TOWARDS SUSTAINABLE FINANCING MODELS FOR MICRO-HYDRO PLANTS IN MALAWI: A CASE OF BONDO MICRO-HYDRO SCHEME

MPHIL (RENEWABLE ENERGY) THESIS

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MPhil (Renewable Energy) Thesis

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DECLARATION

I declare that this thesis is a result of my own research investigations and findings. Sources of information other than my own have been acknowledged and a reference list has been appended. This work has not been previously submitted to any other university for award of any type of academic degree.

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 "Towards sustainable financing models for micro-hydro plants in Malawi: A case of Bondo micro-hydro scheme."

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Head of Department : _____

Signature : _____

Date : _____

DEDICATION

I dedicate this research project to the following:

- my loving parents: Mr Danie Munthopa Lipunga and Mrs Emily Lipunga;
- my caring brothers: Willard, Edgar and Khumbo; and
- my sweetheart Tilitonse.

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All in all I owe it to the Almighty God for his unmerited grace.

ABSTRACT

Malawi is in power crisis. She has one of the poorest rate of electrification with rural areas, where majority (over 80%) of the people live, being worst hit. Ironically the country sits on huge untapped renewable energy resources that if extracted can transform her to energy sufficiency. One form of renewable energy ideal for rural electrification in the country are micro-hydro plants (MHPs). However the technology has not being widely deployed as it faces the problem of lack of sustainable financing models i.e. lowest cost, long term financing models. This study was aimed at examining the key factors underlying the difficulty to develop these financing models in Malawi.

The study used the van Egmond and de Vries' sustainable finance model supported by systems thinking and life cycle model as the theoretical framework. It employed a qualitative research design utilising the grounded theory methodology. It was conducted in two phases: the conceptual phase in order to develop theoretical understanding of the key variables that make up and influence MHP sustainable financing; and the empirical phase that was undertaken through a case study of the Bondo Micro-hydro Scheme.

The study identified "MHP market development" and "MHP infrastructure development and operation" as key components of the MHP physical system, that dictate the behaviour of MHP financial system. The two main influences of the components on the financial system were determination of the quantity of finance to be mobilized and facilitation of resource mobilisation. The study revealed that uncertainties within the constituent elements of the two components bring unsteady-state to the entire financing system as a result affecting financial sustainability. Further to that the study revealed two efficiency-oriented avenues through which the costs of MHPs can be lowered in Malawi. These include (1) streamlining and localising MHP physical system activities; and (2) ensuring active engagement of all relevant stakeholders.

The major limitations of the study include the facts that the study was largely theoretical and that it was based on a single case study which is still in the developing stage. The study recommends the following areas for future research: (1) empirical studies to further test the analytical framework that emerged in this study; (2) comparative financial sustainability studies between

the Sub-Saharan African countries with other developing countries where MHPs have been a success story such as Nepal and India; (3) comprehensive stakeholder analysis within the context of MHP financial sustainability; and (4) studies on the extent to which MHP physical activities can be streamlined and localised as ways of cost containment.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

DOE	Department of Energy
EU	European Union
ESCOM	Electricity Supply Corporation of Malawi
GEF	Global Environmental Facility
IEA	International Energy Agency
IEP	Integrated Energy Policy
IPP	Independent Power Producers
IMF	International Monetary Fund
IRENA	International Renewable Energy Agency
MAREP	Malawi Rural Electrification Programme
MEGA	Mulanje Electricity Generation Agency
MERA	Malawi Energy Regulatory Authority
MuREA	Mulanje Renewable Energy Agency
MHP	Micro Hydro Plants
MMCT	Mulanje Mountain Conservation Trust
NEP	National Energy Policy
ORES	Other Renewable Energy Sources
PV	Photovoltaic
RE	Renewable Energy
SSA	Sub-Saharan Africa
UNDP	United Nations Development Programme
UNIDO	United Nations International Development Organisation

APPENDICES

Chapter 1 : Introduction.

1.1 Introduction

Energy is a strategic resource for any economy due to its enabling impact on development (Lund, 2012). Most socioeconomic developmental activities are dependent on per capita use of energy (Mahmud, Tanbir & Islam, 2012). State of energy supply tends to affect among other things, the availability of basic and social services, rate of business development and income and poverty levels (UNIDO, 2006; Santiago & Roxas, 2012; IRENA, 2012A). As such, access to energy is regarded as a precondition for economic and social development (Modi, McDade, Lallement & Saghir, 2006; Gaul, Kölling & Schröder, 2010; Klunne, 2011; IRENA, 2012A; Tchereni, 2013; Katsi, 2014).

