which one would expect to see some fish, but none was observed during any of my visits. I was told that it is rare to see fish in the reservoir except one type which is seen jumping from the water and diving back. According to my guide, such type of fish is very strange and rare hence people do not have interest in it. The water of Lichenya River from the mountain is so cold for fish farming of common species found in Malawi. As has already been explained close to the mountain provides some cold weather which is evidenced with pipes carrying the water from intake at Bondo 2 to accumulate water

drops outside as condensate from the air. Other evidence of the coldness of the water includes extracts from the literature and community engagement as below.

snow is common on Nyika Plateau in the northern region and on Mulanje Mountain (Britannica, 2022).

Fish farming using heated water from dump load (minutes from the second (CD-0010)

The importation of fingerlings that can survive in such cold water can be the option. However, the terrain is also a challenge. The area is full of troughs and ridges with houses on ridges, slopes covered with tea and pineapple plantations and the streams and rivers on troughs. Such terrain provides limited flatland for excavation of fish ponds. Thirdly, the heavy rains at the mountain make water from the mountain flow with high speed during the rainy season making the excavation of ponds close to the river bank not a good option. The fishponds would easily be flooded or destroyed by the heavy flowing water.

5.3.4. Employment in tea estates and other sectors

It is a concern that the employment opportunities in tea estates have reduced. Previously, community members could find employment for spraying pesticides, application of fertilizers and plucking tea leaves. However, only plucking of tea leaves remains and this is done at the same time when community members also need to pluck own tea. During this time, farmers have money from the sale of their plucked tea sold to tea companies that processes it. The spraying of pesticides and application of fertiliser are currently subcontracted to a company which does the activities with use of a small plane. This has reduced employment opportunities further apart from the income generating activity for many during lean periods when tea is not harvested and sold. There was also Mulanje Canning Factory that was owned by government through Agricultural

Development and Marketing Corporation (ADMARC). The company was taking advantage in value addition of fruits within the districts for making beans in tomato sauce, tomato puree, mixed fruit jam, strawberry jam, pineapple juice, pineapple chunks, whole fruit salad, and spring water (Palichina, 2022 & Mchulu, 2022). It is reported that the company died during the structural adjustment programmes that were championed by IMF in the 1990s. Therefore, employment opportunities within the area have reduced.

5.3.5. Opportunities/barriers for irrigation farming

One of the options in increasing productivity with use of electricity in rural areas is powering irrigation. Irrigation has the advantage of facilitating harvesting of crops many times within the year and being less dependent on rains that are erratic in nature. Irrigation provides added benefits of using electricity during peak hours, hence reducing wastage and optimizing the utilisation of the energy system. The tea in estates is irrigated as estates have their tea on flatland, while tea grown by smallholder farmers is grown on the foot of the mountain, which is undulating as in Figure 1-2. The nature of land on the slopes is undulating with steep slopes in areas where water is flowing. This makes irrigation a challenge. Also, the plants that can grow well with irrigation considering the climate and soil type of the area are limited. Irrigation is therefore not the best option for increasing productivity and that with dense population of the area, the land that requires to be irrigated is very much limited.

Based on the climate and soils of the area, very limited crops including tea, pineapples, bananas, avocado pears can do better. There is very little room for diversification or introduction of other crops. The intensification of agriculture through irrigation and value addition of agricultural products has very minimal chance with the conditions of the area. Tea plantations, pineapple

plants, hilly conditions and the thick forest of the area mean not much grassland for grazing hence animal farming is also a challenge. Of course, there was one case of an irrigation scheme within the community, but this is too small for impact with no cash crops except some vegetables grown. The small landholding capacity of the households provides even more challenges for diversification and increased agricultural activities.

5.4. Climate change and its impact on Bondo Community

On climate change, there are issues to do with changes in rainfall pattern, and a gradual temperature increase but community members had no knowledge of impacts and how to deal with such. The interaction with community members attested to this with no mention of short term and long-term temperature changes and erratic rainfall patterns. Of course, Nangoma and Nangoma (2008) reported that the measurement of temperature at Mimosa Tea Research Foundation recorded the average maximum temperatures of 28.5 Degrees Celsius between 1963 and 1986, while those between 1986 and 2006, had 30.0 Degrees Celsius. This means that temperatures have been on the increase. Kachaje, Kasulo and Chavula (2016) reported that the area under study had averaged temperature increase of 0.04 Degrees Celsius per year. With or without their knowledge on temperature changes, community members are required to be provided with support to circumvent the impacts of such impacts of climate change.

Bondo Community is on the windward area of the mountain; hence it receives heavy rainfall. This huge amount of rainfall is an advantage to the area as it provides a conducive environment for the growth of tea and pineapples. It is also an advantage on the supply of water for the Lichenya River, among major rivers, from which electricity is generated. The challenge of high rainfall, the clay type of soils in the area and the cold air from the mountain is on the growth of maize.

The observations made in the area during my study has not shown any effects of heavy winds such as houses and schools having blown off roofs and falling trees. Of course, it cannot be totally disputed that the area does or does not experience heavy winds, however, the observations and the community engagement had not shown the impact, small or huge, that there had been some effect of heavy winds to the lives and livelihoods of the communities. As reported by (Taulo, Mkandawire and Gondwe, 2008), Mulanje District experiences wind speed as low as 1.2 m/s which is providing further evidence that the mention of heavy winds as one of the stressors in the area may just be a fallacy. Even if the winds could be strong, the huge presence of several trees such as those of avocado pears in many households, blue gum (*Eucalyptus globulus*) by the tea estates for use in curing tea, and the shrubs of tea and pineapples offer the needed protection.

The cultivation of tea by estates is done on huge stretches of flatland while the cultivation of tea by smallholder farmers is done on the undulating part of the areas that are mostly closer to the mountain. Dwelling houses are built on higher ground with shrubs of tea and pineapples around. With such conditions, coupled with clay type of soil, the flooding due to heavy rains and overflow of the rivers and streams has very little impact on the livelihood of the people. With the discussions of the different stressors mentioned during community engagement, there is need to consider other stressors that were mentioned once or two time, or mentioned indirectly or not mentioned at all. These may have critical effect to the resilience of livelihoods of the people. These have also been noted through literature review, interactions with different stakeholders and observations. The coverage of such stressors is explained in other sections.

5.5. Enhancement of the resilience of Bondo Mini-grid as an energy system

The interaction with employees of MEGA, community engagement, literature review and observations provided the themes under which community's suggestions should be grouped. It should be remembered that the review of literature as discussed in section 2.3.2 provide four major dimensions of enhancement of resilience of engineering system as robustness, redundancy, resourcefulness and rapidity. The enhancement of engineering resilience is reported to have the ultimate goal of the reduction of failure, reduction of consequences of failure as well as the reduction of time of recovery from failure. Still within the resilience engineering, systems are also required to meet surge demands, exploit opportunities and successfully counter disruptions. This section discusses several options of enhancement of resilience on engineering systems such as the need for readily available competent personnel, especially at different nodes or critical areas of the system, the need for active participation of different stakeholders, the readily availability of financing, high-level political championing, and that the systems should be designed with adequate safety margins. Lastly, the resilience of engineering systems is required to be treated as situational based and for a particular system and with regard of particular disruptions, and in this case the discussions are mostly applied to Bondo Mini-grid.

As has been observed, there are several dimensions of resilience engineering. All the dimensions are so important to the resilience of engineering systems, including mini-grids. To bring most of them to reality, a proper repackaging is being proposed. In this report, the dimensions can be better considered within the context of financial and technical resourcefulness, regulation, institutional frameworks, capacity building and cross-linkages, and load profile and power demand management. The linkages are helpful and in support of all the discussed dimensions of resilience of mini-grid as in the sub-sections that follow.

5.5.1. Financial and technical resourcefulness

The major challenges on maintaining functionalities of mini-grids dwell on the availability of finances and competent technical expertise. With these, mini-grids should be able to have reduced failure, reduced consequences of failure, reduced time for recovery from failure, be able to possess 4Rs of rapidity, redundancies, robustness, resourcefulness. Bondo Mini-grid, just like the other two mini-grids of Chipopoma and Sitolo PV, came into existence due to donor, community, and private funding. For operation and the maintenance, community's contribution, electricity sales and donor funding come into play where available. Government support is missing, except where UNDP has channelled its money through the Ministry of Energy. With low sales of electricity due to issues of unaffordability of electricity and electrical appliances, unwillingness to pay for electricity, lack of PUE activities and the unpredictable donor and private funding, mini-grids are operating on a very difficult terrain. These affect the technical support to the system as spares or replacements cannot be done in time and qualified personnel cannot be attracted let alone retained.

