EXPLORING OPPORTUNITIES FOR PUBLIC-PRIVATE PARTNERSHIPS IN SMALL SCALE HYDROPOWER PLANTS FOR RURAL ELECTRIFICATION IN MALAWI: A CASE STUDY OF BONDO MICRO HYDROPOWER PLANT

MASTER OF PHILOSOPHY IN APPLIED SCIENCES (RENEWABLE ENERGY) THESIS

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MASTER OF PHILOSOPHY IN APPLIED SCIENCES (RENEWABLE ENERGY) THESIS

By

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University of Malawi

The Polytechnic

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DECLARATION

I, **Precious Chaponda** declare that this thesis is my own original work. Where other sources of information have been used, they have been acknowledged. I hereby certify that this work has not been submitted before in part or full for any other degree or examination.

SIGNATURE :

DATE :

CERTIFICATE OF APPROVAL

We, the undersigned, certify that we have read and hereby recommend for acceptance by the University of Malawi a thesis entitled '*Exploring Opportunities for Public-Private Partnerships in Small Scale Hydropower Plants for Rural Electrification in Malawi: A Case Study of Bondo Micro Hydropower Plant*'.

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Date : ______________________________

DEDICATION

To my wife Bertha and son Zikomo, thanks for understanding when I was spending more time researching than with you.

ACKNOWLEDGEMENT

First, I am most thankful to God Almighty for making it possible for me to work and complete this thesis. I am also grateful to the Centre for Water Sanitation Health and Technological Development (WASHTED) for the scholarship and the Scottish Government for funding my studies at The Polytechnic, University of Malawi. Special thanks should go to Professor James Khomba and Dr Gregory Gamula for their constant feedback, valuable advice, and motivation during my research. Thanks to my brother Murendere for reviewing the thesis and providing valuable advice to perfect it. I am also thankful for Wilson Greya for the encouragement and sharing resources. Further acknowledgement goes to Kelvin Tembo and all my lecturers for their support throughout my studies. Lusungu Kumwenda who gave me valuable time and information during my field visits at Bondo Community is also being thanked. I would also like to thank my classmates and friends for making my research and life worthwhile. To my family and relatives, thanks for encouraging me, always being there, never allowing me to give up and praying for me to finish this thesis; God bless you all!

ABSTRACT

At 2% of the total population, the low rural electrification status for Malawi is a crucial topic. This is because electricity is directly linked to socioeconomic development. To increase the electrification status, knowing that the private sector has enormous resources, the Government of Malawi (GoM) has been calling for Public-Private Partnerships (PPPs) in power projects, including Small Scale Hydropower Plants (SSHPs). However, it is now over a decade since GoM started calling for the PPPs and there are no PPPs in the sector. Are there opportunities for PPPs in SSHPs for rural electrification in Malawi? This was the research question.

A deductive approach was used to answer the research question, with Bondo Micro Hydropower Plant (MHP) being used as a case study. The legal and regulatory framework for PPPs and rural electrification was analysed and it has been found that the framework allows for all types of PPPs and Bondo MHP can be implemented as a PPP. The power consumption of Bondo community was analysed and it has been characterised as having a low load factor, low productive use and low ability to pay, which result in low revenue; willingness to pay is however high. Considering that Bondo is an agriculture community, revenue streams can be improved by investing in agriculture and food processing. Financial analysis was carried out on Bondo MHP under different technical and financial factors and assumptions using RETScreen. It has been established that the power plant has a financial return that is lower than 34%, the commercial base lending rate during the study; hence, it is unlikely to attract private investors. Modelled as a 40:60 public to private investment, the MHP is likely to be financially viable only when the capacity factor is increased from 47%, capacity factor during the study, to over 60%, and when the investment cost and the interest rate on private capital are lowered. Thus, a PPP can be a reality in Malawi where investors are able to develop a SSHP with a high capacity factor at a low cost and interest on loan. Improvement of revenue streams is also a key component for the PPPs to succeed.

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ABBREVIATIONS AND ACRONYMS

ADB	-	Asian Development Bank
AfDB	-	Africa Development Bank
AFREPREN	-	Africa Renewable Energy Policy Research Network
BOO	-	Build Own Operate
BOT	-	Build Own Transfer
BOOT	-	Build Own Operate Transfer
CE	-	Carbon Emissions
CIMA	-	Chartered Institute of Management Accountants
EC	-	European Commission
ESCOM	-	Electricity Supply Cooperation of Malawi
DBFROT	-	Design-Finance-Refurbish-Operate-Transfer
DG	-	Distributed Generation
ESCOM	-	Electricity Supply Cooperation of Malawi
GEF	-	Global Environmental Facility
GHG	-	Greenhouse gas
GoM	-	Government of Malawi
IPP	-	Independent Power Producer
IMF	-	International Monetary Fund
IRR	-	Internal rate of return
kW	-	Kilowatt
MAREP	-	Malawi Rural Electrification Project
MCA	-	Millennium Challenge Account
MCC	-	Millennium Challenge Cooperation
MCS	-	Monte Carlo Simulation
MGDS	-	Malawi Growth and Development Strategy
MEP	-	Malawi Energy Policy

MEGA	-	Mulanje Energy Generation Agency
MERA	-	Malawi Energy Regulatory Authority
MERP	-	Malawi Economic Recovery Plan
MHP	-	Micro hydropower Plant
MIRREIA	-	Mitigating Risks and Strengthening Capacity for Rural Electricity Investments in Africa
MIRTDC	-	Malawi Industrial Research and Technological Development
MMCT	-	Mulanje Mountain Conservation Trust
MUREA	-	Mulanje Renewable Energy Agency
MW	-	Megawatt
NGO	-	Non-Governmental Organization
NPV	-	Net Present Value
NRC	-	Natural Resources Canada
PPP(s)	-	Public Private Partnership(s)
OECD	-	Organization for Economic o-operation and Development
PSRS	-	Power Sector Reform Strategy
RE	-	Rural Electrification
RoI	-	Return on Investment
SADC	-	Southern Africa Development Community
SSHP(s)	-	Small Scale Hydropower Plant(s)
SPV/SPC	-	Special Puporpose Vehicle or Company
TCE	-	Transaction Cost Economic
UN	-	United Nation
UNECE	-	United Nations Economic Commission for Europe
UNIDO	-	United Nations Industrial Development Organization
VfM	-	Value for Money
WASHTED	-	Water Sanitation Health and Technological Development

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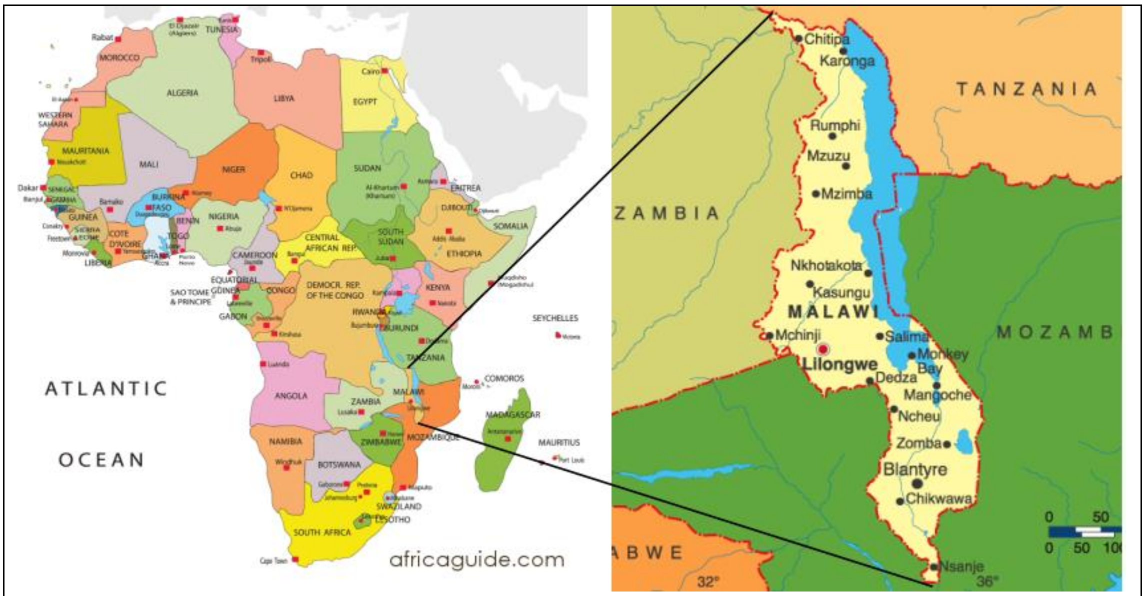
CHAPTER 1

INTRODUCTION

1.1. BACKGROUND OF THE STUDY

Malawi, a Southern Africa country bordered by Zambia to the northwest, Tanzania to the northeast and Mozambique on the east, south and west (figure 1-1), has one of the lowest rural electrification status in Africa. As of 2015, it had an estimated population of 16.8 million, out of which only about 9.8% had access to electricity, of which about 2 % were from rural areas (United Nations Development Programme [UNDP], 2015). To increase rural electrification status, the Government of Malawi (GoM) has been implementing the Malawi Rural Electrification Project (MAREP). The project started in 1980 and its in the eighth phase.



Map of Africa (www.africaguide.com) *Map of Malawi (www.worldmap1.com)*

Figure 1-1: Location of Africa and Malawi

Through the Malawi Rural Electrification Project, power lines have been extended to district administration centres, a number of major trading centres, tobacco growing areas and the 4.5 MW Wovwe Hydropower plant was developed in 1998 (Malawi Government, 2014). However, extending the national grid is expensive, making it impossible for MAREP to reach many rural areas. Moreover, owing to low population densities and a general lack of industries, there is low demand for electricity in rural areas, which makes investments less attractive (Malawi Department of Energy, 2003). In addition, even if extending the national grid was profitable, Malawi is only able to generate 351 MW against a generation requirement of 596 MW (Malawi Government, 2014). Therefore, much recently MAREP has also been involved in the construction of solar villages, which unfortunately also require a big capital.

Nonetheless, it is important to electrify rural areas. According to the Rural Electrification Act of 2004 and the first Malawi Growth and Development Strategy (2006 – 2011) (MGDS I), electricity is key to social economic development – a tool for reducing poverty, transforming rural economies, improving productivity and improving the quality of social services. In this sense, Non-Governmental Organizations (NGOs) such as Solar Aid, Concern Universal, Practical Action, and Mulanje Renewable Energy Agency (MUREA) have also been implementing rural electrification projects. Unfortunately, the NGOs also do not have adequate financial resources to help reach many areas.

The private sector is believed to have enormous resources. In order to benefit from these resources, the Privatization Act was enacted in 1996, signalling a shift from state provision of services to privatization. The Electricity Act was legislated in 1998 and one of its objectives was to end government monopoly in the provision of electricity. However, the private sector did not come to invest in electricity, prompting GoM to shift to Public-Private Partnerships (PPPs). The Malawi Energy Policy of 2003, Power Sector Reform Strategy of 2003 and the 2004 Energy laws, which include the revised Electricity Act, were adopted and they all encourage PPPs in the electricity sector.

In addition, in 2006 the Government of Malawi adopted the MGDS I which identified PPPs as a focus action for delivering all infrastructure projects and provision of public services. To create an enabling regulatory environment, the PPP Policy was approved in 2011 and in the same year, the PPP Act was enacted, replacing the 1996 Privatization Act. The MGDS I identified PPPs and establishment of micro hydropower stations as one of the focus actions for effective implementation of rural electrification programs. The MGDS II (2011 – 2016) replaced the MGDS I in 2011; it continued to encourage PPPs and micro hydropower.

Karekezi and Ranja (2005) defined micro hydropower as small-scale harnessing of energy from falling water such as steep mountain rivers and converting it into electricity in power stations. The Malawi Rural Electrification Act 2004 puts micro hydropower station as having installed power capacity ranging 2kW - 100kW while a mini and a small hydropower station has 100kW–500kW and 500kW - 5MW as their installed capacity respectively. This study was interested in all these stations, calling them Small Scale Hydropower Plants (SSHPs) – Hydropower Plants with generation capacity ranging from 2kW to 5MW.

Studies have shown that Small Scale Hydropower Plants are one of the best option for rural electrification. Small Scale Hydropower Plants require less project capital as compared to extending the national grid or developing new large hydro plants (Tenthani, Kaonga & Kosamu, 2013). They have low capital cost when compared to solar and wind technologies that produce the same power; their maintenance cost is also low when compared to the same (Kaunda, Kimambo & Nielsen, 2012). The power is usually continuously available on demand (Klunne, 2003). There is also evidence that they can work in Malawi, as already there is the 4.5 MW Wovwe, 840 kW Lujeri and the 88 kW Bondo Micro Hydropower Plants (MHP). Interestingly, none of the SSHPs in Malawi is operated through PPPs even though over 10 years have passed since the government started calling for the partnerships.[1]

1.2. PROBLEM STATEMENT

The low electricity generation and distribution rates are a crucial topic in Malawi as electricity is directly linked to socioeconomic development. The least electrified areas are the rural areas, which is also, where many people are in abject poverty and cannot make enough money to sustain their livelihoods. There is a need to bring electricity to these areas. The Government of Malawi has been implementing rural electrification projects, but failing to cover a significant area due to inadequate financial resources. Unfortunately, rural electrification also has low returns on investment and provides very little incentive for private investors (Malawi Department of Energy, 2003). Therefore, as a solution, GoM has been calling for PPPs and one of the technology being encouraged is small scale hydropower. Through the PPPs, GoM is to take up some of the risks in investing in rural areas, thereby making investing in rural electrification attractive.

However, despite over a decade passing since the Government of Malawi started calling for PPPs, there are no PPPs in the electricity sector including SSHPs for rural electrification.[1] Furthermore, there is limited information on whether PPPs can be possible – are there opportunities for PPPs? The research problem takes cognisance of the fact that to attract private investment, among others, the project has to be bankable and offer scope for innovations; there have to be strong local financial structures and an acceptable legal framework (Harris, 2004; UNECE, 2008). There is need for a research that explores if these exist, that is, the opportunities for PPPs in SSHP for rural electrification in Malawi. The findings of this study will contribute to information that can be used to attract PPPs, not only for rural electrification but also for the whole electricity sector.

1.3. RESEARCH AIM AND OBJECTIVES

The research aimed at exploring opportunities for Public Private Partnerships in Small Scale Hydropower Plants for rural electrification in Malawi. It sought to establish if an acceptable

[1] This assumes the adoption of the MGDS 1 in 2006 as the official time GoM started calling for PPPs

PPP could be possible in Malawi, through a case study of Bondo Micro Hydropower Plant. Specific objectives of the study were to:

i. Analyse the existing legal and regulatory framework for PPP development in rural electrification projects in Malawi for opportunities and constraints;
ii. Screen Bondo MHP to establish if it meets the initial criteria for implementing projects using the public-private partnership model;
iii. Analyse electricity consumption characteristics of Bondo community; and
iv. Conduct financial analysis to find out if a PPP for Bondo MHP can result in an improved rate of return that can attract private investors.

1.4. RESEARCH QUESTIONS

In order to address the aim of the study, the following research question was devised: What are the possibilities of implementing a SSHP project for rural electrification in Malawi using the Public-Private Partnership model? Finding the answer to the question involved answering the following specific questions:

i. What are the main opportunities and constraints, in the existing legal and regulatory framework for PPP development, in the implementation of SSHPs projects for rural electrification?
ii. To what extent does the Bondo MHP meet the criteria for implementing projects under Public-Private Partnership?
iii. How can the power consumption for Bondo community be characterised?
iv. To what extent can a PPP improve the rate of return such that Bondo MHP can attract private investors?

1.5. AREA OF THE STUDY

Bondo Micro Hydropower Plant also called Luchenya MHP is in Mulanje District, in the Southern Region of Malawi. Mulanje District is about 66 km from the City of Blantyre while the power plant is approximately at 15 km from the Boma (district headquaters). The power plant is on the left bank of Lucheya River; the intake is located at 2.4 km west of a village called Kalamwa whereas the power house is 1.4 km from the nearest village (Figure 1-2). The power plant was designed to benefit Bondo community, a composition of about 200 households spread in seven villages on the lower slopes of Mulanje Mountain. The community has a hospital clinic and school which were also included in the project plans as beneficiaries.