Electricity is one of the major sources of energy globally. Global regional aggregates of the access to electricity indicate that the Sub-Saharan African region has the lowest rate of electrification worldwide, with the situation being far much worse in rural areas (IEA, 2014; Gaul *et al*, 2010; IRENA, 2012A). Ironically the region sits on huge untapped energy resources (KPMG, 2014; IEA, 2014) which are suitable for both large and small scale electricity generation projects that if undertaken can significantly change the energy situation in the region for the better and hence raising its socioeconomic status.

Malawi is one of the countries in the Sub-Saharan African region, which is experiencing serious challenges in the energy sector that include inadequate capacity to generate electricity and intermittent supply (Government of Malawi, 2012). According to the national census, only 7% of the population use electricity for lighting and 2% for cooking (NSO, 2013). In rural areas where 85% of the population lives, access to electricity has stagnantly remained below 3% (African Development Bank Group, 2011, NSO, 2013; Taulo, Gondwe & Sebitosi, 2015), as such, improving energy supply is the prime concern in Malawi (Taulo *et al.*, 2015). In the Malawi Growth and Development Strategy II energy is one of the key priority areas (Government of Malawi, 2011). Furthermore, the Economic Recovery Plan of the country also requires enhancement of research in other sources of energy, and it specifically mentions renewable energy (RE) (Government of Malawi, 2012) after observing the inadequacy of current sources and the need for diversification. The study deals with micro-hydro plants (MHPs) which are RE

technologies proven to be ideal for rural electrification in Malawi and Sub-Saharan African region due to the availability of unexploited potential. The study focuses on financial sustainability of the MHPs which is an important goal yet to be attained. At the moment, it remains one of the critical stumbling blocks to widespread deployment of the technology despite the existing potential in Malawi and in the Sub-Saharan African region at large.

1.2 Background

There are a number of RE technology alternatives such as geothermal, bioenergy, hydro, wind, solar and marine. Amongst these alternatives, hydro and within it MHPs are identified as promising and proven technology for the Sub-Saharan African region ideal for rural electrification (Kaunda, Kimambo & Nielsen, 2012; Gaul *et al*., 2010; Klunne, 2011). This is the case because the region is richly endowed with enormous untapped hydropower resources suitable for the adoption of MHP technology (Gaul *et al*., 2010; KPMG, 2014; IEA, 2014). The technology has also a long tradition in Africa that dates back to 1895 in South Africa (Gaul *et al*., 2010).

Further to that, MHPs inherently have some comparative advantages over other types of RE technologies. According to Energypedia (2014) and Paish (2002), the relative advantages of MHPs include the facts that:

- They are concentrated energy resources compared to either wind or solar power;
- Their energy availability is readily predictable and the power is usually continuously available on demand;
- They require limited maintenance;
- They are a long-lasting technology;
- They can be integrated with local grid; and
- They have almost no environmental impact.

Further to that GVEP-International (2010) highlighted that MHP systems are very flexible in that they can either be grid-connected, stand-alone or hybrid; they can use run-of-the-river systems hence do not require storage reservoirs/dams to harness the energy from moving water; and they

are relatively reliable in operation compared to wind or solar resources despite their seasonality. Besides, their running costs are cheaper compared to other RE technologies (Kaunda et al., 2012).

However, MHPs suffer from the following shortfalls: they are site-specific hence they must be close to a water source with appropriate terrain to make the installation and energy transmission viable; they are not expandable beyond certain limit since they are limited by the stream's amount of convertible embodied energy; they require a lot of civil works; their output may vary with the rainfall pattern; and although they have low-level environmental impact on the water course, the following two features may get affected: the amount of water in the section of the river where the water is diverted and oxygenation levels with potential interference in the aquatic life (Langley & Curtis, 2004). Besides, in spite of having relatively low running costs, their initial investment costs are relatively higher (Kaunda *et al*., 2012).

In spite of disadvantages noted above, MHPs are applauded for fulfilling technological, environmental, economic and social sustainability criteria in remote and isolated areas (Gurung, Bryceson, Joo & Oh, 2011). This is the case because besides providing power flexibly and reliably to homes and communities in areas not served by national electricity grid, MHPs can produce clean and affordable energy from a sustainable energy source (GVEP-International, 2010).