It is reported that Bondo was able to realise an average monthly income of MWK3, 000, 000 (US\$ 2,951) in 2022 from electricity sales. This is not enough for all its operations and major repairs. The amount is even not enough for salaries of staff members who consists an establishment of three managers, one senior technician, eight electricians, eight linesmen, and eight watchmen among others. It should be noted that the system is able to have as many positions filled within its establishment because MEGA's mother body of Mulanje Mountain Conservation Trust (MMCT) make contributions to remuneration packages of the employees in one way or the other.

Bondo was using the approved tariff of K78 (US\$0.076) for domestic customers, which is lower than the average national approved tariff in use by the grid of K104 (US\$0.10) as of December

2022. Without the internal information of the cost reflective tariff of electricity of the system, adjusted levelised cost of electricity (LCOE) can provide a proper estimate. This is because LCOE is also regarded as “a minimum cost at which electricity must be sold in order to achieve break-even over a life time of the project” (Lai and McCulloch, 2017:3). With differing LCOE from as low as 0.02 to 0.27 US\$/kWh for small hydropower (International Renewable Energy Agency (IRENA), 2012), the tariff of not less than 0.15 US\$/kWh can be a proper estimate for a cost-reflective tariff of Bondo Mini-grid. The tariff by MEGA is therefore on the lower side to make economic sense.

The employees of MEGA are involved in the activities of MMCT hence some remuneration comes from there. Such an arrangement is working well with employees, but not on operations and maintenance where some spares need to be procured and specialised expertise is needed. It is of little wonder that the system is able to attract qualified personnel but fail to timely deal with technical challenges, including failing to clear the backlog of households who had paid connection fees and had already done wiring. Through observations and interactions within the community, there were also issues such as replacement of damaged poles, repairs of a leaky canal that required urgent attention could not be done in time. Synchronisation of all the three power plants for increased power delayed due to issue of lack of financing. Bondo had also been failing to go into contract with companies of mobile phones for simplification of the procurement of electricity units. It is reported that in April 2021, mobile companies were charging an equivalent of US\$35, 000 for the platform that was to be developed for use of MEGA for community members to be able to buy electricity units using phones. The financial requirement as too much considering the electricity sales in a month and also against other pressing issues expansion and operations.

Financing of mini-grids, both as capital cost and operating cost, is the biggest challenge not only in Malawi but all over. The dependence on donor, community contributions and private funding is not enough in ensuring that the existing mini-grids operate smoothly. Public financing is so much missing for supporting mini-grids in Malawi. Several cases studies have been discussed in section 2.4.2, which show that the many progresses made on proliferation of mini-grids in other countries had not only been through government funding, but active involvement of many players such as regulation and lending institutions. Derisking of the rural electrification projects and championing of the electricity access at a very higher level are some of the other ways. The case studies of Indonesia, Tanzania, Vietnam, Ghana, Senegal provide some of the ways how government support can come into play. These have been extensively discussed in the section 2.6.2. Relaxed regulation, the availability of public finance through Rural Electrification Fund (REF) and dedicated credit finance to developers in Malawi can push the total generation capacity of mini-grids to greater levels and help to alleviate the financial issues faced by mini-grid operators.

Technical challenges are mostly closely linked to financial challenges. Hydropower as a very mature technology and is understood by many qualified personnel. Many of the technical issues can also be solved by using standardised equipment and expertise. In addition, attracting qualified and well-experienced personnel can be achieved through competitive remuneration and excellent working environment, which can be achieved with enough financial availability. Such challenges would have been solved partly financing especially public financing (such as grants, subsidies and matching grants) apart from donor funding, private and dedicated credit facilities.

5.5.2. Regulation and Registration Challenges

There is need for a simplified regulatory framework for mini-grids in the country. The arrangement of the permit approval by ESCOM then licensed by the energy regulator. After this the developer has to obtain clearance from the Environmental Department. For hydropower, the developer has to even go further by obtaining water rights. This requires time and resources, and delays in the approval process are very common. Licensing and environmental clearance of mini-grids need to be accelerated through a one stop shop within the Ministry of Energy or Rural Electrification Agency.

For example, for the upgrade of Bondo Mini-grid from 220 kW to 6.5 MW with financial support from Virunga Power, an application was made to the defunct Power Market Limited. The plan was to take advantage of water storage by upgrading the existing reservoir at the intake of Bondo 2. The paperwork was submitted to Power Market Limited (PML) in early 2021 with approvals made in April 2022 after over 10 months. Similar delays were experienced with the proposed 300 kW Usingini Hydropower Power Plant in 2028 and this led to the abandonment of the power plant after Practical Action, the facilitator, pulled out of its operations in Malawi. Such delays do not provide a good regulatory environment for mini-grid establishment in the country. The examples provided give evidence of the delays in obtaining common permits of mini-grid in Malawi as in Figure 2.13.

From the figure, it is clear that the regulatory environment in the country does not fare so well if compared with other countries. It was observed that it takes 360 days to obtain a permit in Malawi, while in countries like Ethiopia, it only takes 10 days for the same. The country performed even worse on cost of obtaining permits as in the Figure 2.12. The delays plus fees paid to various

regulators are costly no wonder it was established that the cost of obtaining permits to set up a mini-grid facility in Malawi is the highest of all countries surveyed in the RISE report, with a quoted figure of \$15,082 as in Figure 2-12. Other countries such as Guinea and Senegal charge close to zero for developers to obtain similar permits. The other regulatory challenge is on tariff adjustment. Bondo applies to MERA for tariff adjustment and the process takes long and, in some cases, what had been applied is adjusted downwards. Such has effects the smooth operations of power plants. The regulatory environment for mini-grids is not conducive as mini-grids are viewed in the same way as the main electricity grid (Caprile and Matinga, 2018).

The regulatory environment in Malawi is also collaborated with the findings contained in a report by DFID on the best mix of enabling environment. The score for Malawi was the lowest at 59% against Kenya's 84%, Tanzania's 81%, Rwanda's 69% and Uganda's 63% (DFID, no date). The areas that were part of the rating included inadequate regulation, policy gaps or uncertainty. In the report it is explained that scoring low means frequently unclear policy commitment to mini-grids, as well as possible changes in electrification plans, regulatory requirements or incentives, and uncertain actual delivery of incentives promised. The inability to charge cost-reflective tariffs, the uncertainty over what should happen when the grid encroaches the mini-grid perimeter were some of the issues for scoring low. It is important that the regulatory environment for mini-grids should be given urgently review if the sector is to thrive.

5.5.3. Institutionalisation of Rural Electrification Agency (REA)

Malawi supports rural electrification through the Rural Electrification Fund (REF), a levy collected from sale of all forms of energy services and products in the country. Rural Electrification Management Committee (REMAC) consisting of senior civil servants who are accountable to the

responsible minister is mandated to develop rural electrification plans and implementation of rural electrification activities (Caprile and Matinga, 2018). However, mini-grid technologies are not the recognised option within the rural electrification plans and activities and they hardly access finances from the funding (Caprile and Matinga, Ibid). Being managed within the civil service, the REF has also been hindered by transparency and accountability issues and many cases of corruption and diversion of funds (Chitete, 2021). Such an arrangement has made mini-grids in the peripherals as the grid extension is preferred and to a lesser extent, standalone solar systems benefit from REF. The hope was on the institutionalization of Rural Electrification Agency (REA), which was planned to be done between 2019 and 2020 as per National Energy Policy of 2018-2023. The institutionalisation of REA recognises the challenges with MAREP hence the policy made the following recommendations (Malawi Government, 2018:56-57).

“To improve the management governance for Rural Electrification and Renewable Energy.....Establishing a Rural Electrification Agency as a semi-autonomous legal entity to manage the Rural Electrification Fund and Rural Electrification activities (in both grid extension and off-grid options) 2018-2020”

The realisation for the need for the institutionalisation of a Rural Electrification Agency (REA) can go a long way in enhancement of the management of REF. The policy had a timeline that REA had to be institutionalised by 2020. But this had not been done as of January 2025 Apart from the enhancement of transparency and accountability of a REF, the arrangement has the potential of attracting external funding from donors, and the private sector among others. Such an approach can increase the coverage of rural electrification and increase installed capacity. Neighbouring countries and others such as Kenya, Tanzania, Zimbabwe, and Zambia, Senegal and Mali have had REA institutionalised long time ago as it has been indicated in 2.6.2.

The other consideration is on amendments of the Electricity Act 2004 and Energy Act of 2004. Calls had been made to have these documents amended (MERA 2019; UNDP, 2016), but there seems to be no movement in the right direction. Delays and failure are hindering the mini-grid developments as they are mostly treated the same way as large and grid-connected systems.