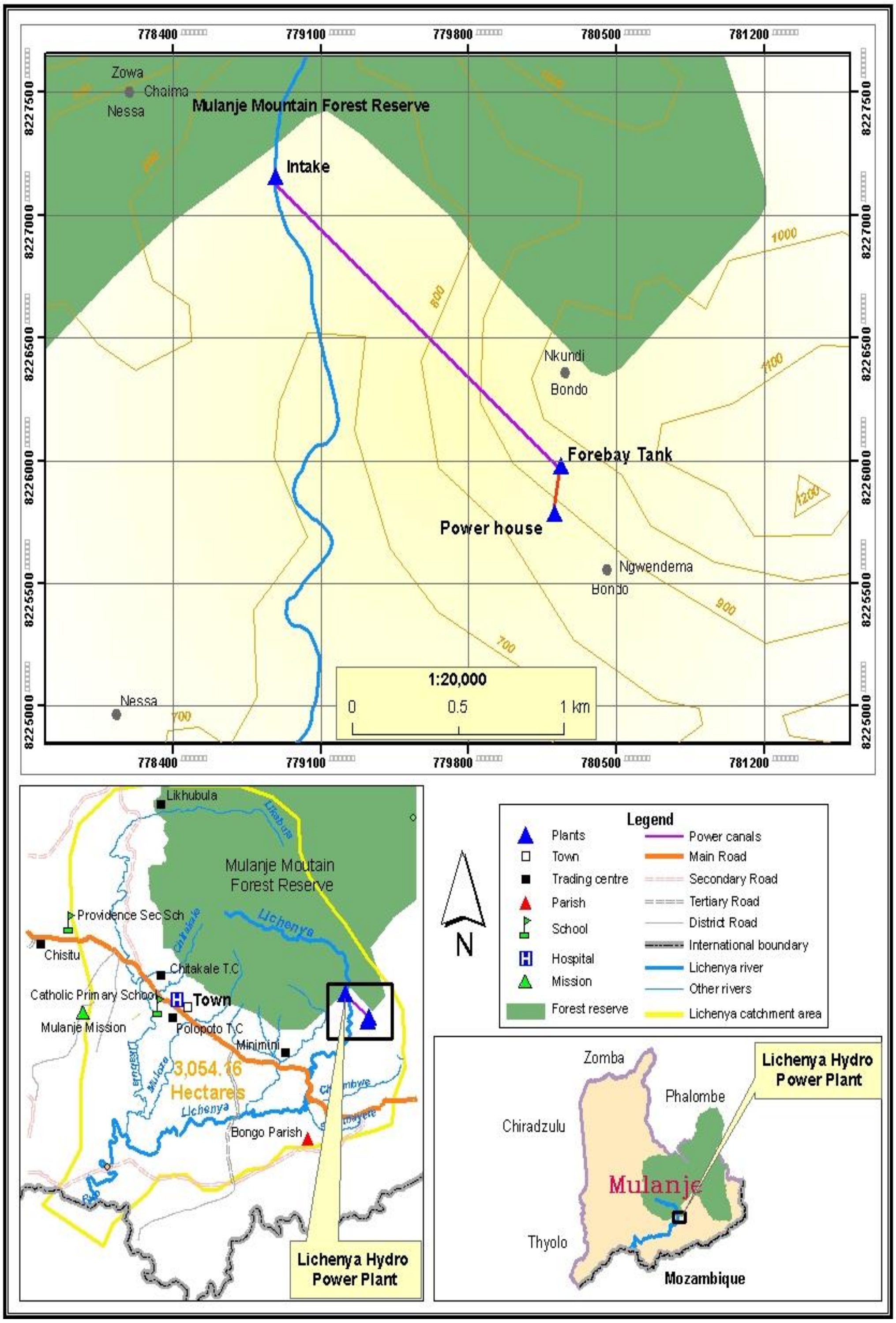


Figure 1-2: Map of Bondo Micro Hydropower Plant

Source: MUREA (2013)

Bondo MHP project was implemented under the Practical Action's European Commission (EC) funded regional micro-hydro project (2007-2012), which was aimed at establishing 11 micro-hydro mini-grids using community based models in Malawi, Mozambique and Zimbabwe. The project for Malawi was coordinated by Mulanje Mountain Conservation Trust (MMCT); while implementation was done by a local NGO known as Mulanje Renewable Energy Agency.

Project implementation commenced in 2008 and completed in 2013. However, electricity distribution did not start until January 2016. From 2013 – 2016 the plant was undergoing renovations after the water tunnels were washed away by floods and system upgrades to comply with Malawi Energy Regulatory Authourity (MERA) electricity distribution license conditions. During the study the power plant was being managed by Mulanje Energy Generation Agency (MEGA), a private company established by Mulanje Renewable Energy Agency.

1.6. RATIONALE OF THE STUDY

From the academic point of view, it was imperative to carry out the study, as there is limited academic work on PPPs and Rural Electrification in Malawi. There is also less research on hydropower in Malawi and little is known about the existing power plants. Thus, the research will contribute to increasing academic work in the area, which can also be used for further research or as an information source.

From the practical point of view, the results of the case study of Bondo MHP forms the basis for improving the technical and financial performance of the power plant and other SSHPs and ensuring that new power plant projects that may be implemented in Malawi are a success. The study has carried out a detailed analysis of the power plant and it has analysed future cash flows for a period of 25 years through financial simulation. Results of the analysis form a base data from which Bondo MHP, other power plants, and new SSHPs can be improved.

To the Government of Malawi and private investors, the study provides the basis for the promotion of PPPs in SSHP projects for rural electrification. The study has established some of the actions that need to be taken to ensure that PPPs to be a reality. The results of the study can also be used for making investment decisions on the Bondo Micro Hydropower Plant.

1.7. LIMITATION OF THE STUDY

The study encountered a lack of detailed financial information about the implementation of Bondo Micro Hydropower Plant. There was a general poor record keeping during the construction of Bondo MHP (Nyengarai & Hungwe, 2011) and it was established during the study that some records were lost during the transitioning from MUREA management to MEGA management. As a solution, where there were no exact information, estimations were conducted using information from literature. Unfortunately, it is impossible to be exact with estimations, which is a limitation of the study.

It is also important to note that SSHPs are site specific, and the implementation conditions and performance are usually different for different locations. This is a limitation as the result of the study may not be applicable to other SSHPs or be lacking for other SSHPs plants. The financial analysis carried for Bondo MHP also did not take into account that management decisions can also improve or lower the performance of a Small Scale Hydropower Plant. As such, caution has to be applied before generalizing or applying the results to different situations. Nonetheless, the study has succeeded in establishing whether it is possible to have a PPP in SSHP for rural electrification in Malawi.

1.8. ORGANISATION OF THE THESIS

This thesis is divided into 5 chapters. Chapter 1 introduces the thesis through a general background, problem statement, research aim and objectives, research questions, rationale and limitations of the study. In Chapter 2, a detailed report of the literature review has been provided. Chapter 3 provides the research methodology, including the approach and strategies that were used. The methods of data collection and analysis including the use of RETScreen to carry financial analysis have also been explained in this Chapter. Chapter 4 gives the research findings and discussion. Chapter 5 provides the conclusion of the study. Details of references cited in the text and appendices have followed this Chapter.

CHAPTER 2

LITERATURE REVIEW

2.0. INTRODUCTION

This Chapter seeks to review literature relating to Public-Private Partnerships, focusing on their implementation in Small Scale Hydropower Plants project, for rural electrification in Malawi. It starts with a review of the definition of PPPs, types and how they are structured, in order to ensure that the research is built on a clear understanding of PPPs. Factors that are critical for implementing projects as PPPs and attracting private investors to PPPs are analysed later in the chapter with an aim of establishing variables, which should be explored further in order to answer the research question. The Chapter ends with a review of theories related PPPs, and relevant literature on rural electrification in Malawi.

2.1. THE DEFINITION OF PUBLIC-PRIVATE PARTNERSHIPS

There is no consensus on the definition PPPs. This is likely because there are various contractual arrangements as well as multiple objectives for which PPPs are used (Hodge & Greve, 2009; Mihaela, 2013). Therefore, for the basis of this study, the definition of PPPs is as provided in the Malawi PPP Act (2011)

> A form of cooperation in which a contracting authority partners with a private sector partner to build, expand, improve, or develop infrastructure or service in which the contracting authority and private sector partner *contribute* one or more of know-how, financial support, facilities, logistical support, operational management, investment or other input required for the successful deployment of a product or service, and for which the Contracting Authority and the private sector partner is compensated in accordance with a pre-agreed plan, typically *in relation to the risk assumed and the value of the result to be achieved* (p. 10).

From the definition, the following key features for PPP projects can be derived: they usually require a big investment, they are complicated to manage and they involve a high risk. A number of PPP guidebooks including European Commission [EC] (2003), International Monetary Fund [IMF] (2004), Asian Development Bank [ADB] (2006), United Nations Economic Commission for Europe [UNECE] (2008) and World Bank (2009), have agreed on these characteristics. UNECE also adds that the projects are usually long-term services provision, sometimes up to 30 years. Examples of the projects as provided in the PPP Act in

Part V, Section 25 (1) are given in 'appendix 1' and energy is included. This is where SSHPs for rural electrification falls.

2.2. TYPES OF PUBLIC-PRIVATE PARTNERSHIPS

There are many types of PPPs which can be formed. The PPPs are commonly described in terms of the following three broad parameters (World Bank Insititute, 2012):

1. **Whether the PPP is for a new or existing asset**: a private company can be involved in financing, building, and managing new infrastructure assets or rehabilitating, extending, financing, upgrading and managing an existing one;
2. **Functions which the private party is responsible for**: the private may take Designing, Building or Rehabilitating, Financing, Maintaining and Operating responsibilities depending on the asset and the service involved; and
3. **How the private party is paid:** a private company may be paid by collecting fees from service users, or by the government, or by a combination of the two.

The nomenclature for the PPP types ussually captures the functions which the private party is responsible for. For example, the PPP type Build-Own-Operate (BOO) means that the private party is responsible for building, ownership and operating of an infrastructure. Other PPP types, as provided by the PPP Act include Build-Own-Operate-Transfer (BOOT), Build-Own-Transfer (BOT), Build-Own-Operate (BOO), Design-Finance-Refurbish-Operate-Transfer (DFROT) and Design-Finance-Build-Operate-Transfer (DFBOT) (Part V, Section 25 (2). The Act also allows for concession or leases and any other type of PPP as the Public-Private Partnership Commission shall dertermine. Further description and more PPP types of are provided in appendix 2.

2.3. STRUCTURING PUBLIC-PRIVATE PARTNERSHIPS

2.3.1. Risk Identification

According to World Bank Institute (2012), "the first step toward structuring the PPP is often to put together a comprehensive list of all the risks associated with the project" (p. 153). This is what can be said as risk identification and possible when one knows what is a risk.

The study reviewed the definitions of risk and established that a risk can mean two things: (1) an unwanted thing, or (2) the potential of being affected by an unwanted thing. For example, European Commission (2003) has defined a risk as any factor, event or influence that threatens the successful completion of a project in terms of time, cost or quality. Here a risk is the an unwanted thing. On the other hand Irwin (2007) has defined a risk as an unpredictable variation in value arising from unpredictable variation in a risk factor, where a risk factor is a variable whose outcome affects total project value and whose value is uncertain. Here a risk is the potential of being affected by an unwanted thing. Both European Commission (2003) and Iwirn (2007) have however provided the same examples of project risk – demand risk, insititutional risk, economic risk and so on. That is their definitions are refering to the same things, which can be confusing. Hence, to ensure that there is one meaning of risk, the study will look at project risk as defined by Keçi (2015) "an event that focuses on the future, emphasize the negative effects, and deals with the probability and consequences" (p. 3145).

Certain risks are common to many types of PPP projects which facilitates grouping the risk into risk categories (World Bank Insititute, 2012). For example, the Global Environmental Facility (GEF) categorised risks in SSHPs for the proposed project, 'Promoting mini grids based on small hydropower for productive uses in Sierra Leone', in Sierra Leone, into Institutional, Technology, Implementation, Economic, Market/financing, Regulatory, Sustainability and Hydrological and Climate Change risks (Global Environmental Facility [GEF], 2012). This is an example of a detailed categorization (Grimsey & Lewis, 2004; IMF, 2004; and European Commission, 2005). Risk can also be categorised as legal and political and commercial risk (OECD, 2008); macro level - covering risks outside the project e.g. environmental and political risks; mesolevel - risks in the project e.g. construction risks; and micro risk - which concern risks that appear between the partners (Li, Akintoye & Hardcastle, 2001).

The categories are useful when identifying risks. Ussually, a checklist with an established (standard) list of risk categories for a project is analysed for risks in a specific project (UNECE, 2008; World Bank, 2009; National Treasury, 2004). The checklist is also reffered to as a risk matrix. However, when using an established list of risks there is the possibility that some risks may be left out; hence, after identifying risks, it is recommended to go through the stages of the project and consider scenarios that my actually happen (National Treasury, 2004). Risk identification is ussually done at a work shop.

2.3.2. Risk Assessment

In many PPP manuals and guidebooks, risk identification is followed by risk assessment. This entails the identification of the impact of each risk (National Treasury, 2004). According to 'National Treasury', the impact is influenced by effect, time, and type of the risk. Using the "GEF" risk categorization, this review has briefly assessed the risk in a SSHP project for a rural electrification in Malawi as follows:

Institutional risks: According to GEF (2012), institutional risks look at the Government and its commitment to SSHP projects. However, in Malawi a whole lot of other institutions including NGOs, ESCOM, Banks and MAREP are concerned.

According to Girdis and Hoskote (2005) the delivery of rural electrification projects in Malawi is affected by institutional risks through a lack of an effective institutional structure, no autonomy in decision-making, no realistic charging policy, high entry barriers, no good selection of areas to be electrified, and not much minimization of capital and operating cost. Girdis and Hoskote proposes making practical, the reforms which have already been passed (e.g. the Power Sector Reform Strategy). A further review of the policies is also required.

Technical risks: This risk encompasses people's acceptance of the technology, design success (failure of technology) and effects of the technology on other water users (GEF, 2012). Considering that already there are SSHPs that were accepted and are working/worked well, the risk of acceptance and failure of technology is low in Malawi. Similarly, SSHPs have no major effects on other water users, especially downstream user, as the water is returned to the river.

Implementation risks: According to GEF (2012), implementation risk include problems, which end up delaying completion of the project. The risk is relatively high in Malawi as from experience; most projects are not completed during the planned time. Bondo MHP experienced this problem and Nyengarai and Hungwe (2011) attributed it to limited expertize and a long learning curve, long process of clearing imported power plant materials and the rising cost in fuel which threatened the project budget. Implementation risks can also result from devaluation of the currency, scarcity of some project materials and materials taking long to arrive as most things are imported in Malawi.

Economic risks: GEF (2012) here looked at people's ability to pay for a connection and electricity use, and found that it is very low for rural people, something that Khennas and Barnett (2000) and Malawi Government (2009) agreed. GEF (2012), Khennas and Barnet (2000), and New and Matteini (2006), have given one way around this - investing in end use technologies so that the electricity is used for productive purposes.

In addition to ability to pay, revenue, demand, and currency risks also fall under economic risk (World Bank, 2009). Demand risk is the central determinant of the PPP's financial viability, especially where user fees comprise the entirety of the private party's revenue stream (US Department of Treasury, 2015). It determines the level of revenue, hence the total profits. The US Department of Treasury adds that demand risk is high for "greenfield projects" as there is no past usage baseline to project the risk.

Market/ Financing risks: Under this risk, the focus is on financing both establishing of a SSHP plant and investing in the community to increases productive use of the electricity (GEF, 2012). The risk is high as SSHP involve a high upfront cost such that the investor has to borrow. Unfortunately, banks and insurance companies are reluctant to provide a loan owing to the high economic risk (JJenssen, Mauring, & Gjermundsen, 2000). Similarly investing in the market means even more money and more financing problems. Other stakeholders have to help.

Regulatory risks: This risk is likely to occur where the regulator is not independent, is not predictable, does not have clear responsibilities and streamlined procedures, does not have clear laws and guidelines and does not have streamlined procedures and over regulates (Girdis & Hoskote, 2005; MIRREIA, 2005; Eberhard, 2005). In Malawi, the Malawi Energy Regulatory Authority (MERA), established under the provisions of the Energy Regulation Act 2004, regulates the energy sector. The roles of MERA are clear in the Energy Regulation Act 2004; they include, among others, provision of license for electricity generation, transmission and distribution, approving of electricity tariffs, resolving conflicts and charging fines. Additionally, Part III of the Energy Regulation Act provides for mechanisms for sourcing funds for its operations, which ensure that it is not dependent on the government. According to New and Matteini (2006), regulator's reliance on the government for funding impedes its independence. Further, activities for MERA and operation guidelines are regularly published on its website, which also ensures that the regulatory body its responsibilities are clear and it is predictable. Therefore, regulatory risk is assessed as low in Malawi.

Sustainability risks: Sustainability concerns arise when a project successfully delivers outputs but fails to achieve project outcomes and objectives and when there is the introduction of other cheap sources of energy (GEF, 2012). Sustainability risk is simply failure to maintain the results of the project.

According to Khennas and Barnett, (2000) sustainaibility risk is high in projects financed using grants; the risk lowers where there is private investment. This is because financial sustainability of SSHPs for rural electrification is dependent on a high load factor (average power demand versus maximum power demand), productive end use, and containment of costs through good design and management and effective management of the installations, including setting up tariffs that keep up with inflation (Khenas & Barnett, 2000). When a project is financed by a grant, usually there is no business-like management resulting in paying little attention on the mentioned financial sustainability factors.

With respect to the introduction of other cheap sources of energy, sustainability risk likely to be high when the national grid extends into an area with an off-grid system.

Hydrological and Climate Change risks: SSHPs are mostly run-of-the-river type hydropower plants, which are dependent on river flow. When the flow is high, there is a high power output while a decrease results in a decreased power output. This dependence unfortunately also makes them vulnerable to hydrological and climate change risks. In addition, SSHP are the most vulnerable; any small change in water level immediately results in changes in power output (Weimman, Muller & Senior, 2007). Harison (2005) has attributed this to SSHP having a little or no storage, as they are usually run-of-river plants. As a solution engineers suggest detailed feasibility studies on hydrological and weather change pattern; and having a system that is designed with safety and sustainability factors to avoid damage of the plant in case extreme weather conditions occurs during plant lifetime.

2.3.3. Risk Allocation

Risk allocation is the third step in the structuring of a PPP. The general agreement is that risk should be allocated to the partners that can best handle them at least cost (PPP Act 2011, Section 23 (9); World Bank Institute, 2012; UNECE, 2008; ADB, 2006; IMF, 2004; & EC, 2003). This means, (according to World Bank, 2009; Iwirn, 2007; and Renda and Schrefler, 2006), allocating risks to a partner that is:

1. Able to control the likelihood of the risk occurring - risks should be given to a partner that can best assess and find a way of avoiding it;
2. Able to control or manage the impact of the risk on the project – risks should be given to a partner that can assess the risk, anticipate it and respond it well; and
3. Able to absorb the risk at lowest cost – this is where the risk can not be controlled.

Proper allocation of risks is important as managing risks comes at a price. For example, if risks rest inappropriately with the public sector, government will raise taxes or reduce services to pay for its obligations when the risks materialise (Jin, 2007). If they rest inappropriately with the private sector, Jin (2007) stated that excess premiums would be charged to the government or to the end users depending on how the private investor is paid.

The output of a risk allocation is often a risk matrix (used as checklist for risk identification on new projects as discussed in section 2.3.1), which lists risks and defines who bears each risk (World Bank Insititute, 2012). The risk matrix ensures that all the risks are addressed during contract negotiations and helps assess how partners are affected by the risk after signing a contract (UNECE, 2008). Hence, many governments, including the government of the Republic of South Africa, have captured standard risk allocation matrices in their PPP Manual. Several researchers have also proposed standard risk allocation matrices, which can be used where the projects are similar. However, in reality, it is important to understand that these models are limited since risks must be analysed and managed on project-by-project basis (Carbonara, Costantino, Gunnigan, & Pellegrino, 2014).