Despite the MHP relative advantages, suitability, the urgent need for energy and proven affordability, Klunne (2012) observed that the implementation of micro-hydro projects in the Sub-Saharan African region [which is also the case with Malawi], does not reflect the enormous potential for the technology, which suggests the presence of other barriers other than the technology itself. One of the identified barriers, which happen also to be pervasive, is "financing" (Klunne, 2012; Glemarec 2012; Gamula, Hui & Peng, 2013; Liu, Masera & Esser, 2013). Presently private capital has been scarce; this has led to reliance on donor aid (Glemarec, 2012; Liu *et al*., 2013; Gaul *et al*., 2010). However, even with the donor assistance, the financial challenges still persist in Africa (UNIDO, 2006), and the situation is much worse for Malawi as more and more donors are not forthcoming either (Liu *et al*., 2013). Thus absence of adequate

financing is an important barrier and a gatekeeper for the wide-spread deployment of the technology (Wohlgemuth, n.d.; Pierpont, Varadarajan, Nelson & Schopp, 2011; Taulo *et al*., 2015). MHPs lack "lowest-cost, long-term financing models" (Klunne, 2009; Klunne, 2011) which are described as "dedicated and affordable financing mechanisms" (Government of Malawi, 2003). This study refers to them as "sustainable financing models" following Klune (2011) who categorically shows that they are supposed to facilitate provision of energy to customers at affordable prices while ensuring long term sustainability of the sector. Due to the absence of these models, MHP projects are struggling to achieve financial sustainability (McKinnon, 2013). Development of alternative and innovative financing models is thus recognised as a means of removing the existing financial barriers (UNIDO, 2006; Klunne 2009; Klunne, 2011; Taulo *et al.,* 2015).

The existing financing arrangements seem not to favour the technology; apparently this suggests either the presence of some underlying barriers or the failure to recognise the impact of already identified barriers on financing. This is the case because financial sustainability is a function of various financial and non-financial factors. Accordingly financial measures that may be required to be implemented need to be companied by and coordinated with non-financial measures in order to design sustainable financing mechanisms (IRENA, 2012B). This is crucial because the unique nature of technology and their related markets, in other words their physical and institutional aspects, lead to their distinct financing needs (IRENA, 2012B). Thus the linkage and the influence of the physical system on the financial system should be known and addressed. Besides, the impact of non-financial barriers (physical system barriers) on financial barriers needs also to be evaluated in the search of sustainable financing models for MHPs.

Accordingly Painuly and Fenhann (2002) noted that identification and dealing with the financial and non-financial barriers is what will lead to designing of innovative policy approaches for the international and domestic financing for the RE technologies. In harmony, Foster-Pedley and Hertzog (2006) extended the thought, by noting the need to look at the industry in a holistic manner and bringing all the motives, barriers, stakeholders and investment opportunities together in one system, as a way that can assist a RE entrepreneur to approach a bank or other commercial financier with a financial proposition that may be better targeted to their investment motives or

better suited to a given risk profile. Despite these important assertions, there has been absence of holistic and context-specific assessment aimed at identifying and analysing the impact of key factors (financial and non-financial) on financing of the technologies. Improved understanding of the factors affecting financial sustainability of MHPs is thus required in order to inform and guide the search and development of sustainable financing models of the same in Malawi. It is therefore, against this background that the study endeavoured to investigate and analyse the factors that underlie the absence of sustainable financing models in Malawi.

1.3 Problem statement

It is recognised that development of alternative and innovative financing models for MHPs is critical to the removal of the financing barriers (UNIDO, 2006; Klunne 2009). It is further recognised that identifying both financial and non-financial barriers and holistically dealing with them is what will lead to designing appropriate financing approaches (Foster-Pedley & Hertzog, 2006; Painuly & Fenhann, 2002). Little attention has however been given to impact of non-financial barriers on financing of MHPs. This is in disregard to the fact that MHPs are typical example of "new economy enterprises" that demand a financial system that is sufficiently flexible to provide them with different financial mechanisms as required by the particularities of their physical system (Thiel, 2001). The study therefore endeavours to assess the factors contributing to the absence of sustainable financing models for MHPs in Malawi, by examining the impact of the nature of physical system of MHPs and the existing barriers therein (non-financial barriers) on financing of MHPs.

1.4 Research objective and questions

The main objective of the study was to investigate and analyse the factors that underlie the absence of sustainable financing models of MHPs in Malawi. The study examined specifically the impact of non-financial (contextual) factors on financing of MHPs. The following were the specific objectives of the study:

1. To determine the main components of MHP physical system that dictate the behaviour of MHP financial system.

2. To determine the specific influences of the components of the MHP physical system on MHP financing.
3. To identify critical areas that are the potential sources for lowering costs of developing and operating MHPs.
4. To examine the roles of key stakeholders, including the legislators and policymakers, operators, financers and end users, towards financial sustainability of MHPs.

In order to accomplish the objectives of the study the following questions were addressed:

1. What are the main components of MHP physical system that dictate the behaviour of MHP financial system?
2. What are the specific influences of the components of the MHP physical system on MHP financing?
3. What are the critical areas that are potential sources for lowering costs of developing and operating MHPs?
4. What are the roles of stakeholders towards financial sustainability of MHPs?