5.5.4. Promotion of Productive Use of Electricity (PUE)

The rural electrified households lack demand for electricity, and have an inability to pay or unwillingness to pay for the electricity and electrical appliances, which affects the financial sustainability of electrification projects (IEA et al., 2020). One of the ways of solving such challenges is to promote rural electrification access programmes alongside productive use of electricity (PUE). The stimulation of electricity demand by the rural communities has twin advantages of increasing income for the utility through increased electricity sales and community/households having increased income, welfare and productivity that come with increased electricity usage. The reported electricity usage of as low as 40 kW during off-peak hours and 110 kW during peak hours out of the 220 kW installed capacity is definitely on the lower side for over 1600 households, some businesses and the social sector. The developer is not realising much in terms of electricity sales and there are no tangible usage for the community to benefit more from electricity availability. This is expected if electricity programmes are implemented for the sake of electrification and not community transformation or without productive use of electricity.

There are challenges as the implementation of PUE programmes is not easy since it requires resources and commitment that include raising awareness, increasing the availability of electricity, providing affordable and energy-efficient appliances, providing financial support, and offering

extension services. These have to be available for incubation of various enterprises and/or supporting modern farming and processing which have the potential of stimulating the local demand of electricity. Several case studies which have elements and the ways of promoting productive use of electricity have been extensively discussed under section 2.6.1.

5.5.5. Load Profile and power demand management

Load Profile and power demand management are important parameters on mini-grid management. Mini-grids are required to meet the demand of power at all times and that the energy system should be aimed at having high load factor and higher ARPU. ARPU is the factor of consumption of electricity and the tariff charged, with higher ARPU achieved with increased power consumption through anchor load and adoption of productive use of electricity (Energy Environment Partnership, 2018). Bondo mini-grid had 8 maize mills connected to it by December 2022, with only 3 of them allowed to operate on a particular day. This is because maize mills require huge power mostly during starting hence there is need for their power management based on the power available. As has already been explained the three generation systems of Bondo are synchronised hence the total installed capacity is 220 kW. However, it is mostly one machine, Bondo 3, which is in operation with Bondo 2 engaged only during peak hours. The reported off-peak generation of 40 kW (18 percent load factor) and peak generation of 110 kW (50 percent load factor) of the 220 kW means very low load factor.

Considering so much generated power against power demanded, MEGA implemented briquette making with use of excess electricity. A briquette machine for making fuel blocks as briquettes from plant residues for use in household cooking is as in figure 1.15 at Bondo 3. The machine was to take advantage of off-peak demand of electricity in making briquette for household cooking.

Much as the machine did not work as was planned, the effort in raising ARPU is appreciated. One way of increasing ARPU for Bondo is to consider activities that will be able to utilise much of the excess electricity during off-peak hours. The other way is to consider implementation of usage of electricity in all times so that the average load factor should increase to higher values. It is encouraging that MEGA has entered into an agreement with Bitcoin through which Bitcoin has installed machines that utilise excess electricity all the time at a fee. The machines have been programmed to only use excess upon satisfying the demand of community needs. Much as this is appreciated for increased income to the developer, stimulating the demand by the community is missing.

There are plans to upgrade the system so that the installed generation capacity of the system should be 6.5 MW and with 2.5 MW dedicated for community use. If the low load factors are to continue to be low at both peak and off-peak hours, there will be no benefits to be realised with power that will be dedicated for community use. There is need to consider ways of increasing electricity usage through programme of PUE and some form of anchor load such as Bitcoin arrangement, including the establishment of light industrial zone within the community. The increased power should be of benefit to the transformation and resilience of the community served.

5.5.6. Capacity Building and Cross-Sector Linkages

The setting up and operations of mini-grids require adequate technical, planning and operational capacities. Mini-grids are often located in rural areas that have difficulties in attracting the required managerial and technical staff. Bondo Mini-grid is around 16 km from the district headquarters and all its managerial and technical staff are based at the headquarters, the arrangement that is costly and difficult to respond to issues in a timely manner. Of course one key technical personnel

is based within the Bondo Community, but this cannot be guaranteed in future as someone may opt to also stay at the district headquarters. Poor mobile phone network also hampers communication in the area . The purchase of electricity units by customers is a challenge as payments are made at Bondo 3 with tokens generated to MEGA office at the district headquarters. Of course, there are plans to have customers buyin electricity using their phones, but this has not started as of January 2025. There is need to have improved recruitment and retention of the right personnel and capacity building of the personnel that are already available. Phone network, passable roads even in rainy seasons, the availablity of market, the access to credits and electrical appliances are required within the locality as they have a bearing in supporting the local community and the energy system, whether direct or indirectly. These require financial commitment, whether from private, donor or public funding. It should be noted that all the challenges explained are better categorised within cross-sector linkages and not within financial resources.

5.6. Enhancing community energy resilience of Bondo

Bondo Community faces so many challenges that limit the enhancement of the resilience of the household or community as it has been extensively discussed under section 5.7. Some of the major challenges are scarcity of land for possible irrigation; challenges on implementation of irrigation, challenges with beekeeping and fish farming, little progress to resuscitate the once-vibrant banana industry, high poverty levels, high population density and growth, and high illiteracy levels. These in return affect the resilience of Bondo Mini-grid. Nevertheless, there is still need to consider various ways of enhancing the resilience of the community and min-grid within the limitations of the challenges. Through stakeholder and community engagement, and literature review, several options were conceived with the major ones discussed in sub-sections that follow.

5.6.1. Framework for enhancement of CER at Bondo with canning factory

The idea of the canning factory fulfils all the requirements for the enhancement of community energy resilience. The establishment of a factory that should absorb the abundant fruits, especially pineapples found in the area, has all the parameters of the KeyMaker Model, increasing the ARPU and load factor, and responding to the PUE activities. It is also interesting that UNDP, as was reported at the first stakeholder's meeting on 6th December 2012¹, was supporting the community in the establishment of the factory. The participants had the reference of the previous company which helped the farmers in providing a ready market for their produce, especially the pineapples, that are abundant in the district. The factory has huge potential towards the enhancement of resilience of the energy system while at the same time contributing to the enhancement of the resilience of the community.

What will it take to have the idea or the vision of the community realised? Such a question is important and the answer lies on partners or MEGA driving or supporting the implementation, as the community on its own cannot manage. Once the factory is in place, the benefits are so many within the enhancement of community energy resilience. I have suggested a framework for how the community energy resilience of Bondo Community can be enhanced with a canning factory as suggested in Figure 5-2. The participants were mostly relating it to the previous canning factory that was operational within the district. In the framework, various linkages that need to be there if community energy resilience of Bondo is to be enhanced are provided. The role of each stakeholder and the expected outcomes related to the framework have been provided.

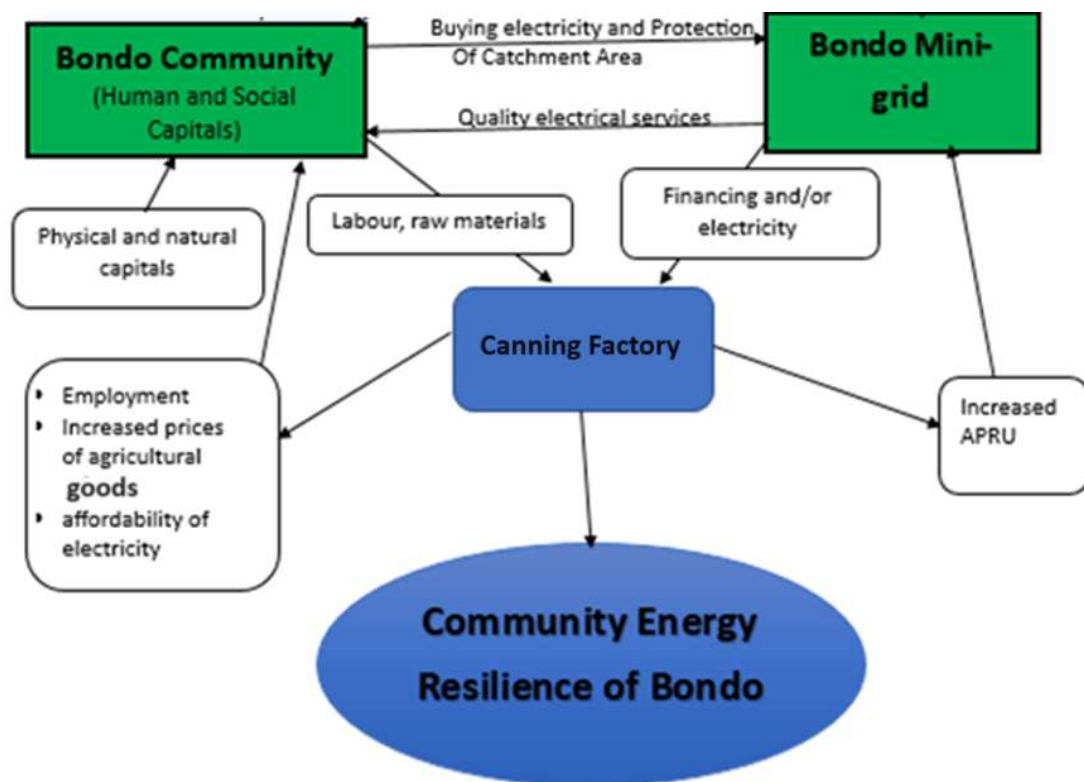


Figure 5-2. A diagram of the suggested Framework for the enhancement of Community Energy Resilience at Bondo Community.