There is also no single PPP in SSHP, which can be used as a reference for allocation of risks in *our* project. Furthermore, there is no PPP manual let alone gazetted risk allocation matrices. However, in the irrigation sector, a study produced a PPP model option for Shire Valley Irrigation Waterway Project (BRL, 2011). The risks identified in the project are similar to that of a SSHP project and can hence be adapted. Alexanderson and Hultén (2007) and European Commission (2003) have also produced PPP models for infrastructure projects; together with BRL the risk allocation matrix in table 2.1 is developed for SSHP project:

Table 2-1: Discussion of a suggested risk allocation for a SSHP project

No	Risk Category	Allocation	Comment
1.	Institutional	Public	The government should create a good environment for promotion of SSHP
2.	Technical	Private	Best assumed by party in charge of construction
3.	Implementation	Private	BRL, (2011) stated that this has to be assumed by party in charge of construction. However, European Commission, (2003) indicated that the Government must retain risks of changes to output specification changes (e.g. exchange rate).
4.	Economic	Shared	BRL, (2011), suggested sharing risks when the demand is low or paying capacity is low.
5.	Market / Finance	Shared	Alexanderson and Hultén, (2007), suggested giving this to the Private. However, BRL, (2011) indicated if the project is not viable on its own, sharing is the best option. Other stakeholders also required.
6.	Regulatory	Public	European Commission, (2003) stated the government can best ensure that no discriminatory legislative comes in to frustrate the project but rather they should facilitate it.
7.	Sustainability	Shared	The private can help to improve management of the power plant and ensure that it is competitive, while the public and other stakeholders invest in the community thereby improving the load factor.

No	Risk Category	Allocation	Comment
8.	Hydrological	Public	According to BRL, (2011) if the risk is not insurable the Public has to take it. Other nature acts under this are floods and earthquakes.

***Note:* Adapted from BRL (2011), European Commission (2003) and Alexanderson and Hultén (2007)**

2.4. REASONS FOR IMPLEMENTING PROJECTS AS PUBLIC-PRIVATE PARTNERSHIPS

Being able to transfer risks to the partner that is able to handle them at least cost is not enough reason to deliver a project as a PPP. Where the project can be delivered through other forms, World Bank (2009) argued, asking the question – should it be delivered as a PPP? According to "the bank", a PPP is appropriate only when it will achieve Value for Money (VfM). This is also emphasized in the PPP Policy for Malawi, which says, "the choice of the PPP arrangement for a particular project will depend on Government's policy in the related sector and on potential Value for Money to be generated under such an arrangement" (p. 8). Similarly, Grimsey and Lewis (2005) identified VfM as the most critical accounting question when structuring PPPs.

VfM is achieved when a PPP project yields a net positive gain to society that is greater than that which could be achieved through any alternative procurement route (European PPP Expertise Centre, 2016). This is usually associated with lower prices for products or services. However, Harris (2004) argued that "VfM can still be achieved by, perhaps, spending a little more than a conventionally procured solution but achieving a far superior service as a result" (p. 10). Hence, VfM should be associated with economy[2], defined as doing less with fewer resources; efficiency[2] defined as doing the same with fewer resources; and effectiveness[2], defined as doing more than before with the same resources (UNECE, 2008). Where there is VfM, in addition to lower prices, higher level of services and reduced risks are expected.

In addition to VfM, the PPP Policy of 2011 has provided the following as other reason for implementing projects as PPPs: ensuring speedy, efficient, and cost-effective delivery of projects, creation of added value, alleviation of capacity constraints, accountability for the provision and delivery of quality services, innovation and diversity in the provision of public services, and effective utilization of state assets. Specific to the electricity sector, Malawi Government (2009), stated that financial resources are scarce such that investments for new generation can only be leveraged by involving the private sector. That is PPPs in the electricity

[2] Definition provided by Imperial College of London (2016)

sector are encouraged for financial reasons. According to Power Sector Reform Strategy 2003 and the Malawi Department of Energy (2003), PPPs are also encouraged as a way of introducing competition and increasing generation capacities.

The reasons behind the promotion of PPPs in Malawi's electricity sector are similar to those from other countries in Africa. The Bujagali Hydro-power Project, the first Independent Power Project (IPP) in Uganda, was implemented as a PPP because a private sponsor was needed to address financing and risk mitigation concerns (Nsasira, Basheka, & Oluka, 2013). In Rwanda, the main reason for delivering projects as PPPs, according to Nuwagaba (2013), is to foster economic growth amidst inadequate finances.

While accessing private finances is of great importance, the roles of public actors including social responsibility, social justice, public accountability, and local knowledge should not be overlooked (Roehrich, Lewis, & George, 2014). Hence, PPPs help combine the strength of the private and the public for the successful delivery of infrastructure or service.

2.5. ATTRACTING INVESTORS TO PUBLIC-PRIVATE PARTNERSHIPS

While VfM attracts the public to PPPs, private investors are attracted by other factors. According to Harris (2004), these include: existence of many potential PPP projects in the country, good credit rating, familiar contractual and legal structures, existence of a committed PPP tasks force, manageable political sensitivities, capable local industries and service firms, strong local financial structures (e.g. banks), and projects which offer scope for innovation in design and are bankable. The given factors are similar to the ones identified by European Commission (2003), which are fair profit, reward for risk mitigation, clear legal/regulatory structure, growth potential, political support, and political stability.

Basing on European Commission (2003), a fair profit, referred to as bankability by Harris (2004), is the number one attraction to PPPs. The fair profit also relates to project risks whereby in return for greater risk exposure, the private sector will require the potential for commensurate increases in profit potential. In agreement, Malawi Government (2009) and Muzenda (2009) indicated that the private is attracted by "financial returns". Adding to this, Malawi Government stresses that, a project is likely to attract PPPs when the rate of return is greater than the base bank lending rate. This is obviously linked to financing of infrastructure projects, which is mainly through bank loans.

Unfortunately, SSHPs projects for rural electrification have the reputation of low rates of return (Kabaka & Gwang'ombe, 2007). Malawi Government (2009) has also indicated this, noting that while there are many SSHP potential rivers (refer to appendix 4) in Malawi, the sites are too small and may have uncompetitive rate of returns to attract PPPs. Similarly, Muzenda (2009) contended, "efforts at attracting the private sector to rural electrification projects are likely to be futile due to the low returns on investment" (p. 45). Nonetheless, this should not stop exploring if there are opportunities for PPPs in SSHP for rural electrification. Malawi Government (2009) encourages a detailed consumer analysis that assesses the level of demand and willingness to pay of beneficiaries and the contribution of government and other stakeholders in order to ascertain if a project has a viable rate of return. Moreover, according to there are examples of Micro Hydropower Plants in developing countries (e.g. Seetha Eliya – Sri Ranka, Barpak - Nepal , Atahualpa and Yumahual in Peru and Svinurai in Zimbabwe) that have viable internal rates of returns (Khennas & Barnett, 2000). However, according to Khennas and Barnett (2000), all these were initially installed to produce mechanical power for a profitable end-use.

Additionally, there are mechanisms which can be used to improve the rate of return on investments. According to Schmidt, Blum and Wakeling (2013) the government should carry out policy reforms, consider subsidies, introduce technology standards and improve access to finance in order to attract investors. Private investors on the other hand, should be encouraged to develop good business models in order to promote the revenue streams (Schmidt, Blum, & Wakeling, 2013). This includes, among others, the use of flat rate charge for using energy in communities where the ability to pay is low as agreed at the Finance and Investment Workshop in 2006 (Finance and Investment Workshop Proceedings, 2006). Further, the workshop agreed that developers must understand how finance markets works, in order to increase their access loans. RETScreen was identified as one of the tools that can help assess the viability of the project to accessing finance and it was used in this research.

2.6. THEORIES RELATED PUBLIC-PRIVATE PARTNERSHIPS

The thoretic literature mostly contains economic and organisation theories related to risk allocation and management. Generally, this is because any investment has risks, and where the Private and Public have to work together to manage the risks, a new organisation is likely to be formed as the two have different objectives and stakeholders. The objective of the private sector is to make profits with shareholders being stakeholders, while the public seeks to improve social welfare and the stakeholders are the voters.

One of the prominent economic theories, relevant in PPPs, is the Net-Present Value. The theory is practiced in VfM assessments whereby, it helps in investment decision by helping determine future cash flows and expected value of uncertainties. However, it is argued that the NPV is weak as it does not take into account the fact that managerial decisions can change cash flows once the project is being implemented (Anamari-Beatrice, 2014). Hence, the real option theory, which modifies the NPV theory, is proposed.

Real options theory refers to the "right, but not the obligation, to take different courses of action (for example defer, abandon and expand) with respect to real assets as opposed to an option on financial securities or commodities" (Chartered Institute of Management Accountants, 2005, p. 95). Using this theory, investment evaluations take into account the managerial decisions which are implemented in response to uncertainties (Anamari-Beatrice, 2014). Classical real options model evaluates new project by identifying a linked portfolio trading strategy for a project with similar risks and returns. From the literature findings, this is complex and may be too intractable to handle. In addtion, it may be impossible to find a project with similar similar risks and returns (Anamari-Beatrice, 2014).

Another prominent economic theory is the Transaction Cost Economic (TCE) started by Oliver E. Williamson in the 80's and used by Nsasira, Basheka, and Oluka (2013) to examine the contractual structure, assets specificity, and comparative costs of buying decision making in the PPPs in the Uganda energy sector. Transaction costs are costs bourne during making an economic exchange, for example, the cost of finding suppliers, negotiating contracts, enforcing contracts. The TCE theory recognises that there are these costs, and asserts that such costs give rise to various forms of economic organisations (Coarse, as cited in Jin, 2007). Precisely, the organizations emerge as a way of economizing on transaction costs in a world of uncertainty, where contractual arrangements are too expensive (Nsasira, Basheka & Oluka, 2013).

The transaction costs are not the only factors for the emergence of PPP organisation. With reference to a rule presented by Chandler (1962), 'strategy follows structure', Petković, Djedović-Nègre, and Lukić (2015) has argued that a PPP as a business structure requires a well designed organisation, reffered as a special purpose vehicle or company (SPV/SPC), to implement its objectives effeciently. The organisations that support the PPPs (for example the PPP Unit, the regulator) also have to be well organised (Jooste & Scott, 2009). Therefore, the organisation theory is also applied. Organisation theory studies organizations to identify the patterns and structures they use to solve problems, maximize efficiency and productivity, and meet the expectations of stakeholders (Boundless, 2016).

2.7. RELATED RESEARCH

There are a number of papers on rural electrification in Malawi. One of the papers, Gamula, Liu, and Wuyuan (2013) provided an overview of the energy sector, explaining that energy supply is a great challenge for people living in rural areas in Malawi. Gamula, Liu and Wuyuan (2013) have provided the following as solution to the low energy supply: a better political will, allocation of more funds from the national budget to the sector, mobilization of resources and putting in place some incentives for the private sector to actively participate. These solutions can also help promote PPPs for rural electrification in Malawi. For PPPs to be a reality, there is a need for political will, funding and resources, and incentives.

Tenthani, Kaonga and Kosamu, (2013) provided another solution to the low rural electrification state. The researchers propose distributed generation (DG), defining it as the production of electricity near or at the point of use, with capacities of not more than 10MW interconnected at a sub-station, distribution feeder or at the customer load levels. According to Tenthani et al. (2013), DG can help avoid the high costs of extending grid lines in addition to solving the low generation problems. This is a characteristic of a SSHP project and indeed hydro power is an example of a DG technology.

Malawi Government (2009) has done significant studies on PPPs in SSHPs for rural electrification. Based on the existing laws, the paper suggests BOOT and BOO PPP structures as one way of promoting the development of SSHPs for rural electrification, of which equity may be either 60:40 or 70:30 between the private and public. It should be noted that the exact equity ratios depends on project's rate of return, whereby if the project is not profitable enough, the public has to give away a significant share of the total profit to attract private investment (Sharma & Qingbin, 2009). Recognizing the low investments returns on rural electrification, Malawi Government (2009) proposed the provision of performance based subsidies, for a limited period until when the electricity charges on an electricity project are high enough to cover full cost of operations. This arrangement is aimed at helping the private to recoup the initial investment.

2.8. SUMMARY OF THE LITERATURE REVIEW

PPPs are a form of cooperation between the public and the private sector to provide a public project or service, in which the private sector is compensated in relation to risk allocated and the value of the result to be achieved. Thus, risks are a critical factor for implementing a SSHP for rural electrification project as a PPP. How the risks are allocated determines the PPP structure and the costs for implementing the project, whereby the cost is high if the risks are allocated inappropriately. In addition, the private party is attracted to projects which have the potential for producing commensurate increases in profit for greater risk exposure.

Unfortunately, the cost for managing risks for a rural electrification projects is ussually high, which results in low rate of return on investments. This should however not stop the study, as there is no empirical evidence in literature that PPPs in SSHPs for rural electrification in Malawi can not work. Moreover, there are cases of SSHPs of rural electrification which have yielded a positive return; where they have failed, it is noted that things like perfomance subsidies, flat rate charges for electricity, can improve the rate of return. An important outcome of the study is that a high power demand, ability to pay, affordability and willingness to pay of the consumers are key determinants for profitability of SSHP for rural electrification. Hence, they were considered as the study was developed further.

CHAPTER 3

RESEARCH METHODOLOGY

3.0. INTRODUCTION

This Chapter presents the methodology which was used to meet the objectives of the study. The Chapter is divided into the following sections: research approach, case study, data collection methods, methods of data analysis and ethics.

3.1. RESEARCH APPROACH

A deductive approach was used to find the answer to the research question: What are the possibilities of implementing a SSHP project for rural electrification in Malawi using the Public-Private Partnership model? This approach was adopted because there is already a general call for PPPs to implement rural electrification projects using various technologies including SSHPs, and not much information on whether the PPPs can succeed or not. Hence, the study centred on analysing specific factors that can help verrify whether or not the PPPs can be implemented successfully in Malawi. These included the existing legal and regulatory framework, the feasibility of implementing SSHPs as PPPs, electricity consumption characteristics and financial perfomance of SSHPs.

Because SSHPs are site specific and for a similar reason why the deductive approach was adopted, a case study strategy was also adopted. The strategy aimed at bringing out detailed information on whether the conditions in Malawi favor the implemetion of PPPs in SSHP for rural electrification. Data collection used both qualitative and quantitative methods involving, key informant interviews, focus group discussions and a household survey.

3.2. THE CASE UNDER STUDY

Bondo Micro Hydropower Plant was selected for indepth study because it was considered to be a rich source of data because of the following:

1. It is a new plant hence it was assumed that it was operating at maximum installed capacity;
2. There are a number of written reports about the power plant;
3. It is not a government power plant, hence it was assumed that the business end and sustainability of the power plant are of high concern; and
4. It was easy and less costly to access the power plant for data collection.

The study included the assessment of the legal and regulatory framewok for PPP development in the implementation of SSHPs projects for rural electrification in Malawi; the assessment of the possibility of managing Bondo MHP as a PPP; the analysis of the power consumption characteristics at Bondo Community in order to establish if they are good enough to attract private investors; and the analysis of the financial perfomance of Bondo MHP under different techinal and financial assumptions, in order to establish if a PPP can result in an improved rate of return which can attract private investors.

3.3. DATA SOURCES AND COLLECTION METHODS

Various methods including interviews, focus group discussions, observation and a household survey, were used to collect data from various sources. The rationale for this multi-faceted approach to data collection was to obtain detailed information and to enlist a cross section of views so that the research the objectives of the study, are properly addressed.

3.3.1 Systematic Literature Review

Government of Malawi strategies, policies and legislations pertaining to the promotion of PPPs, rural electrification, and hydropower technologies were reviewed for information which was used to analyse of the legal and regulatory framework for PPPs. These included the Constitution of the Republic of Malawi 1995, Vision 2020, Malawi Growth and Development Strategy II (2011 – 2016), The Energy Policy 2003, Power Sector Reform Strategy 2003, PPP Policy Framework 2011, the PPP Act 2011, and Energy Laws 2004 (Electricity Act 2004, Energy Regulation Act 2004 and the Rural Electrification Act 2004).

3.3.2 Observation

The researcher, accompanied by the Power Distribution Manager for MEGA, visited Bondo MHP during the study. A walk was made from the intake, to the powerhouse and along some distribution lines. The visit was necessary to appreciate the power plant and to verify writen information about power plant characteristics. Information was gathered through direct observation and using an interview protocol (refer to appendix 6a) which was administered to the Power Distribution Manager and maintenance workers who were found on site.

3.3.3 Semi-Structured Interviews

Informal and semi-structured interviews were conducted to collect data from key informants presented in Table 3-2. Interview protocols developed in consideration of the study objectives, and the speciality of the interviewees, were used for data collection. For example, power plant characteristics information was collected from the Power Distribution Manager.

Table 3-1: Key informants for the research

Data source	Collected data
Former Project Coordinator for MUREA (Informal Interview)	1. Project background information 2. Issues that facilitated or delayed the implementation of the MHP 3. Project design, including business models 4. Feasibility study reports 5. Construction and operation of the plant
Power Distribution Manager (refer to appendix 6a for interview protocol used)	1. Power plant characteristics 2. Issues that facilitated or delayed the implementation of the MHP 3. Hydro resources 4. Technical performance of the power plant including challenges which are experienced 5. General financial performance 6. Number of households supplied with electricity and number of units which are sold 7. The power demand profile
General Manager for MEGA (refer to appendix 6b for interview protocol used)	1. Initial cost of the project and annual costs 2. Financing of the plant 3. Annual income and taxes 4. Management model of the power plant 5. Financial performance of the MHP 6. Success and challenges in running the MHP 7. Issues that facilitated or delayed the implementation of the MHP

3.3.4 Focus group discussions

A focus group discussion with members of the electricity users committee was conducted to gather information, on community contribution towards the development of the plant, the value of Bondo MHP plant to the community, current and acceptable tariffs, and community socio-economic characteristics. Views on the management of the power plant by MEGA were also solicited considering that the community was to manage the power plant in the initial plans. A semi-structured questionnaire was used for data collection (refer to appendix 6c).