The establishment of a caning factory was conceived or proposed by the community representatives themselves. If the company can be established, the benefits realised by the community include better prices of pineapples, direct and indirect employment, and affordability of electricity and the appliances through increased circulation of money in the community. The factory will also be beneficial to other communities within the district, including farmers and business people from as far as Chinakanaka, at an approximated distance of 30 km from Bondo, where tomatoes are produced and sold in abundance. The increased usage of electricity is expected to provide better standards of living and increased income with some businesses established along the way.

There will be more electricity consumed for production and storage of finished products, which will result into increased income for the developer. The operations of the would-be factory may take advantage of the off-peak hours hence helping on power demand management. However, the establishment of the factory is not a simple thing as it requires several parameters including a market survey on quality and quantity of raw materials available, associated costs and activities such as transportation of raw materials and finished products. Cold chain, wholesale and retailing options of finished products, potential demand of finished products and all other logistical challenges will need to be established. Such activities require huge resources and commitment if the idea is to come to reality. Of course, it is indeed worth pursuing the idea so as to make Bondo Community and Bondo Mini-grid have their resiliencies enhanced.

5.6.2. Upgrading of the Bondo

An important theme that came out from the meeting between representative of Virunga Power, two representatives of MEGA and the researcher is on the plans for the system to be upgraded to 400 kW maximum as a temporary measure and then to 6.5 MW as permanent solution. The upgrade to 400 kW maximum was planned with the incorporation of the battery storage. Such plan has the benefit of increasing the available power and stabilisation of power needed during peak hours. During the dry season when water levels reduce leading to reduced generation will mean power generated during off-peak hours mostly at night when demand is low will be stored in batteries for use during peak hours mostly during the day. This means the issue of demand exceeding supply in the dry season will be solved.

However, this is an expensive venture and no wonder that it has not been implemented as it was planned to be done by mid-2022. The arrangement required huge investment including two AC-

to-DC converter, battery bank and DC-to-AC converter. This is because the generated power in AC was expected to be converted to DC for storage in the battery. Battery can only store DC power. Power from the battery was expected to be converted back to alternating current for transmission and distribution to various loads as businesses, households and social sectors. The cost towards the plan was not solving the purpose especially after synchronisation of the generating systems. In my opinion, power demanded during peak hours in the dry season against generation does not guarantee such investment.

The plans for upgrading the system to 6.5 MW with support from Virunga Power is so much welcome. The planned system will take advantage of water storage; hence issues of reduced generation during the dry season will no longer be there. With 2.5 MW dedicated for community's use means so much power for all existing and future needs by the community. Maize mills will no longer be operational on rotational basis. Even the canning factory that is planned will have enough power with such plans. The remaining 4 MW for sale to the grid will provide the financial viability of the system. However, there is need for the community to benefit from electricity sales to the grid in the forms of projects and programmes. With increased population, hence less land for agricultural expansion, the community requires so much support on diversification from agriculture. The upgrading of the system offers some opportunities, but it will depend on agreements made before implementation. Government should provide the necessary enabling environment so that the project can kickstart as with storage the effect with power injected to the grid is advantageous unlike all other IPPs of solar PV and hydropower which bring instability to the grid. The money realised from the sale of electricity to the national grid may also be helpful in financing projects and programmes within the community.

5.6.3. Framework with the establishment of REA

From the literature review on political-economy of energy in the country, one theme that is of huge importance to the enhancement of mini-grids as community energy systems is the speeding up the institutionalisation of Rural Electrification Agency (REA). Malawi planned to have an autonomous body, REA, for driving rural electrification by 2020. However, the REA had not been instituted by May 2024. The institutionalisation of REA in Malawi had been long overdue considering that it is the best practice on management of REF. All neighbouring countries have had their REA instituted long time ago. For example, Zambia had its Rural Electrification Authority created in 2003 (Rural Electrification Authority (REA), 2023), Tanzania had its Rural Electrification Agency operationalised in 2007 (Rural Electrification Agency, 2023), while Zimbabwe had its Rural Electrification Fund established as a statutory corporation governed by the Rural Electrification Fund Act (Chapter 13:20) in 2002 (Rural Electrification Fund, 2023).

The current arrangement of REF as levy from energy sales channelled to Malawi Rural Electrification Programme (MAREP), an arm within the Ministry of Energy has huge flaws. Abuse and corruption, as evidenced by the media reports. No donor or private funder can have confidence in the current arrangement. The need for institutionalisation of REA is well spelt out in the country's energy policy with its deadline overdue. The suggested framework as in the Figure exemplifies the current arrangement of support towards rural electrification against what will happen with REA instituted. The framework indicates two paths of how REF is being managed under current arrangement and how the funds would be managed when REA is instituted.

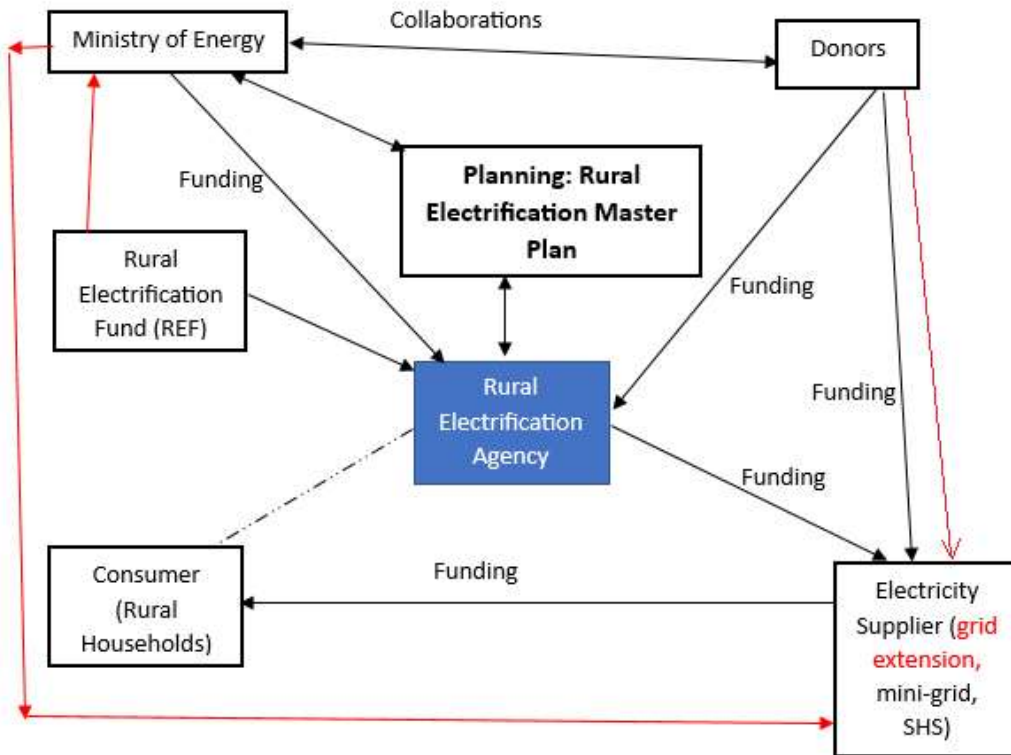


Figure 5.3. A diagram showing the flow of support to mini-grid with institutionalisation REA and without REA

As of May 2024, support towards rural electrification is as represented by the red line in the above figure. The funds from REF goes to the Ministry of Energy, which through REMAC decides the activities of rural electrification. Such funding goes directly to energy suppliers for procurement of equipment and to ESCOM for grid extension to the trading centres that had been approved by REMAC. The grid is extended to trading centres in phases, such as MAREP I, MAREP II, MAREP III up to MAREP 9 in 2024. For example, MAREP XI was planned to electrify 416 trading centres by 2024. It is because of this reason that Eales and Unyolo (2018) reported that MAREP is devoted to grid extension with very little and, mostly, ad hoc support to mini-grids and SHS. The lack of support of REF towards mini-grids is echoed by Alfredo Caprile and Matinga (2015) who reported that mini-grids are not recognized option within the rural electrification framework; hence they do

not receive funding from MAREP. Such makes mini-grids not to flourish as they do not access the much-needed public financing for development and operation.