3.3.5 Household Survey

A household survey questionnaire was administered to heads of households in order to capture information relating to home electricity requirements, economic activities in the area, productive use of electricity, ability to pay for electricity and value of electricity to the households. The questionnaire was carefully designed such that among other things, the interviewer had to introduce himself/herself, provide a brief background of the research and emphasize on the importance of the respondent's cooperation and willingness to respond (refer to appendix 6d).

The questionnaire was administered to selected households, sampled using both random and non-random sampling methods as follows:

1. The sampling population was determined as 210 households. This was the total number of households that were connected during the survey and it was established through an interview with the power distribution manager.
2. A sample size of 36 was determined using a sample calculator, programmed by SurveyMonkey, using the following normal distribution formula:[3]

$$\text{Sample size} = \frac{\frac{z^2 \times p(1-p)}{e^2}}{1 + \left(\frac{z^2 \times p(1-p)}{e^2 N}\right)} \quad \text{.. (i)}$$

Where: N = Population Size = 210; e = Margin of error = 0.15; z = z-score = 1.96

The use of what can be said as a "big" margin of error was justified basing on results of two previous similar household surveys conducted before MEGA started distributing electricity, and the discussions with the Electricity Users Committee, which described the community as being 'homogenous'.

3. Convenience sampling was used for the final selection of the respondents. The respondents were selected basing on closeness to the main road as it was easy to reach them - the households are spread in a vast land and hilly. This method was justified basing on the fact that the community can be said to be homogenous, as described in '2' above. Thus, it was highly probable to get similar information from respondents regardless of where they are located.

[3] Sample calculator is available at SurveyMonkey website and was accessed using this link: https://www.surveymonkey.com/mp/sample-size-calculator/

3.4. DATA ANALYSIS

Collected data was organised and analysed according to the four specific research questions and specific objectives (refer to section 1.3 and 1.4) as follows:

3.4.1. Analysis of the Legal and Regulatory Framework for PPPs

The existing legal and regulatory framework for PPP development in rural electrification projects in Malawi was analysed in order to establish if there are constraints that need to be resolved and opportunities that need to be enhanced in order for the PPPs to be a reality in Malawi. The analysis was conducted systematically as follows:

1. Issues related to legislations, regulations, policies and strategies, which facilitated or delayed the implementation of Bondo MHP project, were identified through interviews, and literature, especially Nyengarai and Hungwe (2011) and The World Bank's evaluation criteria for the legal environment for PPPs.[4]
2. Legislations, regulations, policies and strategies documents, identified through a literature search, were reviewed in order to identify and describe specific legislation, regulation, policy or strategy that is of concern.
3. The specific legislations, regulations, policies or strategies were analysed using personal judgement, by considering their outcomes in relation to promoting the development of PPPs in rural electrification projects. The criteria for "evaluating the impact of regulation and regulatory policy" proposed by OECD, was used in the analysis. The criteria looks at effectiveness, cost-effectiveness, net benefits/efficiency and equity/distributional fairness, outcomes of the regulations, for example, ensuring for technological innovation, macroeconomic growth, and employment (Coglianese 2012).
4. Basing on the analysis in "3" above, the issues were characterised as a constraint or an opportunity.

3.4.2. Public-**Private Partnership Screening of Bondo Micro Hydropower Plant**

Bondo MHP was qualitatively screened to establish if it meets the initial criteria for implementing projects using the public-private partnership model. The study used a screening criteria (refer to Table 3-3) adapted from the South Africa PPP Manual (module 4, page 13).[5] This was used because South Africa has vast experience in PPPs and, like Malawi, it lies in the Southern Africa region; moreover, the screening criteria is accepted by the World Bank (refer

[4] The World Bank evaluation criteria was accessed on http://ppp.worldbank.org/public-private-partnership/legislation-regulation/framework-assessment

[5] The South Africa PPP Manual included in the references, National Treasury. (2004)

to World Bank Institute, 2012). The screening criteria also included areas for consideration when conducting a PPP feasibility study prepared by the Public-Private Partnership Commission (PPPC) for Malawi.[6]

Screening was done by answering screening questions (Table 3-3) using researcher's own expert judgement and information from literature:

Table 3-2: PPP Screening Criteria

Criteria	Screening Question
Legal provisions	What is the nature of the Contracting Authority's functions, the specific functions to be considered in relation to the project, and the expected inputs and deliverables?
	To what extent does the law allow a private partner to perform the functions in terms of an agreement?
	What is the most appropriate form by which the Contracting Authority may implement the project under an agreement?
Scale of the project	Is the project large enough to justify PPP transaction costs?
Opportunities for risk transfer	Is there good reason to believe that a PPP will be affordable to the Contracting Authority?
	Is there good reason to believe that a PPP will transfer appropriate technical, operational or financial risk to the Partner?
	Is there good reason to believe that a PPP will provide value for money compared to the alternative of traditional public procurement?
Outputs specification	Is it possible to specify outputs in clear and measurable terms, around which a payment mechanism can be structured?
Public interest	Is the Government interested in implementing the project as a PPP?
Market capability and appetite	Is there a potentially viable commercial project and a level of market interest in the project?
Capacity of the Contracting Authority	Can the Contracting Authority effectively enforce a PPP agreement, including the ability to monitor and regulate project implementation and the performance of the Partner in terms of the agreement?

Note: Created using National Treasury (2004), World Bank Institute, (2012) and http://www.pppc.mw/articles/the-ppp-feasibility-study

3.4.3. Power Consumption Analysis

Power consumption analysis was aimed at establishing whether the power consumption characteristics for Bondo MHP are good enough to attract private investors. Specific areas that

[6] http://www.pppc.mw/articles/the-ppp-feasibility-study. Accessed on 20 March, 2017

were analysed included consumer demand, power uses, affordability and willingness to pay for electricity. Under consumer demand, the study centred on load factor. This was in consideration that a high load factor is one of the factors for financial sustainability of SSHPs (Khennas & Barnett, 2000), while financial sustainability is one of the factors that attracts private investors to PPPs (Harris, 2004; European Commission 2003). On the other hand, the analysis of power uses, affordability and willingness to pay centred on establishing the level productive use of electricity, tarriffs which the community can manage and the value of electricity to the community respectively. The framework for the power consumption analysis which was used is sumarised in Table 3-4 below:

Table 3-3: Power consumption analysis framework

Study area	Parameter under study
Consumer demand (Power demand profile)	Load factor
Uses of power	Productive use
Affordability	Acceptable and manageable tariffs
Willingness to pay	Value of electricity

All the parameters were assessed as either high or low, with high meaning that the parameter is attractive to investor and low, not attractive.

3.4.4. Financial Analysis

Financial performance analysis was carried out to establish if a Public-Private Partnership could result in an improved rate of return that can attract private investors. Thus, a comparison was made on the financial performance of Bondo MHP under modelled public, PPP and private implementation arrangements.

Financial analysis was carried out using RETScreen (Renewable Energy Technologies Screening) version 4, a free computer programme that uses Microsoft Office Excel Worksheets. This is a clean energy management software for energy efficiency, renewable energy and cogeneration, project feasibility analysis as well as ongoing energy performance analysis (Natural Resources Canada, 2017). It uses a five-step standard procedure (Energy Model, Cost Analysis, Emission Analysis, Financial Analysis, and Sensitivity and Risk Analysis) to analyse projects as shown in figure 3-1. Emission, sensitivity and risk analysis are however optional and were not carried.

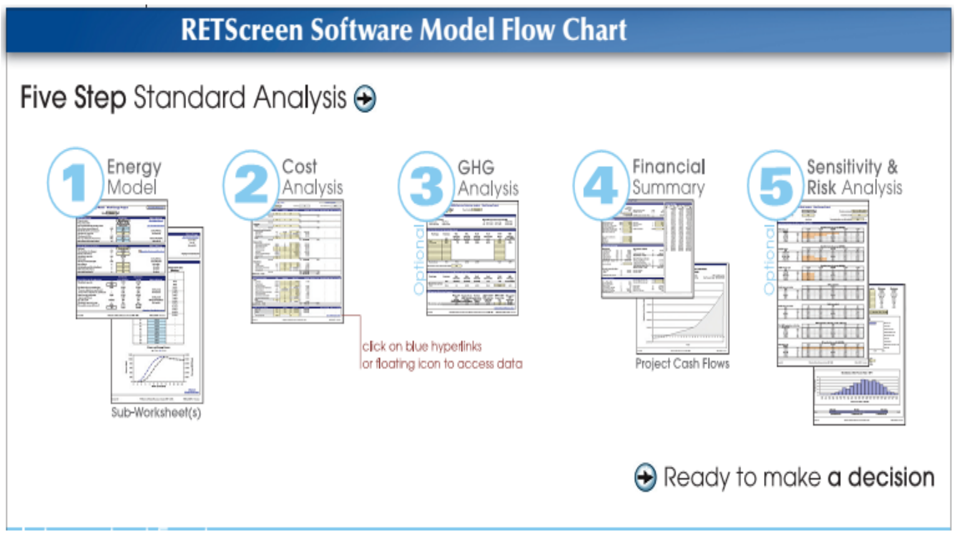


Figure 3-1: RETScreen software model flow chart
Source: Natural Resources Canada, 2005

Financial analysis was carried out under different technical and financial operating conditions and assumptions, combined as Scenario 1, 2 and 3 as follows:

1. **Scenario 1:** Under this Scenario, RETScreen input parameters were based on the actual parameters of Bondo MHP as established through interviews with key informants, literature review, site visit, and data analysis. Detailed costs for implementation of Bondo MHP project were however not available due to a general poor record keeping during the construction of Bondo MHP (Nyengarai & Hungwe, 2011). It was also established during the study that some records were lost during the transitioning from MUREA management to MEGA management. Table 3-3 presents the key parameters and inputs that were used for financial analysis under Scenario 1.

   Scenario 1 was divided into three as follows:

   - Scenario 1a, modelled with the initial cost as wholly financed by a grant (100% grant), which is also actually how Bondo MHP was financed;
   - Scenario 1b, modelled with the initial cost as a 40% grant and 60% loan (private financing) which imitates a 40:60 public and private ownership PPP, suggested by the Millennium Challenge Cooperation (Malawi Government, 2009); and
   - Scenario 1c, modelled with the initial investment of 100% loan; that is wholly financed by the private.

Table 3-4: RETScreen key parameters and inputs under Scenario 1

Step	Parameter and Input	Comment
Start	**Analysis type:** Method 2	Method 2 was selected as it allows detailed financial analysis as compared to method 1.
Energy Model	**Analysis type:** Method 1	Simplified analysis was appropriate because the MHP is operational. Hence, there was no need for detailed hydrological analysis, selection of hydro turbine, etc. which is done under method 1.
	Hydro turbine: 60 kW	60 kW is the maximum generation capacity of Bondo MHP.
	Capacity factor: 47 %	This is the average power produced by the power plant in a day (on 7 to 14 February 2016) to the absolute power that the power was designed to produce in a day.
	Export rate: 92.68 $/MWh	At Bondo, electricity tariffs are categorised into households – 92.34 $/MWh, social institutions – $46.2/MWh and Businesses – 109.23 $/MWh. However, RETScreen uses one tariff hence the tariffs were averaged using percentages of the categorised users.
Cost Analysis	**Analysis type**: Method 1	Only few details of the costs for the construction of Bondo MHP were available hence the use of Method 1. The total installation cost was established as $406,000.00 and the costs for other parameters were estimated from it. Having few details did not affect the study as the total cost is the main input to financial analysis.
	Feasibility cost: 3 % of the total project cost	The size of the project justifies using 3% as the cost for the feasibility study. Feasibility study costs for SSHP normally range from 0% - 5% of the total project cost (Puyot, 2013).
	Development cost: 10% of the total project cost	Development costs (all cost related to managerial activities) uses a significant amount of money even for small projects (Puyot, 2013).
	Engineering cost: 17 %	Includes costs for project designing, tender and contracting and contract supervision.
	Power systems cost: 60%	Includes costs for hydro turbine and transmission lines hence a substantial amount is required.

Step	Parameter and Input	Comment
	Balance of system & miscellaneous: 10%	Includes cost for spare parts, training, transportation and contingence. The power plant was constructed using off-the-shelf equipment, thereby requiring less initial spare parts. However, a substantial amount may have been spent on transportation, as the turbine was not sourced in Malawi. Therefore, basing on expert judgement, 10% may be 10% for this category is justifiable.
	Operational and Maintenance Cost: $45,000	Includes cost for labour, office stationary, insurance, transmission line etc. During the study, the power plant was in its third month of operation hence full annual operation and maintenance cost was not available. According to Puyot (2013), the cost may range from 3% to 6% of the project cost while International Renewable Energy Agency (2012) says the cost may range from 1% to 4%. After considering these estimates, a 4% cost for operational and maintenance seemed justifiable.
	Periodic Cost: $10,000	This include the cost for civil works after 5 years and extensive turbine repairs after 10 years. The cost was estimated considering that the turbine is brand new such that periodic repairs are likely to be needed; and the area periodically floods which will also necessitate major civil works.
Financial analysis	**Inflation rate:** 15%	Average inflation rate from July 2015 – July 2016
	Discount rate: 23.5%	Central bank discount rate for Malawi quoted on 18 September 2016
	Loan Interest Rate: 34%	Commercial bank base lending rate quoted from http://www.natbank.co.mw on 18 September 2016
	Project life: 25 years	Provided by MEGA
	Incentive grants: $406,000	The power plant was constructed using a grant from several organisations.
	Electricity escalation rate: 28%	The electricity escalation rate was estimated by averaging the percentage electricity tariff increase for the period 2014 – 2015 and 2015 – 2016.

2. **Scenario 2:** Here Scenario 2a, 2b and 3c were modelled as under **Scenario 1** but with a hypothetical reduction in initial investment cost of 20% and increase of the capacity factor from 47%, which was the actual capacity factor[7], to 60%.

   The rationale for reducing the initial investment cost by 20% was the observation the cost might have been high because of the following: the use of untrained staff resulting in resource wastage, poor procurement methods protracted implementation of the project, and the devaluation of the currency that occurred before completing construction work (Nyengarai and Hungwe 2011). During a site visit, it was also established that the intake, water channels, and powerhouse were washed away by floods, at least twice before the MHP was commissioned. These are results of a weak feasibility study and may have increased the initial cost as well. On the other hand, the increase of the capacity factor to 60% is justified as Bondo is a regulated run-off river type MHP; capacity factor for these types of MHPs can go as high as 90% (Puyot, 2013).

3. **Scenario 3:** Under this Scenario, a hypothetical reduction in operation cost of 20% and a reduction of loan interest rate from 34% to 15% were introduced to Scenario 1b, producing Scenario 3.1, and was also applied to Scenario 2b, producing Scenario 3.2. That is, s, Scenario 3 was built from Scenarios representing PPPs. The rationale for the interest rate reduction is the fact that a PPP can help the private to access "cheap" loans, for example, from development banks. On the other hand, the operation cost may be reduced by subsidies as proposed by Malawi Government (2009) and an increase in capacity factor (an increase in capacity factor would mean more connections but using the same human resources).

Note that financial analysis was carried under the assumption that the power plant selling 100% power being produced. RETScreen calculates a number of key indicators of financial viability. Key (output) Indicators of financial viability that were analysed include the following:

1. Internal Rate of Return (IRR): presented in percentages, it is the true interest yield of the project over its lifetime. It is also known as the return on investment (RoI) and was the focus of the study;
2. Simple Payback: presented in years, it is the length of time that it takes for a proposed project to recoup its own initial cost, out of the income or savings it generates;

[7] Capacity factor was found by averaging the power produced by the power plant in a day (on 7 to 14 February 2016) comparing it to the absolute power that the power was designed to produce in a day.

3. Net Present Value (NPV): presented in years, it is the value of all future cash flows, discounted at the discount rate, in today's currency; and
4. Energy Production Cost: Presented in USD/kWh, this is the cost to produce a kWh of energy.

3.5. ETHICS

During the collection of data, the researcher ensured that there were no violations of research ethics by applying guidelines and codes of ethics of the National Commission for Science and Technology (NCST) and the and recommendations from the research supervisors.[8] Research participants were treated well, making sure they are not harmed physically or psychologically. Consent was sought when conducting the interviews and conducting questionnaire survey; the participants had the freedom to withdraw where they were not comfortable. In addition professional issues were followed, and no fabrication or altering of results has been done. All the assumptions in the research are stated.

[8] NCST guidelines and codes of ethics which were used are covered by:
NCST. (2011).*The Framework of Guidelines for Research in the Social Sciences and Humanities in Malawi*. Lilongwe. (available at https://www.ncst.mw/?page_id=372)
NCST. (2015). *Procedures and Guidelines for the Conduct of Research in Energy, Industry and Engineering in Malawi*. Lilongwe. (available at https://www.ncst.mw/?page_id=372)

CHAPTER 4

RESULTS AND DISCUSSION

4.0. INTRODUCTION

This Chapter presents and discusses the results of the study. It starts with the results of the analysis of the legal and regulatory framework for PPPs, followed by the Public-Private Partnership Screening of Bondo MHP, the analysis of the electricity consumption characteristics of Bondo community, and finishes with the analysis of financial performance of Bondo MHP under different Technical and financial conditions and assumptions.

4.1. ANALYSIS OF THE LEGAL AND REGULATORY FRAMEWORK

The results under this section are from the analysis of the legal and regulatory framework for PPP development for rural electrification projects in Malawi. The analysis was conducted as described in section 3.4.1, focussing on establishing opportunities and constraints for the PPPs. The strategies, policies and legislations, which were analysed, are briefly described below:

1. *The Constitution of the Republic of Malawi 1995.* This is the supreme law for Malawi;
2. *Vision 2020.* It sets out the long-term development perspective for Malawi;
3. *Malawi Growth and Development Strategy II (2011 – 2016).* This is a medium term national development strategy formulated to attain the Vision 2020;
4. *The Energy Policy 2003.* It was adopted in 2003 to provide guidelines on matters related to energy development, supply, use, distribution, pricing and governance;
5. *Public-Private Partnerships Policy Framework 2011.* It sets out the policy framework for initiating, designing and implementation of PPPs in Malawi;
6. *PPP Act 2011.* This is an overarching legislation for PPPs in Malawi;
7. *Electricity Act 2004.* The Act makes provisions for the regulation of the generation, transmission, wheeling distribution, sale, importation and exportation, use and safety of electricity and for matters connected therewith or incidental thereto;
8. *Rural Electrification Act 2004.* It provides for the promotion, funding, management and regulation of rural electrification in Malawi; and
9. *Energy Regulation Act 2011.* The Act provides for energy regulation in Malawi.

4.1.1. Opportunities and Constraints for PPPs in SSHP for Rural Electrification

The results of the analysis are presented in table 4.1 below:

Table 4-1: Opportunities and Constraints for PPPs in SSHP for Rural Electrification

No	Issue	Policy/Strategy/Legislation	Strategy/ Policy/Legislation statements in general	Analysis	Assessment
1.	Rural electrification projects can be implemented in Malawi/ business opportunities	The Constitution of the Republic of Malawi 1995	It guarantees enhancement of quality of life in rural communities	The policy for the government is to accelerate rural electrification in order to enhance the quality of life and to facilitate development. Thus, rural electrification is an investment option. Moreover, private investors are likely to get assistance from the government to ensure speedy implementation and the success of the project. This is regardless whether the project is being implemented as a PPP or not.	Opportunity
			It gives every person the right to development		
		Vision 2020	It gives intensifying rural electrification program and making electricity affordable as strategic options for sustainable natural resources and environment management		
		MGDS II (2011 – 2016)	It provides for accelerating rural and urban electrification programme as one of the focus actions in order to generate and distribute sufficient energy		
		The Energy Policy 2003	It gives accelerating rural electrification as one of the strategies for improving access to energy		
2.	Restrictions on private sector investments in rural electrification	Vision 2020	It gives ending the monopolistic nature of the electricity sector as a strategic option for the development of an efficient supply of electricity	MUREA, despite being an NGO was allowed to develop and operate Bondo MHP. Generally, as discussed in section 1.1, the Government has shifted its policy form monopolising the electricity sector to private sector involvement and there are no restrictions on who can implement rural electrification projects. The policy has however not	Opportunity
		Malawi Energy Policy 2003	It provides for removal of bureaucratic obstacles to private investment		
		MGDS II (2011 – 2016)	It gives facilitating implementation of independent		

No	Issue	Policy/Strategy/Legislation	Strategy/ Policy/Legislation statements in general	Analysis	Assessment
			power production and promoting private sector involvement focus actions in order to generate and distribute sufficient energy	been very effective as apart from NGOs, no other private investors are currently involved in rural electrification projects.	
		Energy Regulation Act 2004	Promotes competition		
		Rural Electrification Act 2004	Allows everyone to participate in rural electrification activities		
3.	Promotion of renewable energy technologies Malawi	MGDS (2011 – 2016)	Promoting of exploitation of renewable energy resource is given as a strategy for improving electricity generation	Rural electrification projects using renewable energy technologies, including SSHPs, have an edge over projects using non-renewable energy technologies. This is in terms of accessing government support e.g. accelerating development and funding and developers are likely to benefit from the regulated prices of hardware for power plants.	Opportunity
		The Energy Policy 2003	It gives promoting the use of solar and other renewable energy sources as one of the ways of reforming the energy supply industry		
			It gives putting in place measures for reducing prices, removing barriers and promoting the development of renewable energy technologies.		
		Rural Electrification Act 2004	Renewable energy technologies projects are given additional priority on the priority list of projects for funding or development		
			It seeks to ensure that renewable energy technologies equipment are available and at a low price		
		Energy Regulation Act 2004	It gives MERA the duty to promote the exploitation of renewable energy resources		

No	Issue	Policy/Strategy/Legislation	Strategy/ Policy/Legislation statements in general	Analysis	Assessment
			It regulates prices for renewable technologies		
4.	Incentives to invest in rural electrification/ funding constraints	Malawi Energy Policy 2003	It has provided the following rural electrification policies: • Implementing appropriate cost minimization of rural electrification schemes • Establishing an institutional framework to enable plant and equipment to be made available to projects at low cost	MUREA benefited from tax breaks on hardware imports that were used for the MHP (Nyengarai & Hungwe, 2011). The legal and regulatory framework provides for incentives including subsidies and tax breaks in order to accelerate rural electrification. The incentives can help reduce the investment cost thereby attracting investors to rural electrification projects.	Opportunity
		Rural Electrification Act 2004	Provides for grants and subsidies to rural electrification projects		
			Funding is only available to projects that are proved technically, financially, economically, socially and environmentally feasible.	Being strict to financial viability and rate of return as pre-conditions to support projects with rural electrification funding, condemns other areas to having no electricity.	Constraint
			The project with the highest internal rate of return is placed at the top of the priority list of rural electrification projects.		
5.	Requirement of a licence to generate and distribute electricity for rural electrification	Malawi Energy Policy 2003	Provides for application of simple contracting/licensing procedures, e.g. using a model license that it is appropriate for off-grid rural electrification	The license has a fee attached to it which increases the cost of rural electrification (refer to appendix 3 for fees). In addition, license acquisition process is onerous; requiring verification of financial, technical and experience of applicant, viability of the project, an	Constraint
			Tariffs and tariffs adjustments have to be approved by the authority (and the public)		

No	Issue	Policy/Strategy/Legislation	Strategy/ Policy/Legislation statements in general	Analysis	Assessment
		The Electricity 2004	Sets a license as one of the requirement for rural electrification	environmental certificate, which may delay the project. At Bondo MHP, for example, MEGA had to reconstruct the distribution system so that it is of the same standard as the national distribution system. This was costly and it delayed electricity distribution. In regards to yearly renewal of the license, this can be cumbersome and expensive for a system that can stay for over 20 years (e.g. MHP).	
		Energy Regulation Act 2004	It gives power to MERA to receive and process licence applications for energy undertakings		
			It gives MERA powers to grant, revoke or amend licences granted under this Act and Energy Laws;		
			The licenses have to be renewed annually		
		Rural Electrification Act 2004	Rural electrification activities have to be licensed after showing evidence of access to financial, technical and human resources to get a license.		
			One can hold more than one license (generation licensee may apply a distribution license or renewable energy license and vice-versa).	The provision to hold more than one licenses gives investors full control over the implementation of the project, as there is no reliance on another organisation to distribute electricity.	Opportunity
6.	Conflicts and grievance redress mechanisms	The Constitution of the Republic of Malawi 1995	It gives every person the right to access any court of law or any other tribunal with jurisdiction for final settlement of legal issues.	Like in other businesses, conflicts, misunderstandings, crimes etc. are bound to occur in rural electrification projects. Without proper mechanism for addressing the issues, investors would be wary losing their money, for example, where a supplier does not fulfil the contract requirements.	Opportunity
		Energy Regulation Act 2004	It gives MERA powers to arbitrate commercial disputes under this Act and Energy Laws; resolve or mediate consumer complaints against licensees		

No	Issue	Policy/Strategy/Legislation	Strategy/ Policy/Legislation statements in general	Analysis	Assessment
				The framework provides for conflicts and grievance redress mechanisms and institutions are in place (e.g. MERA and courts). The World Bank framework for evaluation (PPPIC, 2016) looks at whether the courts are efficient, impartial, not corrupt and not expensive. From the researcher's knowledge, the court system for Malawi is reliable and impartial. Thus, it can ably handle conflicts related to PPPs. Moreover, there is a commercial court, special for business and investment related cases.	
7.	Tariff setting and adjustments	Energy Regulation Act 2004	Tariffs and prices for rural electricity have to be authorized by the authority.	Electricity tariffs at Bondo community were negotiated with MERA and are part of the license. Tariff regulation helps the government meet its social obligation of ensuring that electricity is affordable. However, it can be a problem, where it is unreasonable and it does not support investors' interests. Thus, approved tariffs have to make business sense.	Opportunity
			Tariffs and prices are part of the license		
			Tariffs and price adjustment can be administered only after approval of the authority.		
		Energy Act 2004	Allows setting of tariffs that allows the licensee an opportunity to recover his cost of service	Recovery of investment and making a reasonable profit can help the project succeed, hence attracting investors.	Opportunity

No	Issue	Policy/Strategy/Legislation	Strategy/ Policy/Legislation statements in general	Analysis	Assessment
			including reasonable return on capital and encourage efficiency.		
8.	The national grid can be extended to an area with an off-grid system	Energy Regulation Act 2004	Allows for extension of Grid into an area with rural electrification system.	Extending grid into an area with an off grid system reduces the customer base as it is likely that some people are likely to leave the off grid system and connect to the national grid. Hence, the revenue is likely to go down. In the event that the private investor transfers the off grid system to another area, it is not guaranteed that returns will equal the previous location. This uncertainty is not good for investments.	Constraint
		Rural Electrification Act 2004	It gives electricity consumers an option of either continuing with an off-grid electrification system or connecting to the interconnected system when it extends to an area.		
			A concessionaire is given an option of either removing the off-grid installation or connecting such installation to the interconnected system where consumers opt for later		
			Provides for compensations for the costs involved in the removal and reinstallation of the rural electrification installation and a consequential (when a grid system arrives in the area).		
9.	Constraints in the law on scope of PPP projects	Public-Private Partnerships Policy Framework 2011	Provides for enactment of the PPP Act, which allows for formation of any type of PPP in Malawi.	Basing on the PPP Act, any type of PPP can be formed in Malawi. This is an opportunity for rural electrification as it presents many options for risk sharing which can attract investors. Viability gap schemes also encourage investments	Opportunity
			Provides for establishment of a Viability Gap Schemes to provide incentives for PPP projects that are economically justified but financially not feasible without		

No	Issue	Policy/Strategy/Legislation	Strategy/ Policy/Legislation statements in general	Analysis	Assessment
			reasonable support of their investments or operation	in rural electrification where projects are usually financially not feasible. While the PPP Policy Framework prohibits unsolicited bids, the PPP Act of 2012 has provided for measures for accepting them. This is an opportunity as the private sector has a chance of identifying projects, which are aligned to their interests. Considering that, the public has limited resources, which would hinder its ability to carry many studies to identify PPP projects, allowing unsolicited bids also ensures that there are many projects being identified for PPPs.	
			Prohibits unsolicited bids		
		PPP Act 2012	The PPP Act 2012 allows for formation of any type of PPP (e.g. BOOT, BOT, DFROT, DFBOT, Concessions or leases or any type as appropriate) is allowed in Malawi.		
			Provides for handling of unsolicited bids – they have to be referred to the PPPC for review and feasibility studies. The PPP Policy Framework of 2011 prohibits unsolicited bids.		
		Rural Electrification Act 2004	Allows for concessions in Rural Electrification		
10.	Rural electrification projects are limited to 5 MW	Rural Electrification Act 2004	Defines power for rural electrification as at 5MW	5MW may be small to have a profitable investment (economies of scale).	Constraint
11.	Rural electrification property may be expropriated	The Constitution of the Republic of Malawi 1995	It allows for the expropriation of property when done for public utility and only when there has been adequate notification and appropriate compensation, provided that there shall always be a right to appeal to a court of law (Section 44 (4)) of the Constitution)	Expropriation of property may scare investors, as there is risk of abuse; however, this has never occurred in Malawi.	Constraint

4.1.2. Key Findings of the Analysis of the Legal and Regulatory Framework for PPPs

The following are key findings of the analysis of the legal and regulatory framework for PPPs presented in Table 4-1:

- Any form of PPPs in SSHP for rural electrification can be transacted in Malawi;
- Private investors are likely to get Government support in the implementation of renewable energy projects and rural electrification projects;
- PPPs mainly originate from the government, however there are set procedure for accepting and implementing unsolicited bids;
- No-one is prevented from making an investment in rural electrification; and
- There is provision of subsides for rural electrification activities.

However, to promote PPPs in SSHP for rural electrification, some provisions and legislations may need to be changed. Some of the changes include:

- Reducing or removing licensing and renewal fees for rural electrification activities;
- Annual renewal of licence should be conditional; there is no need for annual renewal for power plants with a life span of over 20 years;
- Increasing energy output for rural electrification activities (for example, from 5 MW to 10 MW);
- Including necessary provisions that expedite the licensing process; and
- The grid system must not be extended to areas where there is an off-grid system that is operating favourably (technically and financially).

4.2. PUBLIC-PRIVATE PARTNERSHIP SCREENING OF BONDO MICRO HYDROPOWER PLANT

Bondo MHP was screened using the screening criteria described in section 3.4.2. in order to answer the following research question: To what extent does the Bondo MHP meet the criteria for implementing projects under Public-Private Partnership? The screening criteria was made up of questions, which were answered by the researcher’s expert judgement and information from literature. The answers are presented in Table 4-2.

Table 4-2: Screening results of the possibility of managing Bondo MHP as a PPP

No	Criteria	Screening Question	Results
1.	Legal provisions	What is the nature of the Contracting Authority's functions, the specific functions to be considered in relation to the project?	The Contracting Authority is tasked with electrifying rural areas including electricity generation and distribution using SSHP technologies.
		To what extent does the law allow a private partner to perform the functions in terms of an agreement?	The law allows a private partner to perform any activity related to rural electrification project.
		What is the most appropriate form by which the Contracting Authority may implement the project under an agreement?	Considering Bondo MHP was built, and is being owned and operated by the private, the most likely PPP transaction is Build Own Operate (BOO).
2.	Scale of the project	Is the project large enough to justify PPP transaction costs?	Yes, it is large enough and there is the possibility of expanding.
3.	Opportunities for risk transfer	Is there good reason to believe that a PPP will be affordable to the Contracting Authority?	A PPP would lead to improved risk allocation thereby which is likely to result in the reduction of operation cost making the PPP affordable.
		Is there good reason to believe that a PPP will transfer appropriate technical, operational or financial risk to the Partner?	Yes, for Bondo MHP, the private is already managing technical, operational and financial risks.
		Is there good reason to believe that a PPP will provide value for money compared to the alternative of traditional public procurement?	Sharing of market risk can improve commercial viability hence value for money.
4.	Outputs specification	Is it possible to specify outputs in clear and measurable terms, around which a payment mechanism can be structured?	Yes, payments can be based on the amount of electricity units sold.
5.	Public interest	Is the Government interested in implementing the project as a PPP?	No direct interest to implement Bondo MHP as a PPP was reported. It was also established that ESCOM is reluctant to enter into a Power Purchase Agreement. However, market sounding can result in market interest.
6.	Market capability and appetite	Is there a potentially viable commercial project and a level of market interest in the project?	Considering that the demand for electricity is high in Malawi, the project can be commercially successful.
7.	Capacity of the Contracting Authority	Can the Contracting Authority effectively enforce a PPP agreement, including the ability to monitor and regulate project implementation and the performance of the Partner in terms of the agreement?	Yes, as in Malawi, there is a capable Public-Private Partnership Commission in place.

The results show that a PPP transaction is possible for Bondo MHP. This is despite there being no public interest to implement the project as a PPP. Public interest can be created with market sounding of the project.

4.3. A POWER CONSUMPTION ANALYSIS

The focus of the study in this section was to establish whether the power consumption characteristics for Bondo Community are good enough to attract private investors. Using the methodology described in section 3.4.3, the following were established:

4.3.1. Power Demand Profile

A power demand profile for Bondo MHP, for the dates 7 February to 14 February 2016, prepared by MEGA using a kilowatt-hour meter is presented in figure 4-1. Hourly readings over the 7-day period were averaged on hourly basis to develop the power demand profile.

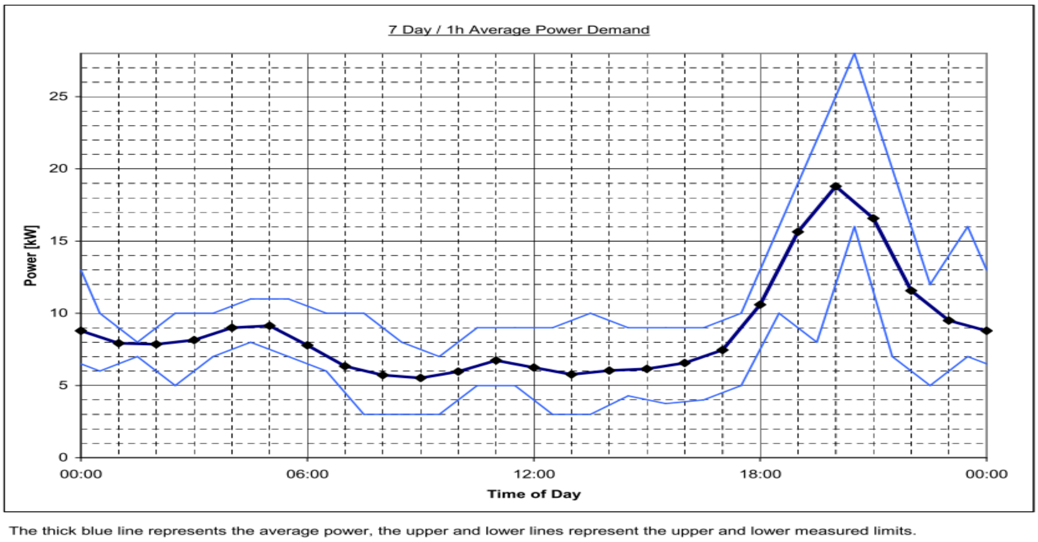


Figure 4 -1: Power Demand Profile for Bondo Micro Hydropower Scheme
Source: MEGA (unpublished)

Key characteristic of the power demand profile above are as follows:

- Maximum power demand = 28 kW
- Average power demand = 8.7
- Minimum power demand = 3.0 kW

The average power demand for Bondo was calculated as 8.7 kW with a standard deviation of 4.3. The standard deviation indicates that the daily power demand over the seven days were clustered around the average power demand.

Using the Maximum power demand and the minimum power demand, the load factor for Bondo Community can be estimated as follows:

Load factor = (Average power demand/Maximum power demand) × 100%

= (8.7/ 28) × 100%

= 31%

At lower than 50% this can be said to be a low load factor. A low load factor means that power usage is not constant; thus, the demand is occasionally high. Basing on the calculation, power demand is expected to be constant about 31% of the time, which is not good in terms of fixing the power to be available in the system. This is noticed on the amount of power that MEGA had to make available in the system compared to what was used (Table 4-4) during the period when the power demand profile was developed.