The proposed framework is showing the routes and benefits if the management of REF is to be channelled into REA. With REA as an autonomous institution reporting to the Ministry of Energy there will be so many benefits. There will be accountability and transparency on usage of funds thereby bringing confidence for financiers to make contributions to the projects of the institution may engage in. The confidence on the usage of has the potential for REA to have three sources of funding as REF, donors and central government through ministry of energy. REA will drive a master plan so as to know which area requires grid, mini-grid or standalone solar system. REA in turn will provide the enabling environment including technical and financial support to the energy suppliers.

Of course, there will still be need for collaborations and flexible arrangements among the Ministry of Energy, regulator, donors and REA itself if proper working arrangement is to be achieved. Rural households as consumers will benefit with direct support and reduced electricity tariffs. The institutionalisation of REA should be done within the shortest possible time considering that the deadline as per the energy policy is well overdue.

5.6.4. The mini-grid customers not subsidised vs grid customers subsidised

Malawi has lifeline tariff so that many people, including the poor, are able to afford some fixed number of units at a highly subsidised rate. A lifeline as ably defined by (Hako, 2024) as ‘a highly specialised subsidised electricity tariff intended to provide relief to low income customers with limited means’. The government of Malawi through Electricity Supply Corporation of Malawi (ESCOM), provides this lifeline tariff to all its customers. All domestic customers in the country

pay lifeline tariffs for the first 50 kWh. This means both the rich and the poor are benefitting from such arrangement with government providing the subsidies. The domestic customers of mini-grids, who are probably the poorest, are not supported; hence they do not have own lifeline tariffs within the establishments of mini-grids.

The subsidy that the government provide to the domestic customers that are connected to the national grid should be extended to the customers of that are serviced by mini-grids as they are also Bonafide citizens. There is need to support mini-grids' customers so that they are able to access fixed electricity units at a highly subsidised tariff. Such can be helpful in incentivised the customers to upgrade their usage of electricity mostly from tier 1-2 towards tier 3-4 with reduced tariffs. Subsidised tariffs can also go a long way in supporting productive use of electricity and adoption of electric cooking in the area.

5.6.5. The “dumping” of electricity access in rural areas

The study reveals that the provision of electricity access in the rural areas is without complimentary services and products. The overall aim of rural electrification is expanding access rate rather than supporting economic growth. The observations and community engagement has revealed that the provision of electricity to the rural community by grid and mini-grid is taken as a solution on its own. There are no tangible complimentary services and products in rural growth centres where grid is extended and the rural areas that are serviced mini-grids such as Chipopoma Sitolo and Bondo. There are no tangible projects related to economic uplifting of the people implemented at Bondo, except the research project on the adoption of electric cooking that was implemented by Access to Energy Institute (A2EI). The project targeted only 20 selected households receiving one-plate electric stoves, two pots and a wonder box each. The other one is the project for briquette

making, where community members were encouraged to bring any dried and soft plant waste for turning into briquette at no cost. This was done as a way of providing a substitute to the felling of trees for firewood in the Mulanje Mountain Forest Reserve. The electrification projects of rural areas in Malawi can be taken as a form of dumping electricity on rural masses, with no regard as to supporting them on community resilience and economic transformations.

As has already been reported, the provision of electricity access especially to rural communities on its own has been observed not enough in fostering the local economy (Garniati, Owen and Kruijsen, 2014). Section 2.4.1 has provided several incentives that are required to accompany electricity access if broader goals of sustainable and resilient livelihoods are to be achieved. These include providing support on accessibility of electrical appliances whether through loans and grants; establishment of light industrial zones alongside electricity access; provision of cross-subsidies to make electricity cheaper and affordable; provision of subsidies to compensate developers operating in rural and remote areas; the involvement of universities and research centres to conduct researches for informing successes and challenges of rural transformation with electricity. Rural electrification should be promoted alongside the promotion of productive use of electricity. Where possible rural electrification requires to be championed at the highest level possible, even at presidential level as it was done in Ghana and Senegal, if more support is to be realised. These are not being done hence missed opportunities for diversification, resilient livelihoods and economic transformation. Provision of electricity access should not be a solution on its own as that is regarded as ‘dumping’ of electricity access, but should have the goal of enhancing transformative and resilient livelihood options.

5.7. Some pertinent themes that are important to the study

There were some interesting themes that came out of the study and these are discussed as in the sub-sections that follow

5.7.1. Community Resilience – at a crossroad of mini-grid, biodiversity and watershed

The establishment of the mini-grid in the area was aimed at facilitating energy transition and make community members thrive, that is, the households should be able to make gains in wealth creation and building assets; hence reduced dependence on the mountain resources. Basic uses of electricity such as lighting, charging phones and entertainment were observed to be prominent in the area. Small businesses such as barber shops, video shows and selling refrigerated soft drinks are also carried out. What was observed to be so much missing is the Productive Use of Electricity (PUE) and electric cooking. This can be attested to the low load factor

Normal load is mostly less than 110 kW for all the 1600 households including 4 maize mills running on a day. The peak load of 110 kW takes place between 5 pm and 9 pm. The off-peak load of 40 kW is mostly recorded during late hours of the night. (SSKII- MEGA-001)

Such low uptake of electricity means that there is indeed no productive use of electricity and the electric cooking is vividly missing. Such being the case, the community is heavily dependent on the mountain for firewood and charcoal for cooking leading to loss of ground cover and felling of trees. All this leads to reduced stability of water flow in rivers (Development Alternatives Inc, 2006) and flooding of rivers during wet season and drying of the rivers in the dry season. The

reduced stability of the water flow also leads to erosion of the slopes resulting into huge loads of silt into the rivers. Hydropower generating capacity is, obviously being reduced in such cases.

In the dry season there is continued low water levels over the years hence reduced electricity generation. Maize mills fail to run during the dry season (SSKII-008)

At Bondo 3, the river carried rocks and stones through the penstock to the turbine blades. Much as these were successfully removed, the turbine has reduced generation capacity as some blades got bent. (SSKII- MEGA-002)

Big challenge is siltation and debris accumulation into the river stream (FGD-009)

The lack of PUE means that the mini-grid is not maximised by community members for the enhancement of their resilience. The mini-grid has managed to attract and retain professionals within the health, education and other sectors, which means increased population. The population is mostly dependent on land as resource and the Mulanje District's low land holding size of 0.6 ha per household in 2016 (Malawi Government, 2017b) is complicating the existing problems. Such small land holding capacity means people cannot grow enough food for their consumption the whole year round. Let alone. the community members cannot produce enough cash crops for sale. With no tangible alternatives, community members are forced to look forward to unsustainable livelihood options such as illegal logging of forest trees to have timber, firewood and charcoal burning for both home use and sale, bush fires for hunting and encroachment of the forest reserves for farming land.

Such dependence on the mountain and forest products is affecting the biodiversity of the mountain and the watershed. The loss of biodiversity is having an impact on the wellbeing and resilience of

the community more especially on disturbance of the watershed, which, in turn, affects electricity generation. Of course, there are some efforts on conservation especially by some chiefs around the community, but the laws and lack of enforcement and the fact that the majority are lacking or have no tangible alternatives are not helping much. The following extracts provide credence on what happens on forest conservation.

As chiefs, we volunteer to protect the trees, but the outdated laws of forest prevent us to enforce or work better. We can catch a person logging tress and take him/her to police only to have the person released within days after paying a fine which is mostly within K30,000 (US\$ 28.5). The person may even be a danger to us and boast to have come out scot-free. Need to review forest law (CD-010).

There are also challenges with changes of officers at the forestry department. Personnel get transferred so often. MMCT helped with the construction of road block with the aim of curbing the movement of trucks loaded with timber and poles but trucks are let to pass by forestry personnel (CD-011).

Much as there are some hazardous activities happening such as continued cultivation of steep river banks with pineapples flourishing in such areas, there are activities that take place for the preservation of the catchment area. Field visits have shown that there is increased planting of trees, reduced logging and taking care of the planted trees on the slopes of the mountain around Bondo area. Institutions such as MEGA, MMCT, Lujeri and Sukambidzi Trust are supporting this on taking care the Lichenya River catchment areas, unlike the other sections of the mountain. The evidence for the care of the catchment area is supported per the abstract below.