Table 4-3: Available power versus used power at Bondo MHP

Available kWh per 24h		**Used kWh per 24h**			
Relative to Peak	Absolute @ 60kW		Relative	Absolute	Per House
Max. 672.0	1440	Max. 283.0	42.1%	19.7%	1.3
Avg. 399.4		Avg. 209.8	52.5%	14.6%	1.0
Min. 216.0		Min. 141.0	65.3%	9.8%	0.7

Source: MEGA (Unpublished)

Basing on the data in Table 4-4, more power is made available in the system relative to the power that is used. For example, when an average of 399.4 kWh power was available, only 52% percent was used (209.8 kWh); this represents 14.6 % when compared to the absolute available power. Despite less power being used, MEGA has to maintain a lot of power in the system due to the occasional high demand. Unfortunately, this is costly for the system.

To ensure that there is no excess power in the distribution lines, which can result in accidents, MEGA diverts excess power to heat metal rods dipped in a water tank as shown in figure 4-3. The heated water does not have any productive use.

Figure 4-2: A water tank for use of excess energy from the generator

Further analysis of the power demand profile in figure 4-1 showed that power consumption is very low during the day but increases from 18:00 hours to 23:00 hours. Specifically, during the given interval, power consumption doubles as presented using the pie chart in figure 4-3.

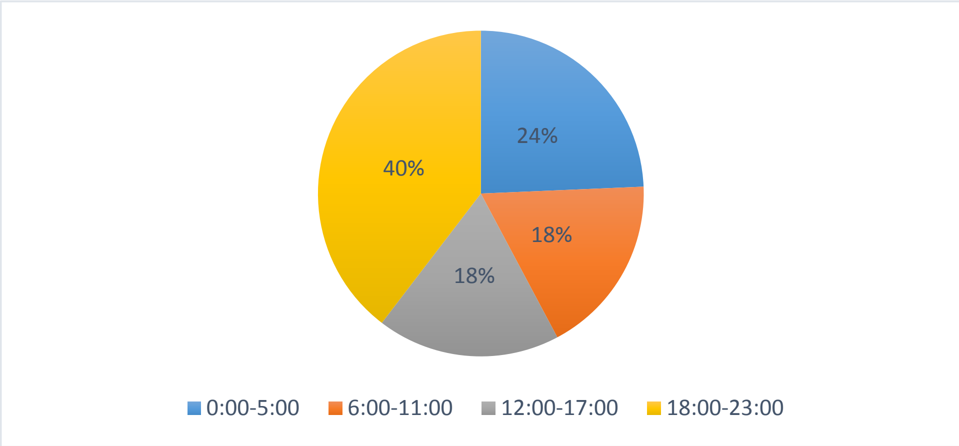


Figure 4-3: Percentage power used in different time interval

During the study, Bondo MHP had 210 connected households with an average power consumption of 1 kWh per day per household. To increase power consumption, MEGA plans to increase the number of connections. Bondo MHP can take up to 400 connections basing on the current power demand profile. However, increasing the number of connection will not necessarily ensure maximum use of the power plant. Assuming the current power usage pattern does not change, there will still be low power consumption during the day. Hence, MEGA is also encouraging opening of businesses that use electricity during the day including the operation of a maize mill and a welding shop. It is also exploring feeding electricity to the national grid as an independent producer. This is likely to result in an increased load factor.

4.3.2. Power Uses

At Bondo community, households, businesses and public institutions are the main users of electricity. In order to establish the level of productive use of electricity, the study tried to establish the types of electrical appliances and the pattern of use. The results are presented in the following subsections:

4.3.2.1. Household use

The main electrical appliances and the percentage of people that use them at Bondo community are as presented in the bar chart in figure 4-4. The households were also asked the type of electrical appliances, which they would like to own/use in the next 5 - 10 years and the results, are also shown in the figure.

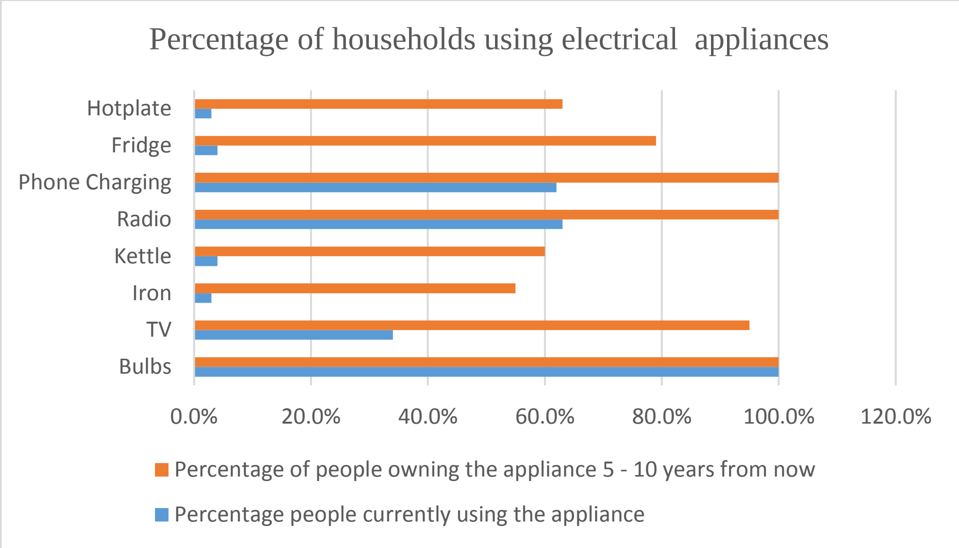


Figure 4-4: Percentage of households using electrical appliance

From the figure 4-4, it can b e seen that apart from lighting, other main uses of electricity, are home entertainment (television and radios) and charging phones. Very few households use electricity for cooking, with only about 12% and 7% reporting to use cooking hot plates and water boiling kettles respectively. The results also show that almost all the households would like to own radios, phones, and televisions. However, not more than 70% would like to own iron, kettles, and cooking hotplates. The households indicated that the use of irons and kettles was resulting in high electricity bills while fridges are not affordable.

The survey also collected data on the average power rating of the appliances and the time of use. The results are as presented in Table 4-5 below.

Table 4-4: Average power rating and time of use of appliance

Appliance	Power rating	Main time of use																							
		00:00 - 05:00						06:00 - 11:00						12:00 - 17:00						18:00 - 23:00					
Bulbs	20 w	x	x	x	x	x	x													x	x	x	x	x	x
TV set	80 w																			x	x	x	x	x	x
Iron	1200 w							x																	
Radio	30 w							x	x	x	x	x	x	x	x	x	x	x	x						
Phone	5 w							x	x	x															
Fridge	150 w	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Hotplate	1200 w							x						x						x					
Kettle	1000 w							x																	

x means the appliance is in use

From the results in table 4-5 clearly, the high load experienced from 18:00 – 23:00, is as result of the use of light bulbs, the fridge, and the television sets. During the day, fridges and radios make the main load. By multiplying the power rating of the electrical appliance, the time of use and the percentage number of appliance available in the community, the study was able to estimate the total power used by the appliances in a day hence the percentage of power used. The results are as presented in Table 4-6.

Table 4-5: Total power used by the appliance

Appliance	**Power used**	**Percentage power consumption**
Lights	128.04	50.41%
Fridge	27.94	11.00%
Radio	40.33	15.88%
TV	31.66	12.47%
Iron	5.59	2.20%
Kettle	1.29	0.51%
Phone	0.28	0.11%
Hotplate	18.86	7.42%
TOTAL	**253.98**	**100.00%**

Table 4-6 indicate that lights make up the major load for the day, using up to 50% of the daily power. This also explains why electricity usage is doubling at 18:00 – 23:00 as this is also the period when light bulbs are switched on. Cooking hot plates also take up a significant load despite there being few households that use them. This is because of a high power rating. There are few kettles and irons in the community and they are used for a short period hence taking up a small load. It is also noted that while there are a significant number of households that use electricity for phone charging (about 63% as shown in figure 4.4) the load used is small. Phones have a low power rating, an average less than 5 watts.

4.3.2.2. Businesses

Businesses that were using electricity at Bondo during the survey included 10 barbershops, 6 video show rooms, 7 grocery shops, and 1 alcohol shop. There was also a maize mill and a welding shop, which were not operating during the study. Table 4-7 shows electrical appliances, which were recorded and power rating.

Table 4-6: Businesses at Bondo Community and Appliances

Business	Electrical Appliance	No of appliances	Power rating (Watts)
Operating			
6 Video show rooms	TV Set	6	100
	Speakers	10	20
	Lights	6	20
	Security lights	4	20
7 Grocery shop	Fridge	5	300
	Radio	6	50
	Lights	7	20
	Security Lights	7	20
1 Bar	Amplifier and Radio	1	250
	Lights	1	20
	Security lights	1	20
10 Barber shops	Electric shaver	10	5
	Lights	10	20
	Security lights	8	20
Not Operating			
1 Maize mill	Lights	3	20
	Maize mill	1	2500
1 Welding shop	Grinder	1	1400
	Welding machine	1	600
	Lights	2	20

The average power that is used by the appliances, excluding the maize mill and the welding shop, was estimated as 30.28 kWh per day by multiplying number of appliances by power rating and hours of use in Microsoft Office Excel. The power is distributed between the appliances as presented in figure 4-5.

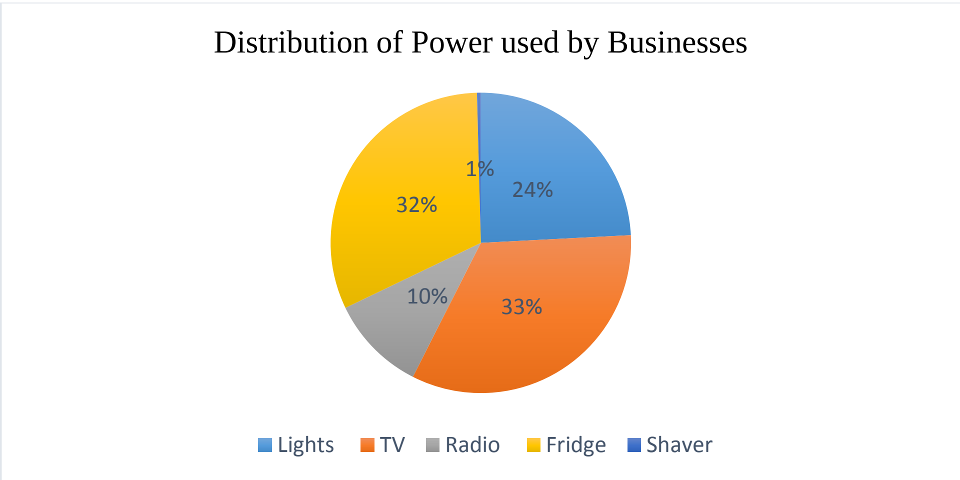


Figure 4-5: Distribution of power used by the appliances

The figure 4-5 shows that Television sets use 33% of the 32.28 kWh power used by businesses. This is the highest consumption under businesses. Following closely are grocery fridges, using

32% of the total power. Video show rooms and groceries were the major consumers of electricity during the study. The barbershops consume the least energy, with the electric shavers using only about 1% of the total power.

The total power that is expected to be used by the welding shop and the maize mill, once operational was estimated as 63.72 kWh. That is total power used by businesses is likely to double once the maize mill and welding shop is operational.

4.3.2.3. Public institutions

Public Institutions at Bondo mainly use electricity for lighting. The institutions and the electrical appliances that are used are as presented in Table 4-8 below:

Table 4-7: Public institutions at Bondo community and appliances

Institution	Electrical Appliance	Max. Power Consumption
Health Centre	4 Light	20 Watts
	1 small fridge	80 Watts
Classrooms (Primary)	20 Lights	20 Watts
Classrooms (CDSS)	10 Lights	20 Watts

The total power used by institutions is calculated as 7.76 kWh with about 75% being used by lights and the 25 % being used by a small fridge at the hospital.

4.3.2.4. The total power consumption

Basing on the findings above, the total power consumption at Bondo community, as estimated through the survey is 294.02 kWh with 86.4% being used by households (253.98 kWh), 11.2% going to businesses (32.28kWh), and public institutions using 2.6% (7.76 kWh). The estimated power consumption is higher than the 210.0 kWh, the average consumption and the maximum power consumption of 283.0 kWh, found using the kilowatt-meter. The difference could be a result of increase in power consumption since the household survey was carried two months after data was collected using the kilowatt hour meter. It could also be an indication of survey errors, for example failure to correct the exact durations when appliance are used. Nonetheless, the difference with the maximum power consumption is 2.7%, which is acceptable.

The total power is estimated to be distributed between households, businesses and institutions as shown in the pie chart in figure 4-5:

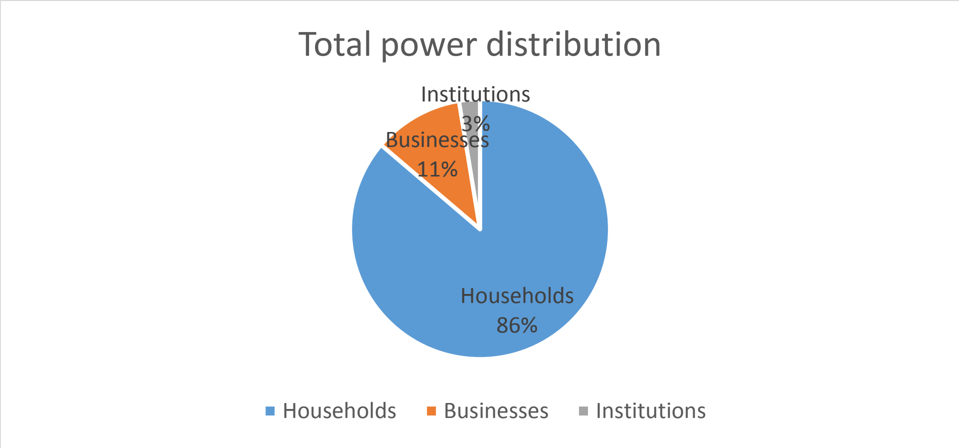


Figure 4-6: Total power distribution

From figure 4-6, it can be noted that households use most of the power (86.6%). Over 50% of this power is used for lighting, which is not productive use. Only 11.2% of the power is used by businesses, which can be said to be productive use. That is, there is a low productive use of electricity at Bondo Community.

4.3.3. Affordability

When Bondo MHP was commissioned in January 2016, most of the households had about 1000 electricity units, which had received free when the power plant was being tested. The power plant opened with 40 connections and power consumption was noticed to be high. However, when data for the load profile in figure 4-1 was collected (that is when the power plant had 210 connections) it was observed that energy consumption per house had decreased by an average of 46 percent. The decrease can be attributed to energy conservation, which was being encouraged, and/or the payment for electricity after the free units had now run out. The latter is related to affordability, whereby, it can be said that the households could not afford buying electricity units to match the usage as to when they had free units. In fact, during the survey, some households indicated that they stopped using irons and electric kettles after the free units had run out as were leading to an increased amount of money spent on electricity.

The household survey collected information on other sources of energy and cost, which was used to assess affordability further. The data showed that the households could be categorised into three, basing on the sources of energy:

1. Household A: uses paraffin for lighting, batteries for radio and firewood for cooking;
2. Household B: uses batteries for lighting and the radio, and cooks using firewood; and
3. Household C: uses Solar Photovoltaic (PV) System for the radio and lighting, cooks using firewood.

The survey established the cost of the energy sources, which are presented in Table 4-9:

Table 4-8: Cost for energy sources and per month

Energy use	Household A		Household B		Household C	
	Source	**Min. Cost**	**Source**	**Min. Cost**	**Source**	**Min. Cost**
Lighting	Paraffin	K900.00	Batteries	K500.00	Solar PV	K 0.00
Radios	Batteries	K500.00	Batteries	K500.00	Solar PV	K 0.00
Cooking	Firewood	K2,000.00	Firewood	K 2,000.00	Firewood	K 2,000.00
Total		**K3,400.00**		**K 3,000.00**		**K2,000.00**

Table 4-9 shows that Household C uses the least cost energy sources. However, out of the 36 households that were interviewed, only two households (a grocery shop owner and a bicycle taxi owner) had a solar PV system, characterised by a 20 watts solar panel and a car battery. There are very few solar PV systems in the community owing to a high upfront cost.

At about K3,000.00, household B has the second least cost energy sources while household A, at MK 3,400.00, has the highest cost for energy. An estimated over 90% of the households belong to Household B category. Hence, the study used the category as a point of reference for comparison with the cost of electricity in the community.

At MK64.68 per unit (kWh), the average daily cost of electricity for a household is MK64.80, which translates to K1,940.40 in a month (30 days multiply by MK64.68/day). Since most of the households do not use electricity for cooking, MK2,000.00 which is the cost for firewood is added to the cost of electricity resulting in MK3,940.40 as the total cost of energy. This is higher by 31% than the K 3,000.00 that is spent by household B for energy. This would mean that households that use electricity spend a lot of money on energy; hence, it could be said that electricity is not affordable.

However, unlike batteries, electricity is also used for other activities including powering television sets, fridges and light bulbs are switched on for long hours. Additionally, the cost for firewood per month reported during the survey is a suppressed cost as there are times when cooking fuel is sourced for free, for example maize stalks and husks. Hence, the assessment for affordability also involved the comparison of the estimated real cost of energy under Household B and the estimated cost for unsuppressed use of electricity. The unsuppressed household use of electricity was established as about MK 13,543.00 per month while a household opting to use batteries for electrical energy needs except cooking and ironing would spend about MK 35,600.00 a month (refer to appendix 5 for the estimations). Thus, electricity is actually affordable.

The study also analysed economic activities in the area to understand whether they can manage to pay for electricity. The results revealed that the mainstay for the people of Bondo is agriculture, with almost every household owning a garden. Main cash crops that are grown in the area are tea, bananas and pineapples; maize is also grown on a small scale for food. The results of the study are as presented in the Figure 4-7:

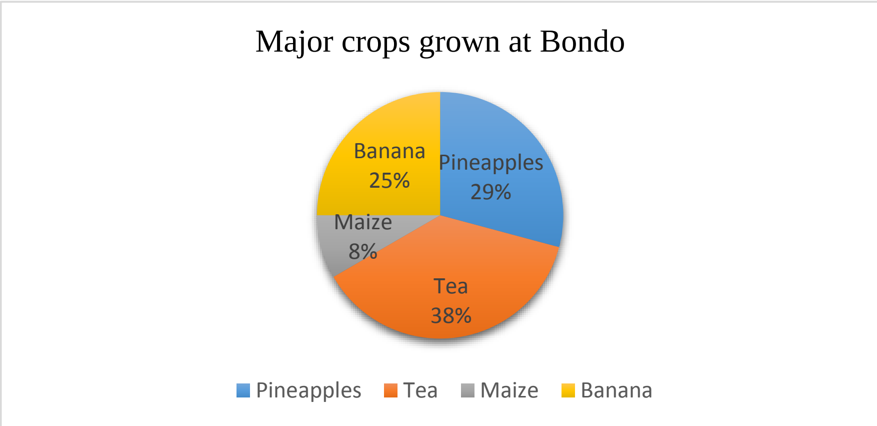


Figure 4-7: Main crops grown at Bondo

During the study, Banana Bunchy virus disease had attached most of the bananas in the area and the District Agriculture Office had instructed the community to uproot all the bananas and plant new ones. This could result in loss of income from bananas for about one to two years, the time it takes for bananas to produce the first bunch. Hence, the study also analysed crops combinations and the results revealed that only about 4% of the population (growing banana's only) were likely to be greatly affected as presented in Table 4-10 below:

Table 4-9: Crop combination at Bondo Community

No.	Crop combination	Percentage
1.	Pineapples and bananas	17.39%
2.	Pineapples and tea	21.74%
3.	pineapples, bananas and tea	8.70%
4.	Maize and tea and banana	4.35%
5.	Bananas only	4.35%
6.	Bananas and tea	13.04%
7.	Bananas, tea and maize	13.04%
8.	Tea only	13.04%
9.	Maize only	4.35%
Total		**100.00%**

Tea and Bananas are sold monthly, generating about MK 15,000.00 and MK 12,000.00 monthly income for the households respectively. Pineapples on the other hand are sold seasonally between December and March and they generate about MK 100,000.00 in the whole season.

With most of the households, growing tea (refer to figure 4-7 above) the average minimum monthly income is MK 15,000.00. This was also reported during the survey whereby about 46% reported to earn between MK 20,000 to MK 50,000.00 while 15% reported to earn less than MK 20,000.00 and 23% reported to earn MK 50,000.00 to MK 100,000.00 and over MK 100,000.00 respectively. The income is mainly used to buy food, mainly maize, which was bought at MK 6,500.00 a bag during the survey and was reported to be enough for about 2 months. Education came as the second major use of money, with those with children at the community secondary school spending about MK 6,500.00 per term per child on fees. About 30% of the households that were interviewed had a child or dependant at the community secondary school.

The survey did not carry out an asset inventory; however, it was established that most of the households owned the houses which they were living in and most of the houses have iron sheets. Generally, the community cannot be described as poor. Thus, they can afford to pay for electricity at about MK 1,940.40, the average amount calculated for a month. During the survey, only two heads of households complained about the prices of electricity. Judging from the average monthly minimum incomes and use of the money, the community is most likely to afford paying for electricity at MK 5,000.00. Going further than this price, corresponding increase in income would have to be in place otherwise the community would have problems in paying for electricity.

4.3.4. Willingness to Pay

To study willingness to pay, the question on the value of electricity was included on the household questionnaire. Over 90% of the households indicated that electricity is of greater value as the children are now able to study at night, and the social life has improved due to being able to watch televisions. The community is ready to pay for electricity.

4.3.5. Summary of the discussions

The electricity consumption for Bondo MHP is characterised by a low load factor, with many variations between the average hourly consumptions and the minimum and maximum hourly consumptions. There is low productive use of electricity such that during the day, there are low consumptions and a high power consumption at night as the community mainly use electricity for lighting. There are few businesses and their power requirements are low. Affordability, at about MK 5,000 is low. Willingness to pay for electricity is however high.

Considering that the willingness to pay for electricity is high, the power plant can be made attractive to investors by improving the incomes of the households. Bondo being an agricultural community, as an example, installation of a small food processing plant can increase the day load, improving the revenue for MEGA. In addition, the food processing plant can help add value to the agriculture produce resulting in more money to the community; hence, increased ability to pay for electricity.

4.4. FINANCIAL ANALYSIS

Financial analysis was carried out using RETScreen software to answer the following research question: To what extent can a PPP improve the rate of return such that Bondo MHP can attract private investors? As described in section 3.4.4, three scenarios were analysed and the findings and discussion are presented in the following sections:

4.4.1. Scenario 1: Present Technical and Financial Operating Conditions

Scenario 1 was divided into Scenario 1a, modelled with the initial cost as wholly financed by a grant (100% grant); Scenario 1b, modelled with the initial cost as 40% financed by a grant; and Scenario 1c, modelled with the initial investment as 0% grant. The results for financial analysis under Scenario 1a are as presented in Table 4-11:

Table 4-10: Financial summary under Scenario 1a

Financial viability		
Pre-tax IRR – equity	%	29.1%
Simple payback	yr	0.0
Net Present Value (NPV)	$	977,364
Energy production cost	$/MWh	63.02

The results in Table 4-11 reveal that the IRR for Scenario 1a is 29.1%, which is 2% higher than the Reserve Bank of Malawi base lending rate of 27% quoted in October 2016, but lower than the commercial bank base lending rate of 34%. With reference to the commercial bank base lending rate, the project may be considered as unattractive to the private investor. The simple payback period, as shown in the table, was calculated as 0 years. This is because the initial cost was wholly financed by a grant, which does not require paying back. The Net Present Value (NPV) was calculated as 977,344 USD, which is the value of the project in today's dollars after 25 years. The NPV shows a 58% jump from the initial investment of 406,000 USD. The energy production cost was calculated as 63.02 $/MWh (0.06 $/kWh), which is within the typical costs for electricity generated by small hydropower plants, given as ranging from 0.02 $/kWh to 10 $/kWh (International Renewable Energy Agency, 2012).

RETScreen Software also generates a graph for cumulative cash flows. Under Scenario 1a, the generated graph is as in Figure 4-8 which shows that the cumulative cash flows are positive after 16 years.

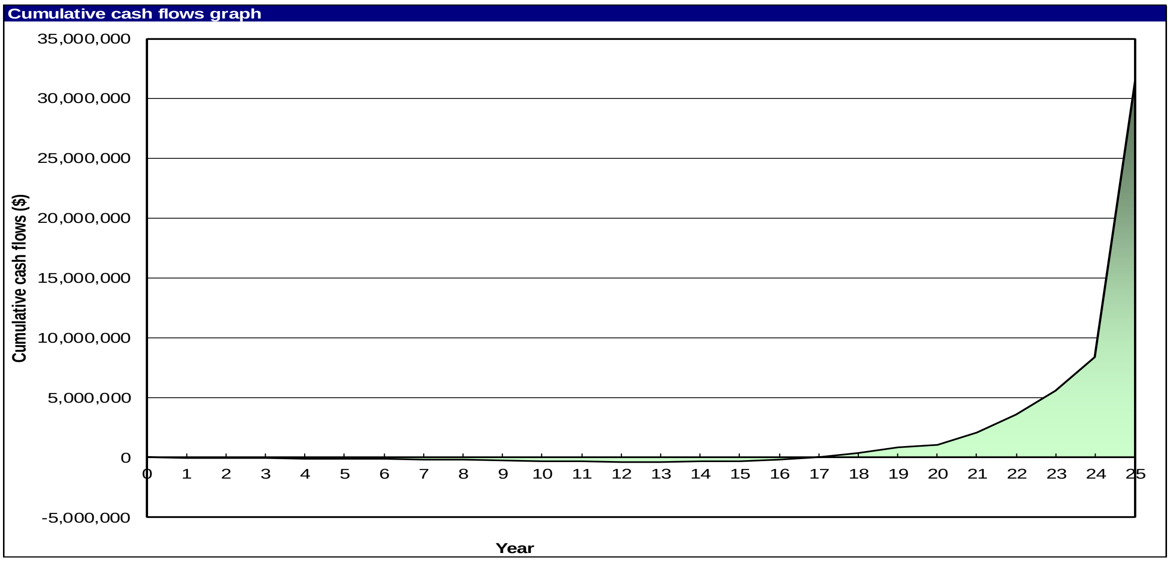


Figure 4-8: Cumulative cash flow of the project under scenario 1a

The full results of the analysis under Scenario 1 are as presented in Table 4-12

Table 4-11: Results of financial analysis of modelled MHPs under Scenario 1

Scenario	Parameter			
	IRR	Simple pay back	NPV (USD)	Energy production cost (USD/KWh)
Scenario 1a (100% grant)	29.1%	0.0	977,364	63.02
Scenario 1b (40% grant)	19.1%	-20.5	538,160	76.35
Scenario 1c (0% grant)	16.5%	-34.1	245,357	85.23

The results in Table 4-12 show that under Scenario 1a, the IRR is 10% high as compared to IRR of 19.1% under Scenario 1b and it is 12.6% high as compared to the IRR of 16.5% under Scenario 1c. Generally, the IRR is decreasing when grant financing to the initial investment is reducing. Likewise, the NPV is decreasing while the energy production cost is increasing. The Simple pay back period for Scenario 1b and 1c are negative, which is an indication that the positive cash inflows do not outweigh the cash outflows. This is difficult to interpret, hence the negative pay back are not discussed further.

It can however be noted that the power plant is performing better financially, where there is some grant as compared to when there is 0% grant. This is the case when the public take some of the risks to investing in a project; the financial viability of the project improves, making the project attractive. Nonetheless, the financial performance of the power plants under Scenario 1b and Scenario 1c is not good enough to attract investors, as the IRR is lower than the commercial bank base lending rate.

4.4.2. Scenario 2: Reduction in Investment Cost and Increased Capacity Factor

Under Scenario 2, the power plant was modelled with the initial investment cost reduced by 20% and capacity factor increased from 47% to 60%. The results of the analysis are as presented in Table 4-13.

Table 4-12: Results of financial analysis of modelled MHPs under Scenario 2

Scenario	Parameter			
	IRR	Simple pay back	NPV (USD)	Energy production cost (USD/KWh)
Scenario 2a (100% grant)	48.8%	0.0	1,822,110	49.37
Scenario 2b (40% grant)	26.0%	-35.0	1,470,676	57.72
Scenario 2c (0% grant)	22.5%	-58.3	1,236,385	63.29

The financial analysis results show a general increase in viability of the project. The increase is higher where there is grant financing, and reduces with a decrease in the grant. At 48%, under Scenario 2a the IRR is above the commercial bank base lending rate of 34%. This is a Scenario whereby the power plant is wholly financed by a grant. For Scenario 2b which models a PPP and Scenario 2c which models 100% private financing, the IRR are 26.0% and 22.5% respectively. These are all below the rate that can attract a private investor. Similarly, the energy production is high when there is no grant, and decreases with an increase in the level of grant financing.

4.4.3. Scenario 3: Reduction in Operation Cost and Loan Interest

When the hypothetical reduction in operation cost of 20% and reduction of loan interest of 19% (15% subtracted from 34%) were introduced to Scenario 1b and Scenario 2b, the resulting modelled power plants were called Scenario 3.1 and Scenario 3.2 respectively. The power plants were analysed in RETScreen Software and the results are in Table 4-14. Also included in the Table are the results of financial analysis of Scenario 1b and Scenario 2b for comparison purposes.

Table 4-13: Results of financial analysis of modelled MHPs under Scenario 3

Scenario	Parameter			
	IRR	**Simple pay back**	**NPV (USD)**	**Energy production cost (USD/KWh)**
Scenario 1b (40% grant)	19.1%	-20.5	538,160	76.35
Scenario 3.1	26.8%	-52.4	1,255,490	54.58
Scenario 2b (40% grant)	26.0%	-35.0	1,470,676	57.72
Scenario 3.2	30.2%	115.5	1,992,401	45.32

The results in Table 4-14 reveal that the IRR for Scenario 1b increases from 19.1% to 26.8% when the operation cost is reduced by 20% and the interest on loan is reduced from 34% to 15%. With reference to the commercial bank base lending rate of 34%, or the central bank base lending rate of 27%, the power plant under Scenario 3.1 is not good enough to attract private investors. However, when the IRR is compared to the 15% loan interest rate, which was used for the analysis, the power plant may be said to be attractive to investors. Similarly, Scenario 3.2 shows an increase in IRR from 26.0% to 30.2% when operation cost and loan interest are reduced. This also makes Scenario 3.2 power plant attractive, when it is considered that the loan interest was at 15%.

4.4.4. Summary of financial analysis results

The results show that under the current technical and financial conditions, Bondo MHP has a low internal rate of return to attract private investors. This is despite the power plant being wholly grant financed. The rate of return is improving with an increase in capacity factor and reduction in initial cost. This can be achieved through a PPP whereby, as an example, an experienced private investor can bring innovation, efficiencies, and technological experience resulting in improvement in capacity factor and cost reduction. Nonetheless, from the analysis it would take a high increase in capacity factor and a very big reduction in initial cost for the power plant to be attractive, which may not be easy to achieve even with a PPP.

When a reduction on loan interest and operation cost is applied to the PPP models, there is a great improvement in financial performance, especially where the power plant has a high capacity factor and a reduced initial cost. With reference to the interest on loan, which is used, the PPP power plants can attract private investments. This is also possible through a PPP whereby the private investor can bring efficiency while the public can bring access to “cheap” loans. These “cheap” loans are available from development banks such as the African Development Bank (AfDB) and the World Bank. The private can access the loans easily where the Government of Malawi guarantees the loans.

Generally, it is noted that when the cost for implementing the project is shared, the attractiveness of the project is better as compared to where the cost sorely rests with the private. Thus, PPPs can help improve the rate of return on investment to the private and hence encourage investment and improve the rural electrification status for Malawi.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1. CONCLUSION

The overriding purpose of this study was to explore opportunities for Public Private Partnerships in Small Scale Hydropower Plants for rural electrification in Malawi. To accomplish the goal, it was necessary to establish if an acceptable PPP could be formed in the sector through a case study of Bondo Micro Hydropower Plant. This involved a systematic review of the legal and regulatory framework for PPPs, Public-Private Partnership Screening of Bondo Micro Hydropower Plant, power consumption analysis and financial performance analysis of Bondo MHP using RETScreen to find out if a PPP for Bondo MHP can result in an improved rate of return that can attract private investors.

The results of the study have shown that the legal and regulatory framework has put in place necessary provisions for the development of SSHP for rural electrification under PPP arrangement. For example, it allows rural electrification to be an investment option, transacting of any type of PPP, subsidies and viability gap schemes for projects that are not profitable. Nonetheless, there are some provisions that need to be reviewed to enhance the promotion of PPPs. For example, the power generation capacity for rural electrification could be increased from 5 MW to 10 MW, licensing and renewal fees for generation and distribution of electricity for rural electrification could be reduced or removed and including necessary provisions that expedite the licensing process. All in all Bondo MHP can be implemented as a PPP.

The power consumption analysis revealed that at Bondo Community, the load factor for electricity consumption is about 31%, which is not good and costly for the power plant. Electricity is mainly used for lighting resulting in a power demand profile that dips during the day. Willingness to pay is high and yet the ability to pay (affordability) is low.

Financial analysis of Bondo MHP modelled as a PPP, under the technical and financial factors prevailing during the study, produced a rate of return that was lower than the commercial bank base lending rate of 34 percent. It was seen that the rate of return was improving with an increase in capacity factor and reduction in initial cost, which can be achieved through a PPP. Nonetheless, from the analysis it would take a high increase in capacity factor and a very big reduction in initial cost for the power plant to be attractive. Financial performance could be improved further through a reduction on loan interest and operation cost.

Overall, the initial assessment of the findings indicate that it would be difficult to form an acceptable PPP in SSHP for rural electrification in Malawi. This however does not mean that a successful PPP cannot be formed. An in-depth look shows that rural electrification projects using SSHP technologies and implemented as PPP, when coupled by improvements in financial and technical operating conditions, can be bankable. These improvements in operating conditions can be possible because SSHP technologies offer scope for innovations, which could result in reduction in investment and operation cost and improvement in capacity factor. The PPP itself provides an opportunity for access to low interest loans.

Nonetheless, a PPP cannot be successful in a community with unfavourable power consumption characteristics. As solution, rural electrification project should include initiatives promotion of productive uses of electricity, especially during the day. This could be one of the risk, which the Government could take in a PPP.

5.2. RECOMMENDATIONS

To improve the findings there is need to incorporate other PPP related factors, which were not incorporated in the study. These include:

1. Estimating the Value for Money which a PPP could create;
2. Establishing the most appropriate shareholding ratio for the partnerships;
3. Determine the exact level of public investment or subsidies, loan interest rate on the capital that can improve financial viability of the SSHP project;
4. Determine community investments for improving power uptake during the day, while contributing to socioeconomic development of rural areas; and
5. Analysis of the capacity of the private sector including views of possible investors.

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APPENDICES

Appendix 1: Infrastructure facilities and services which can be delivered through PPPs

In the PPP Act 2011 the types of infrastructure facilities and services that can be implemented as PPPs are found in Section 25 (1):

Section 25 (1): The Minister responsible for Finance or a Contracting Authority, where authorized, and as facilitated by the Commission, may enter into a public private partnership arrangement involving the following types of infrastructure and services –

a) transportation including road, rail, marine and air transport;
b) the extraction, processing and distribution of water;
c) sanitation;
d) telecommunication;
e) energy;
f) mineral, petroleum and natural gas;
g) education, sports and health;
h) housing;
i) tourism;
j) social service; and
k) any other type of infrastructure and services as the Minister may from time to time designate by notice published in the Gazette.