Companies such as Lujeri, are providing nursery of trees and community have the duty to planting the seedlings. Trees are planted on catchment area of Lichenya River. ... we also need to take care of tress that are available while at the same time planting others (FGD-009)

The other parts of the mountain that had been visited continue to face challenges of environmental degradation due to human activities. One such area is at the intake of Ruo-Ndiza Hydropower Plant. The area had very few trees and it was clear that others had been logged. The area upstream Lujeri River 2 is another area in a sorry state with loggers openly felling trees during the day. I was shown a place where timber from the mountain is sold openly. Any attempt to stop people harvesting trees for timber in these areas was reported to be matched with threats on one's life. Such developments may have an effect on the Lichenya catchment area as the mountain is the same and one. Such calls for ways on how the community members should be supported in forging alternative livelihood options and resilience building.

5.7.2. Energy, water and biodiversity nexus

Hydropower development will always have effects to natural resources, including biodiversity, social and cultural aspects. One of the challenges is when a hydropower system is planned to benefit the community whose livelihood is dependent on the same catchment area of the river. Such bring many threats including encroachment of the catchment area for agricultural land, harvesting of timber species, overgrazing of the land, fuelwood collection and introduction of evasive species (Uprety *et al.*, 2010). All these are not uncommon within Bondo Community. The dependence on the natural resources becomes the norm when the community served is subjected to poverty. To the local people around Mulanje Mountain, conservation of biodiversity is not a priority with the mountain regarded as nature's opportunity for the communities' existence and

survival (Borgstein, 2017). The link between biodiversity and livelihoods and also between conservation and poverty reduction are dynamic and locally specific. The approach requires nexus thinking in that the competing sectors of biodiversity conservation should not be considered on its own without poverty reduction strategies and resilient building of the local community. It is encouraging to note that the area around Bondo has some improvements on conservation effort unlike other areas that do not have interventions such as this provision of electricity access.

The conservation effort should be matched with interventions such as provision of finances and alternative livelihood options. The example is the case study that is reported by Guo *et al.* (2007) of the intervention by government of China. After Yangze River as a source of hydropower electricity got encroached, the government of China started to give out some cash as compensation to the community members within the catchment area. Such cash incentives, which were provided for 5-8 years, helped the community members to convert previously encroached forest for farmland back to forest. The logging of trees was completely stopped leading to reduced soil erosion and siltation, and biodiversity was conserved. However, not all governments can afford the provision of monetary incentive. The other way is to put in place market-based approaches or livelihood options that support local communities to diversify away from dependence from unsustainable livelihood options.

There is need to put in place interventions that are able to increase productivity and adding value to existing products within the locality for job creation and increased income generation. It is reported that MMCT facilitate various livelihood alternatives such as small-scale irrigation schemes, aquaculture and bee-keeping among others. Much as these are non-existent in Bondo because of the unfavourable conditions of very cold water, scarcity of land, slopes and a very humid environment in the mountain slopes, they are very much beneficial on increasing income

and accumulating of assets. The feasible option for Bondo was observed to be a factory setup for manufacturing of jam, marmalade and juice to take advantage of the abundance of pineapples in the area. Such value addition of pineapples provides prospect of the people around the community to benefit with better prices of raw pineapples and job creation for the people working in the factory and the support towards the whole value chain.

5.7.3. Electricity by grid or mini-grid – not an easy path

From the engagement of the community, one theme that came out is that it is not easy to have electricity access by rural community. It was revealed that Bondo Community had given up the possibility of having electricity access. The community's representatives visited ESCOM, the state utility, on how electricity could be extended to the area in 2006. They were provided with a quotation of extending the grid from the nearest medium voltage, which was prohibitively expensive. The community members had no option but resigned to the fate that they would never experience electricity access in their lives. The following was the extract from the third workshop giving evidence as to how everything unfolded.

Extending grid electricity from Minimini, the nearest place to have the grid connection, at a distance of 15 km was quoted as K85 million (an estimated equivalent of US\$613,000.00 in 2006). As chiefs, members of parliament and councillors in the area, we sat down to map the way forward but could not come to a solution as the money required was so huge. There was no way that such an amount could be raised even with some external connections that were available (CD-012)

It therefore came as a surprise to the community that the representatives of Mulanje Mountain Conservation Trust (MMCT) and District Council's office brought the idea of generating electricity locally, taking advantage of Lichenya River in 2007. Considering the importance of such an initiative and that the community members had needed electricity so much, the idea was received with open arms. Community members freely volunteered land and labour towards the project. The project did not come so easy as it took 7 years with first connections happening in 2014.

Though not so easy to have electricity access in rural areas, whether grid or mini-grid, the benefits are so many. The people, as has been witnessed through the testimonies in Bondo Community, are in need of electricity and appreciate the benefits that come with electricity access. There are reasons that prevent ESCOM extending electricity access to both semi-urban. ESCOM is appraised by the regulator based on financial and non-financial measures (vsakala, 2021) and extending its grid to rural areas can only make ESCOM perform unsatisfactorily, unless with external support. The inherent nature of rural areas like low demand of electricity, inability to pay and unwillingness to pay for electricity and electrical appliances provide no incentive to ESCOM when the institution is appraised on financial matters.

The electrification for a rural community, whether by mini-grid or mini-grid, is by mere chance due to lack of enabling environment and the missing government support. It is because of this, that the whole country has only three main mini-grids of Sitolo PV, Bondo Hydro and Chipopoma Hydro whose futures are uncertain due to operational challenges. It is little wonder that the people of Bondo never thought they would witness electricity in their lifetime by 2006.

5.7.4. Concessional agreement in managing the Mulanje Mountain Forest Reserve

The other theme that came out of the community engagement is the proposal for a concessional agreement in management of Mulanje Mountain Forest Reserve. The suggestion of the MMCT to emulate African Parks' arrangement with Malawi Government came out at the third stakeholders' engagement on December 2, 2022. Participants at the meetings were of the view for the nexus approach in management of the forest reserve, because of the interconnectedness and interdependence of energy, water and biodiversity. In achieving the nexus, participants were in support of MMCT entering into an agreement with Malawi Government so that the trust can have bigger role on management of the reserve. Under such an agreement, the sentiments are that MMCT should be given the exclusive rights in management of Mulanje Mountain Forest Reserve (MMFR), of course, in partnership with Department of Forest. In the current scenario, exclusive mandate is with the Department of Forestry with MMCT in the peripheral or providing supporting role just like any other institution working in the sector. Participants were of the opinion that the department has its approach of silo-thinking of forest conservation and possibly reforestation only. So far MMCT's approach has been nexus as all sectors of fauna, flora, watershed, and community resilience are supported. The evidence of the suggestion for the concessional agreement is as per quote below.

MMCT is pushing for concessional agreement with government so that the institution can have exclusive rights towards the protection of Mulanje Mountain Forest Reserve. A similar arrangement had been made between government and African Parks in which Majete Game Reserve, Kasungu National Park, Liwonde National Park are managed by African Parks. The challenge is that Forestry Department has mandate of sectoral, only

consider trees, while MMCT will have a nexus approach with consideration of forest, water, energy, community resilience and their interaction. (CD-013)

The proposal for the agreement is modelled on the agreement between Malawi Government and its Department of National Parks and Wildlife on the one hand and the African Parks on the other hand. The Malawi Government went into agreements with African Parks with the latter having exclusive rights on management of Majete Game Reserves, Liwonde National Park and Nkhota Kota Wildlife Reserve. The African Parks, also a trust, has recorded some successes on the management of game reserves and national parks in the country. With the example of Majete Game Reserve whose management of the reserve was transferred to African Parks in 2003, there had many positives within the reserves. The reserve was regarded as an ‘empty forest’ as animals were depleted through poaching before African Parks came in. There was reduction of surveillance as only 12 rangers and zero tourism income when the Department of National Parks and Wildlife had overall mandate. With Africa Parks, there were huge improvements starting with the introduction of 3000 animals representing 17 species, including rhinos, elephants, leopards, buffalos, cheetah and giraffe (African Parks, 2022). By 2020, there were over 12,000 large animals, and 165 permanent employees. It is reported that the communities around the reserve were not left behind but supported for bee-keeping, fish farming, and two solar-powered irrigation schemes.

The increased number of rangers and the introduction of technology on surveillance have been of huge help on conservation and reduced human-wildlife conflict. Visitation to the reserve is reported to have been increased leading to increased income levels, with the community having a share of the benefits. It is reported that in 2020 an equivalent of US\$75,765 was spent on community support in the sectors of education, health and agriculture (African Parks, Ibid). The

positives on management of the reserve and the accrued benefits like increased employment and increased income from increased visitation and the various support provided to the surrounding communities are so much acknowledged.