Appendix 2: Types of PPPs and their descriptions

Table A2: Types of PPPs and their description

PPP Type(s)	Overview Description and Reference	Type of Asset	Functions Transferred	Payment Mechanism
Design-Build-Finance-Operate (DBFO), Design-Build-Operate (DBO) Operations & Maintenance (O&M)	Under this nomenclature, the range of PPP contract types are described by the functions transferred to the private sector.	New infrastructure	As captured by contract name	Can be either government or user pays
Build-Operate-Transfer (BOT), Build-Own-Operate-Transfer (BOOT), Build-Transfer-Operate (BTO)	This approach to describing PPPs captures legal ownership and control of the project assets. Under a BOT or BOOT project, the private company owns the project assets until they are transferred at the end of the contract. In contrast, BTO contract, asset ownership is transferred once construction is complete.	New infrastructure	Typically, design, build, finance, maintain, and some or all operations. Under some definitions, BOT or BTO may not include private finance, whereas BOOT always includes private finance	Can be either government or user pays
Rehabilitate-Operate-Transfer (ROT)	In either of the naming conventions described above, "Rehabilitate" may take the place of "Build" where the private party is responsible for rehabilitating, upgrading, or extending existing assets	Existing infrastructure	As above, but "rehabilitate" instead of "build"	Can be either government or user pays
Concession Examples under concessions include Rehabilitate-Lease or Rent-Transfer (RLT), Build-Rehabilitate-Operate-Transfer (BROT). Rehabilitate-Operate-Transfer (ROT) described	In concessions, a private entity takes over the management of a state-owned enterprise for a given period during which it also assumes significant investment risk. In the PPP context, a concession is mostly used to describe a "user-pays" PPP. On the other hand, "Concession" is sometimes used as a catch-all term to describe a wide range of PPP types.	New or existing infrastructure	Design, rehabilitate, extend or build, finance, maintain, and operate—typically providing services to users	User pays—in some countries, depending on the financial viability of the concession, the private party might pay a fee to government, or might receive a subsidy

PPP Type(s)	Overview Description and Reference	Type of Asset	Functions Transferred	Payment Mechanism
above would also be a concession.				
Lease or affermage	A lease or affermage contract is similar to a concession, but with the government typically remaining responsible for capital expenditures.	Existing	Maintain and operate, providing services to users	User pays—private party typically remits part of user fees to government, to cover capital expenditures
Management	Under a management contract, a private party is paid a fee for managing an existing asset or business. Management contracts transfer limited responsibilities and risk to the private party, and are not always considered as a type of PPP.	Existing	Some aspects of operations (management)—typically many operational staff remain public-sector employees	Government pays—usually a fixed element plus performance-related element
Build-Lease-Transfer (BLT).	A private entity builds a new facility largely at its own risk, transfers ownership to the government, leases the facility from the government, and operates it at its own risk up to the expiry of the lease.	New infrastructure	As captured by contract name	The government usually provides revenue guarantees
Build-Own-Operate (BOO)	A private entity builds a new facility at its own risk and then owns and operates the facility at its own risk. The private sector has no obligation to transfer the asset to the public.	New	Typically all functions	The government usually provides revenue guarantees through long-term take-or-pay contracts for bulk supply facilities or minimum-traffic revenue guarantees
Private Finance Initiative (PFI)	PFI is typically used to describe PPP as a way to finance, build and manage new infrastructure	New	Design, build, finance, maintain—may include some operations, but often not providing services directly to users	Government pays

Source: World Bank Institute, 2012

Appendix 3: An extract of schedule for license fees and registration certificates

A full one available at on MERA's Website. Follow the link below:

http://www.meramalawi.mw/documents/licensing_fees_schedule.pdf

DISTRIBUTION RELATED LICENCES		
CAT. III	Small Distributors 2 MW and above but less than 10 MW	USD 5,000
CAT. IV	Very Small Distributors 0.5 MW and above but less than 2 MW	USD 2,500
CAT. IV	Very Small Distributors Less than 0.5 MW.	USD 1,250

GENERATION RELATED LICENCES		
CAT. III	Small Generators 0.5 MW and above but less than 10 MW	USD10,000 payable in Malawi Kwacha equivalent
CAT. IV	Very Small Generators Less than 0.5 MW	USD 5,000 payable in Malawi Kwacha equivalent

ELECTRICITY LICENCES APPLICATION FEES

	Nature of Fee	Fee K t
	Application fee for: (a) issue of license .. .. (b) renewal of license .. .. .. (c) amendment of license .. (d) transfer of license	50, 000 00 50, 000 00 50, 000 00 50, 000 00 50, 000 00

COMBINED GENERATION AND DISTRIBUTION		
CAT. II	SMALL GENERATORS 2MW and above but less than 10MW	USD15,000 payable in Malawi Kwacha equivalent
CAT. III	VERY SMALL GENERATORS Less than 2 MW	USD 10,000 payable in Malawi Kwacha equivalent

RURAL ELECTRIFICATION ELECTRICITY ACTIVITIES		
CAT. I	Small Hydropower Station and associated distribution reticulation	K250,000.00
CAT. II	Mini Hydropower Station and associated distribution reticulation	K150,000.00
CAT. III	Micro Hydropower Station and associated distribution reticulation	K75,000.00

a) On application …….. K20,000.00
b) On issue …………….. K5,000.00
c) On renewal ……. …. K20,000.00
d) On amendment ……..K10,000.00
e) On transfer ……..….. K20,000.00

RENEWABLE ENERGY TECHNOLOGIES

a) On application ……………… K10,000.00
b) On issue ………………..…… K 5,000.00
c) On renewal ………………….. K10,000.00

Appendix 4: Potential PPP sites

North Rukuru	5 MW
Sere River	500 kW
Manchewe/Kazichi Rivers	200 kW
Lufira River	
Kalenje River	
Kaseye River	
Chitimba River	
Chingoti River	60 kW
Hewe River	45 kW
Nchenanchena River	30 kW
Sasasa River	20 kW
Nswadzi River	75 kW
Lizunkhuni River	50 kW

Source: Malawi Government (2009)

Appendix 5: Estimated Unsuppressed Cost for Energy

Unsuppressed Cost for Electricity

Item	Quantity	Power rating (Watts)	Hours in use (h)	Energy (wh)
Lights	5	6	7	210
Security lights	2	7	12	168
TV	1	150	3	450
Kettle	1	1000	0.5	500.0
Hot plate	1	1000	1.5	1500
Radio	1	30	5	150
Phone charger	2	1	1	2
Fridge	1	150	24	3600
Iron	1	1200	0.3	400
Total load per day				**6980.00**
Total units per day				**6.98**
Total cost of electricity units per month @ MWK64.68 per unit				**13,543.99**

Unsuppressed Cost for Batteries and Firewood (Household B)

Item	Unit	Quantity	Rate (MWK)	Total (MWK)
Batteries for Lighting and Radio	No	10	500	5000.00
Firewood for cooking	bundle	4	700	2,800.00
Charcoal for ironing	Jumbo	4	200	800.00
Car battery charge for TV and Fridge	No	60	300	18,000.00
Transport to charge the battery	Days	30	300	9,000.00
				35,600.00

Appendix 6: Questionnaires

Appendix 6a: Interview Protocol for the Power Distribution Manager

QUESTIONS:

A. IDENTIFICATION

Interview Date	
Name Interviewer	Precious Chaponda
Contacts	Email: preciouschaponda@yahoo.com Cell: 0999619354/ 0888498862
Name of respondent	
Position at Bondo MHP	
Contact Number	
Email	

B. QUESTION AREAS

B1: Key information required about the plant.

Hydro Turbine Type	
Power capacity	
Power exactly produced per year	
Manufacture	
Model	

What is the life of the hydro power plant? ________________

B2: More information about the Micro Hydropower Plant

B2.1 RESOURCE	
Gross head *(Vertical distance the water falls from the drop site [i.e. Forebay tank for Bondo])*	
Maximum tail water effect *(Maximum reduction in available gross head that will occur during the times of high flow in the river)*	
Drainage area *(Area of land that collects precipitation which contributes to the flow of water in the river at the intake site)*	
Mean flow *(Average amount of water that flows at an intake site)*	
Residual flow	

(flow that is left in the river after some water is channeled to the turbine)	
Percent time firm flow is available in a year	

B2.2 HYDRO TURBINE	
Design flow *(if not known, flow that is available over 30 percent of time)*	
Number of turbines	
Generator efficiency	
Generator availability	
Available flow adjustment factor	

FINANCIAL INFORMATION

C.

D. QUESTIONS

C1: Information required for cost analysis

C1. 1: Initial cost of the project	
Feasibility study cost	
Plant development cost (project management, permits and licenses, travel and accommodation and etc.)	
Engineering cost (designing, installation, civil works, supervision etc.)	
Hydro turbine cost	
Road construction costs per km (and total)	
Transmission line costs per km (and total)	
Substation project cost	
Energy efficiency measures project cost	
Spare parts	
Transportation	
Training and commissioning	
Contingencies	
Interest during construction	
What was the total initial cost?	

C1. 2: Annual Costs (Operation and Maintenance)	
Parts and labor	
Contingencies	
Total Annual Cost	

C1.3 Periodic Costs		
ITEM	YEAR	
Turbine and generator major maintenance		
Channel and weir maintenance		
End of project life cost		
Total Periodic Cost		

C2: Information required for financial analysis

C2. 1 Financing of the plant: How was the plant financed? Is it through any of the following, indicate how much?	
Incentives and grants	
Debt ratio	
Debt	
Equity	
Debt interest rate	
Debt term	
Debt payment	
C2. 2 Income tax – do you pay tax on the revenue you get? What is the payment structure?	

C2. 3 Annual income	
Electricity exports/sold (Mwh)	
Electricity export rate	
Electricity export income	
Electricity export escalation rate	

C2. 3 Clean energy (CE) production income – do you get money from carbon credits?	
Clean energy production credit rate	
Clean energy production income	
CE production credit escalation rate	

C2. 4 Other income	
Other source of income	
Energy sold	
How much is it giving	
Income escalation rate	
Duration	

That is all, thank you for your time and the information.

The End

Appendix 6b: Interview Protocol for the General Manager

A. IDENTIFICATION

Interview Date	
Name Interviewer	Precious Chaponda
Contacts	Email: preciouschaponda@yahoo.com Cell: 0999619354/ 0888498862
Name of respondent	
Position at Bondo MHP	
Contact Number	
Email	

B. QUESTIONS

PART A

B1: Information required for cost analysis

B1. 1: Initial cost of the project	
Feasibility study cost	
Plant development cost (project management, permits and licenses, travel and accommodation and etc.)	
Engineering cost (designing, installation, civil works, supervision etc.)	
Hydro turbine cost	
Road construction costs per km (and total)	
Transmission line costs per km (and total)	
Substation project cost	
Energy efficiency measures project cost	
Spare parts	
Transportation	
Training and commissioning	
Contingencies	
Interest during construction	
What was the total initial cost?	

B1. 2: Annual Costs (Operation and Maintenance)	
Parts and labor	
Contingencies	
Total Annual Cost	

B1.3 Periodic Costs		
ITEM	YEAR	
Turbine and generator major maintenance		
Channel and weir maintenance		

End of project life cost		
Total Periodic Cost		

B2: Information required for financial analysis

B2. 1 Financing of the plant	
Incentives and grants	
Debt ratio	
Debt	
Equity	
Debt interest rate	
Debt term	
Debt payment	
B2. 2 Income tax – do you pay tax on the revenue you get? What is the payment structure?	
B2. 3 Annual income	
Electricity exportes/sold (Mwh)	
Electricity export rate	
Electricity export income	
Electricity export escalation rate	

B2. 3 Clean energy (CE) production income – do you get money from carbon credits?	
Clean energy production credit rate	
Clean energy production income	
CE production credit escalation rate	

B2. 4 Other income	
Other source of income	
Energy sold	
How much is it giving	
Income escalation rate	
Duration	

PART B

1. At the outset of Bondo Micro Hydro Scheme, it was proposed that community management approach will be used to manage the scheme. Why was the approach abandoned?

   ____

   ____

   ____

2. How is the community involved in the management of the scheme presently?

3. Presently Mulanje Energy Generation Agency (MEGA) manages the Scheme. What is the institutional framework (organization structure) of MEGA?

4. What is the composition of the board for MEGA?
   Number of board members =
   Number of community members =

5. Is there a constitution, which is used to govern operations of MEGA? If yes and if possible please share it. If not available, how are operations of MEGA governed?

6. Have you ever considered collaborating with the government in your rural electrification activities? How would you love the government to come in to help you?

7. Rural electrification activities are generally commercially not viable and usually fail. What can you say about the commercial viability of your scheme? (probe for the business model of MEGA)

8. Apart from selling electricity units, what are the other sources of revenue for operation of the scheme?

9. Does the scheme benefit any of the following:

	Details
Government subsidies	
Carbon credits	
Donation/Grants from development	

That is all, thank you for your time and the information.

The End

Appendix 6c: Electricity Users Committee Questionnaire

QUESTIONS

1. How is electricity used in the community?
2. Before electricity, how were you performing the same activities?
3. How much is spent on electricity?
4. What is the community members' major source of income?
5. How did the community contribute to the development of the site? In monetary terms, how can it be valued?
6. What is the present contribution?
7. How has the community benefited from the scheme apart from having electricity?
8. Is the community happy with the current electricity prices? How much can they add on top of what they are paying now?
9. What business activities have come about because of electricity?
10. During the development of the Micro Hydro Scheme, the community were to manage the scheme. Are you aware of this? What were expected to be your roles? (Probe to establish if they would have managed and the skills which the community has)
11. Were you communicated of the changes in the management system?
12. Are you happy with how the scheme is currently being managed?
13. Has electricity brought any social economic development?

This is the end

Appendix 6d: Questionnaire for household survey

INTRODUCTION

Hello, my name is Precious Chaponda and I am a Masters of Philosophy in Applied Sciences, Renewable Energy student at The Polytechnic of the University of Malawi. As a requirement for the award of the MPhil, I am supposed to carry out a research for a thesis. I am therefore exploring on opportunities for Public-Private Partnerships in small-scale hydropower plants in Malawi with Bondo Micro Hydropower Scheme (MHP) as a case study. I therefore would like to ask you some questions in relation to your usage of electricity from Bondo MHP.

Please note that all the respondents are randomly selected and the results will be confidential. Do you have any questions on this survey or on the project before I start?

Please note that you can say no to this interview or stop it at any time during the interview.

QUESTIONS

A. Household information

A1	Traditional Authority	
A2	Group village headman	
A3	Name of respondent	
A4	Gender of respondent	*Male = 1 Female = 2*
A5	Name of household head	
A6	Gender of household head	*Male = 1 Female = 2*
A7	Size of household	

B. Load Calculation: Household electric equipment

Do you have any of the following in your home? How many do you have presently and are you thinking to have in the given years to come?

	Item	Present no/ size	5 years in future	10 years in future	15 years in future	20 years in future	25 years in future
B1	Bulbs						
B2	TV						
B3	Iron						
B4	Kettle						
B5	Fan						
B6	Radio						
B7							

B9. Do you use electricity to charge phones? If yes, how many phones are in your household and how long does it take to charge them?

____

B10. Do you use electricity to iron clothes? If yes, how long do you spend ironing the household clothes per day?

____

C. Productive uses of electricity

C1. Do you use electricity to carry out business activities? (*Yes = 1 No = 2)* ______________

C2. If yes in C1, what is the name of the business and what is the business activity?

____

C3. How much money do you make in the business in a month? ________________________

C4. How much do you like to be making………. years from now

5 years	10 years	15 years	20 years	25 years

D. Electricity bills

D1. What is the current electricity bill for the household and the business, and how much are you willing to pay in the given years to come?

Bills	Present	5 years to come	10 years	15 year	20 years	25 years
Household						
Business						

D2. How much were you spending in a month on the given list below before electricity came.

Ironing ____

Lighting ____

Cooking ____

Radio (Batteries) ____

E. Value of electricity to the household

What has been the trend in your livelihoods from the period before electricity to the present? *[Refer to the table below for specific areas and your responses]*.

	Category	General comment on the trend 5 years before electricity	General comment on the trend after electricity
E1	Working time	1 = increased 2 = same 3 = decreased 4 = don't know	1 = increased 2 = same 3 = decreased 4 = don't know
E2	Income	1 = increased 2 = same 3 = decreased 4 = don't know	1 = increased 2 = same 3 = decreased 4 = don't know
E3	Social life (Entertainment)	1 = increased 2 = same 3 = decreased 4 = don't know	1 = increased 2 = same 3 = decreased 4 = don't know
E4	Body health	1 = increased 2 = same 3 = decreased 4 = don't know	1 = increased 2 = same 3 = decreased 4 = don't know

F. SOCIOECONOMIC

F1. How long have you lived in this area
1) Over 20 years
2) Less than 20 years
3) Less than 10 years

F2. Give reasons why you moved into this area
1) Native of the area
2) Farming
3) Livestock grazing
4) Fishing
5) Employment
6) Business
7) Marriage
88) Other (specify) __________

F3. What is the main source of income for this household? (Choose only one option)
1) Agriculture (livestock)
2) Agriculture (crops)
3) Agriculture (agriculture marketing)
4) Fisheries (catching fish)
5) Fisheries (fish marketing)
6) Fisheries (fish farming)
7) Forestry (timber products)
8) Forestry (non-timber products)
9) Forestry (charcoal)
10) Business
11) Employed
12) pension/social aid
13) Remittances
14) Daily labour/temporary
88) Other/specify

F4. What Agriculture crops do you grow?
1) Maize
2) Bananas
3) Pineapples
4) Tea
88) Other/Specify

F5. Why are the crops grown? ____

F6. If how much do you earn from the crops? _____________________

F7. What is your average monthly income?
1) Less than MK 20,000
2) Between MK 20,000 and MK 50,000
3) Between MK 50,000 and MK 100,000
4) Greater than MK 100,000

F8. In the last month, how much did your household spend on:
1) Food ___________
2) Health Care____________
3) Rentals______________
4) Electricity____________
5) Pit Latrine Emptying
6) Transport
7) Water____________
8) Waste Disposal______
9) Drainage system construction________
10) Education__________
11) Communication/Phones_____________

That is all, thank you for your time.

The end