It is tempting to consider a similar arrangement be considered on management of Mulanje Mountain Forest Reserve. MMCT had been working in the area of the conservation of the mountain and supporting livelihood in communities around the mountain. It is understood or tempting to think of concessional arrangement championed by community and MMCT be successful. So much power should be given to MMCT through concessional agreement on management of the reserve. However, it is not known whether such arrangement where MMCT has more powers over the Department of Forestry can result in positives on conservation of biodiversity and increased support to the communities. It is also not known whether the positives seen with African Parks can be replicated with MMCT assuming greater role on management and conservation of Mulanje Mountain. The successes registered by African Parks provokes the debate that MMCT are in better position to manage the mountain reserve, of course, the government through Department of Forestry will still be involved as a partner and through provision of oversight.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1. Introduction

Poverty among peri-urban and rural areas of developing countries remains a challenge for the respective governments, developing partners and the poor people themselves. Of course, there are several ways of interventions, and this study is aimed at tackling the vice with electricity access and mini-grids. Electricity remains one of the key drivers towards economic transformations, but on its own not much economic positives can be realised. Several complimentary services and products are required. Many stakeholders are also required to take their active roles, and more importantly are the poor themselves to be actively involved and should have progressive thinking. In this chapter, key findings, implications to policy, proposed areas for future research and concluding remarks are included

6.2. Summary of Key Findings

The results of findings of this study have been presented and discussed in chapter. From these, a summary of key findings had been drawn and presented below.

1. Electrification access to the poor has multiple benefits towards the attainment of local development and international agendas including SDGs. However, the benefits do not come on their own, but how the implementation is done plus the complimentary products and services that have been accompanied with. Rural customers require to be actively engaged so that they take electricity as a driver towards their own economic transformations and resilience building. The activities on productive use of electricity therefore need to be planned and intensified even before the mini-grids are developed.

2. Mini -grids for rural electrification cannot be developed, let alone survive, without external help. This is because rural people have low power demand, little affordability, unwillingness to have transition and are poor. Government support supplemented with private sector and donor funding is still key towards the survival mini-grids in particular and rural electrification projects in general.
3. There is need to have streamlined regulations for mini-grids in the country to encourage developers make investments in the sector. Regulation provides a fertile ground and where regulation is burdensome, success tends to depend on whom one knows rather than what one can do. Malawi has burdensome and strict regulations that inhibit the growth of the sector; hence the urgent need to have some reforms and amendments done.
4. Generation of electricity in rural areas by hydro source happens within biodiversity hotspots, which may contain endemic or near endemic species. Such requires extra efforts in conservation with the rural poor having their dependences on natural resources of forestry, water and agriculture. Efforts are needed so that there is little or no deforestation, encroachment of protected areas, destructive hunting such as use of fires and unsustainable fishing. In avoidance of these, communities should be supported on diversification, and building their own resilient livelihoods.
5. Higher levels of political support such as at presidential level can provide very quick gains as was the case of what happened in Ghana and Senegal. It becomes easier to attract the involvement of donors and the private sector with a popular champion driving such an agenda. In addition, the commitment and lamentations of such higher authority are always taken seriously or a law or policy on its own, which is so much missing in the country.

6. Vulnerability is on the increase in the rural areas of Southern Malawi due to poverty levels, climate change, exogenous shocks, high population density and unsustainable population growth. There is need for urgent intervention on various livelihood options. Key are improved and modern agricultural practices, value addition to agricultural practices and diversification, whether combined with agriculture or completely out of agriculture. Rural electrification has a role in these interventions.
7. The reluctance for the establishment of the Rural Electrification Agency (REA), which was planned to be done by 2020 is not helping for rural energy system to access REF. The current arrangement of REF being managed within the ministry means issues of abuse corruption on the use of REF will continue. No transparency and accountability on the use of REF is not helping. The institutionalisation of REA, as the best practice in many other countries, needs to be done with the urgency it deserves.
8. The country has so much resource potential energy resources, which if exploited in the form of mini-grids can go a long way in the expansion of electrification rate. There are many perennial rivers in Mulanje District in Southern Malawi and Chitipa, Nkhata Bay and Rumphi in Northern Malawi. These rivers have the potential to increase the numbers of mini-grids and the combined generation capacity if exploited. The country also has a relatively high insolation in the range of 5.1 to 5.79 kWh/m²/year and that there are several areas with mean wind speed of 5 m/s annually, which can be exploited for more solar PV and wind mini-grid establishment.

6.3. Implications to policy

The results of the study reveal shortfalls on several policy issues that need to be addressed if mini-grids and the communities being served are to thrive. The study came up with some implications to policy as discussed.

1. The first is on the policy implementation with the case of the institutionalisation of rural electrification agency, which was planned to be done by 2020. By May 2024, this had not been done, even though it was explicitly explained within the energy policy document of 2018- 2023. The failure or delays to institutionalise REA does not make sense if the mini-grid sector is to expand and to be well supported. Missing the target on institutionalisation by 4 years after the planned date shows lack of seriousness in following up on own policy documents. What is included in the policy document require serious adherence. The Ministry of Energy, which has the mandate, is required to speed up the issue.
2. Currently, mini-grids are treated the same way as large-scale generation plants. This makes the process of approvals and clearance so long and very costly. There is need to amend relevant documents so that mini-grids fall in their own category. The amendments need to be treated with the urgency they deserve.
3. Customers served by mini-grids need not to be discriminated against, as they also require lifeline or subsidised tariffs. Subsidised tariffs need not to be enjoyed by only those connected to the main grid. It does not augur well when all customers of main grid enjoy subsidised rates for the first 50 units. The poor household of mini-grids need also benefit from government subsidies through subsidised tariffs. There is need for a policy document for protecting all poor customers regardless of grid or mini-grid connections. After all,

those of mini-grid should be regarded to be among the poorest; hence deserve the most of the support.

4. The transformation of rural communities requires multi-stakeholder approaches. Electricity access for rural areas should not be for the ministry of energy alone. Ministry of trade, agriculture, natural resources, water and irrigation are required to be part of the bigger solution if tangible results are to be achieved. There is also need for policy documents in guiding the coordination of various players on mini-grids and how they can contribute to economic transformations.
5. Water and environmental clearances for small systems like mini-grids need to be merged within the electricity generation and distribution licenses. The proposal is to have a one-stop shop with relevant personnel managing affairs of all permits and licensees as a way of fast-tracking the processes.

6.4. Recommendations for future research

This study has demonstrated various ways of enhancing community energy resilience in general and Bondo Community in particular. Considering that the study area is limited to Bondo Community and that the results have brought forth several knowledge gaps, the following areas are recommended for further future research:

1. The formulation, amendments and implementation of policies is hinged on political economy of a particular country. There is need to have understanding of how power and allocation of resources in the energy sector, the electricity sector and the rural electrification is structured and spread out. It is only upon such explicit understanding that

it will be known how to influence the policy documents. Therefore, political economy of the energy sector requires some studies;

2. The research was conducted within the context of Bondo Community. There is need to have similar or different approaches applied in investigating other areas of similar characteristics. Thereafter, there should be need to make comparisons so there is a way of looking at differences and similarities on results and recommended actions;
3. The study was within the area of socio-economic aspects of rural energy system and community. There is need to consider research work within the technical aspects such as power quality and conformity to the standards of the main grid;
4. With the arrival of grid electricity, mini- grids have the options of turning into SPD or SPP or even the abandonment from the area. A study on the better approaches, the technological requirements and implications to the grid and community on transition need to be studied and understood within the local context; and
5. The major challenge facing mini- grid is lack of financing. Different models of financing and the operating models of min-grids require understanding within the local context.

6.5. Concluding Remarks

This study has shown that electricity access is a driver of economic and resilient transformation. The benefits are not realised with just expanding the electricity access. This is because the characteristics of the poor or rural communities prevent the people to realise the economic benefits of electricity access. Complimentary services and products need to accompany the electricity access. Also, several stakeholders have to take their active roles in support. The setup of leaving everything to the energy provider and/or the ministry of energy alone is not helping. Ministries of agriculture, trade and finance have huge roles to play. Microfinancing institutions or banks,

research institutions and district council within the locality have roles to play. The communities themselves are key in embracing new technology brought in their locality and inculcating positive mindset within themselves.

Rural electrification projects including mini-grids have own challenges as they deliver electricity to rural and poor people. The survival of the projects and mini-grids are hampered by the poverty levels and attitudes of the people. This is affecting the willingness and affordability of electricity and electrical appliances. Financial and technical resourcefulness of mini-grids are at risks. It is little wonder that many mini-grids for rural electrification fail to survive beyond pilot phases. Regulations and licensing, lack or limited government support and centralisation also affect the resilience of mini-grids.

Bondo Community requires projects or programmes that should solve the challenges of the community itself and the mini-grid. The mini-grid as a hydropower is dependent on the catchment area that is a biodiversity hotspot. Failure to empower surrounding communities means destruction of the biodiversity. The establishment of a caning factory to take advantage of abundant fruits found in the area and support of clean cooking were the priority areas by the community itself. Support to these is very much welcome.

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APPENDICES

Appendix 1: Guideline for FGD and SSKII

Areas of discussions and suggested responses for consideration are

Stressors, local early warning systems and recovery options

1. Main stressors (stresses and shocks) in the area and their impacts to crops, animals, buildings and incomes
2. Mitigation and adaptation measures to the stressors as in:
 - (a) Early warning systems, if any;
 - (b) Household responses;
 - (c) Institutional responses, both formal and informal, responses; and
 - (d) Suggested ways of withstanding and recovery from future challenges of similar nature and others

Sources of livelihoods and business availability and opportunities

1. Livelihood options in the area, including their advantages and disadvantages
2. Various businesses conducted in the area and perception to profitability
3. Business financing options available and other challenges faced by businesses.
4. Viable business options known but not done in the area and why not pursued

Electricity, Opportunities and Challenges

1. Various uses of electricity, their rankings and how electricity can improve standards of living
2. Knowledge of opportunities with arrival of electricity– productive use of electricity and huge consumption activities such as cooking

3. Challenges for not taking advantages of opportunities with arrival of electricity such as
 - a. affordable and flexible financial services (savings and credit schemes, micro-finance), whether formal or informal,
 - b. Availability and affordability of electrical appliances etc.
 - c. Lack of markets
 - d. Lack of supportive infrastructure such as quality of electricity, poor roads, lack of market lack of training and exposure etc.
4. Explanations on what should the electricity system do for the community to benefit more
5. The changes in terms of services, equipment acquired, income levels, jobs created and sustained, businesses established and standard of living resulting from electricity availability at household and community levels
6. Opinion on affordability of electricity (whether, too low or about right)
7. Satisfaction/dissatisfaction over the delivery of electricity. How and why? Suggested ways of improvements

Community Energy Resilience and Co-design

1. Communities' role in supporting the electrical system and the general catchment area
2. Incidences of power failures, causes and impact including
 - (a) The most affected sector (education, business, health, household etc.
 - (b) The most affected usages (household lighting, street lighting, equipment powering (mention the equipment) etc.)
3. The solutions to reduce impact of such power failure
4. Suggested solutions to depend on when such power failure continue to occur in future
5. Aspiration for an improved electricity system and improved livelihood options

6. Aspiration for improved livelihood options
7. Networks and institutions helpful during stressors

Appendix 2: Summary on the number and gender of participants and time taken for each FGD at village level

No.	Village				Duration of FGD (minutes)
		Males	Females	Total	
1	Nkhulambe	2	12	14	57
2	Kudyere	5	4	9	49
3	Nkuta	5	5	10	62
4	Ngwendema	6	6	12	86
5	Mlima	6	4	10	73
6	Maimbere	6	3	9	89
7	Namainja	8	1	9	63
8	Kaponda	5	4	9	40
9	Nnessa	6	3	9	103
10	Kalamwa	5	5	10	73
11	Bondo II	5	4	9	81
12	Nkundi	4	6	10	56
13	Bondo I	4	5	9	128
14	Zamulire	6	5	11	63
15	Khanyizira	11	3	14	53
16	Chaima	5	5	10	74
17	Nandolo	5	5	10	65
TOTAL		94	80	174	

Appendix 3: Ethical Approval from (MZUNIREC)



MZUZU UNIVERSITY

DIRECTORATE OF RESEARCH

Mzuzu University
Private Bag 201
Luwinga
Mzuzu 2
MALAWI
TEL: 01 320 722
FAX: 01 320 648

MZUZU UNIVERSITY RESEARCH ETHICS COMMITTEE (MZUNIREC)

Ref No: MZUNIREC/DOR/21/61

25th Nov., 2021

Mr. Vincent Mwale,
Mzuzu University,
P/Bag 201,
Mzuzu.
Email: mwale.v@mzuni.ac.mw

Dear Mr. Vincent Mwale,

**RESEARCH ETHICS AND REGULATORY APPROVAL AND PERMIT FOR
PROTOCOL REF NO: MZUNIREC/DOR/21/61: HARNESSING THE NEXUS BETWEEN HYDRO
MINI-GRIDS AND COMMUNITY ENERGY RESILIENCE: CASE STUDY OF BONDO HYDRO MINI-
GRID**

Having satisfied all the relevant ethical and regulatory requirements, I am pleased to inform you that the above referred research protocol has officially been approved. You are now permitted to proceed with its implementation. Should there be any amendments to the approved protocol in the course of implementing it, you shall be required to seek approval of such amendments before implementation of the same.

This approval is valid for one year from the date of issuance of this approval. If the study goes beyond one year, an annual approval for continuation shall be required to be sought from the Mzuzu University Research Ethics Committee (MZUNIREC) in a format that is available at the Secretariat. Once the study is finalised, you are required to furnish the Committee with a final report of the study. The Committee reserves the right to carry out compliance inspection of this approved protocol at any time as may be deemed by it. As such, you are expected to properly maintain all study documents including consent forms.

Committee Address:

Secretariat, Mzuzu University Research Ethics Committee, P/Bag 201, Luwinga, Mzuzu 2; E-mail address: mzunirec@mzuni.ac.mw

Wishing you a successful implementation of your study.

Yours Sincerely,



Gift Mbwele

MZUZU UNIVERSITY RESEARCH ETHICS ADMINISTRATOR

For: CHAIRMAN OF MZUNIREC

Appendix 4: A summary of the frequencies of mentioned disasters

NODES	STRESSES	FREQ.	VILLAGES AFFECTED
Other Stressors	Low prices of pineapples	3	<u>Kalamwa, Bondo, Kaponda</u>
	Low prices of tea	4	<u>Bondo, Kaponda</u>
	High interest on business loans	1	<u>Kalamwa</u>
	Farming being seasonal	1	<u>Kalamwa</u>
	No market place	3	<u>Kalamwa, Kaponda</u>
	Farming business not profitable	1	<u>Kaponda</u>
	Wild fires	1	<u>Kaponda</u>
	Lack of capital	1	<u>Kalamwa</u>
	Blackouts	1	<u>Khamvuzira</u>
	Price fluctuations	1	<u>Nkuta</u>
Disasters (Major disasters)	Floods	14	<u>Nkhulambe, Bondo1, Bondo 2, Chayima, Zamulire, Nkundi, Kudvere, Mlima, Nkuta, Ngwendema</u>
	Poor soils	1	<u>Bondo 1</u>
	Strong winds	21	<u>Zamulire, Kaponda, Bondo, Bondo 2, Chayima, Ngwendema, Nkhulambe, Kalamwa, Namainja, Nnessa, Nandolo, Nkhulambe</u>
	Heavy rains	14	<u>Khamvuzira, Nandolo, Nnessa, Ngwendema, Nkundi, Bondo 2, Kalamwa, Nkundi, Bondo 1</u>
	Too much sunlight	1	<u>Chayima</u>
	Animal diseases	3	<u>Kaponda, Nkhulambe, Ngwendema</u>
	Predators for animals	2	<u>Kaponda, Nambere</u>
	Seasonality of pineapples	1	<u>Kalamwa</u>
	Blackouts	3	<u>Kudvere, Nkuta</u>
	Lightning	1	<u>Kudvere</u>
	Poverty	1	<u>Kudvere</u>
	Drought	1	<u>Nandolo</u>
	Soil erosion	3	<u>Mkhulambe, Ngwendema, Kaponda</u>
	Armyworms	1	<u>Nkundi</u>
	Banana diseases	1	<u>Zamulire</u>
	Not enough water this side	1	<u>Bondo</u>
	Children drowning	1	<u>Bondo 2</u>
	Termites	1	<u>Ngwendema</u>
	Small worms	1	<u>Nkundi</u>
Climate change	Dry spells	1	<u>Bondo</u>

Appendix 5: Co-design ideas and their frequencies through SSKIs and FGDs

ITEM NO.	CO-DESIGN IDEA MENTIONED	FREQUENCY
1	Increase Generation capacity	10
2	Factory for juice-making from pineapples, peaches and mangoes	8
3	Construction of a clinic/hospital	7
4	Construction of School/school blocks	6
5	MEGA should have an office at the power house	6
6	Good road	3
7	Planting of trees	3
8	Close Collaborations between MEGA and the community	3
9	Animal farming (Dairy or piggery) in groups	3
10	Connection of electricity to those not connected	2
11	Revolving loan fund	2
12	Electrical maize mill	2
13	Electric cooking stoves	1
14	Electric pump for irrigation	1
15	Do not Know	5
21	MEGA should tell us and we will help on implementation	7