1.5 Significance of the study

Financial sustainability remains one of the critical goals to be achieved in order to ensure widespread deployment of MHPs in Malawi and in the Sub-Saharan African region at large. At present, the absence of appropriate sustainable financing models is one of the significant impeding factors to this achievement. Compounding the problem is lack of understanding of the factors that contribute to the absence of the models. The study is first of its kind to address the problem by providing a context-specific analysis of the factors underlying the difficulty to developing these sustainable financing mechanisms in the region focusing on Malawi. The study develops a reference framework that provide holistic understanding of key variables and their linkages that are critical to financial sustainability of MHPs.

The study is significant both practically and theoretically to stakeholders who are critical to the development of MHPs. To the promoters, it highlights areas that need urgent improvements in order to attract potential investors and financiers for MHPs. To the developers and operators, it

provides them with a framework that highlights the challenges and the key variables that must be taken into account in assessing the commercial and financial viability of MHP projects and in lobbying policy makers for necessary improvements based on specific contextual factors on the ground. And finally to the policy makers (i.e. government agencies), the study reveals their driving role and the ripple effects of their action and inaction on all the efforts of all the other stakeholders.

Theoretically, the study makes a significant contribution to the body of knowledge on sustainable financing of MHPs focusing on the impact of non-financial factors on sustainable financing; an area that is scarcely addressed in the existing literature. Furthermore the analytical framework developed will be useful in the conduct of future study as this subject area lacks specific frameworks. Finally the study serves as a reference point for future studies.

1.6 Chapter outline

The report consists of six chapters as follows:

Chapter 1 – introduces the study by outlining the background, problem statement, research aim and questions, significance of the study and finally the chapter outline for the report.

Chapter 2 – presents the theoretical background of the study. It explains the van Egmond and de Vries' sustainable financing model which forms the basis for the study and the systems theory and life cycle analysis models that supported it.

Chapter 3 – discusses the research methodology; in particular, it gives the details of the research design, methods of data collection and analysis that were employed, together with reasons for their choices. Further to that the chapter explains the limitations of the methodology and how ethical issues were addressed.

Chapter 4 – presents the results and ensuing discussion of the in-depth literature study that formed the phase one of the study.

Chapter 5 – presents the results and ensuing discussion of a case study (i.e. Bondo Micro-Hydro Scheme) which formed the phase two of the study.

Chapter 6 – provides the summary, conclusion and recommendations of the measures that need to be undertaken in light of the findings of the study and further highlights the areas for future research.

Chapter 2 : Theoretical Framework

2.1 Introduction

In order to achieve the research objectives, the study utilised the van Egmond and de Vries' sustainable finance model which was supported by the systems theory and life cycle analysis model. This chapter discusses these models that formed the theoretical framework of the study.

2.2 The van Egmond and de Vries' sustainable finance model

2.2.1 Nuts and bolts

The study is based on the two-part sustainable finance model developed by van Egmond and de Vries (2015). According to the model, a sustainable finance model is a combination of two systems – physical and financial systems. The physical system being where production and consumption of physical resources take place; on the other hand the financial system is responsible for mobilising finances to facilitate the production and consumption in the physical system (van Egmond & de Vries, 2015). The physical system is concerned with the development of required physical (and institutional) infrastructures, in the case of this study, may include building of the plant (MHP) and development of regulation, policies, information, education and awareness campaigns and empowerment programmes. The development of the infrastructure is the productive aspect of the physical system while consumption of resources in the process of development of the infrastructures, represents the consumptive aspect.

Production leads to consumption that creates the demand for mobilisation of financial resources hence the work of the financial system. Consequently the behaviour of the financial system is dictated by the interactions of the productive and consumptive elements of the physical system (van Egmond & de Vries, 2015). Apparently the financial system simply reacts to the conditions of the physical system; unfavourable conditions within and in relation to the physical system will most likely result in unfavourable conditions in the financial system resulting in negative impacts (the barriers) on the mobilisation of the required resources and vice versa. Hence the physical system challenges which are generally referred to as "non-financial" challenges play a significant role in originating financial challenges. In other words, where there are minimal and not physical barriers, financial barriers are likely to be minimal too. Thus, in the search of sustainable financing models, considerations should be made of the condition of the physical system, since

its structural requirements and condition drive the behaviour; consequently, in order to change the behaviour, it is important to change the thinking that underpins the [physical] system structure and conditions (Zokaei, Elias, O'Donovan, Samuel, Evans & Goodfellow, 2010).

It is important to recognise that the systems – both physical and financial – are facilitated by the interactions of various stakeholders such as governments, banks, regulators among others (Mainelli & Manson, 2011). The stakeholders are the actors or the decision-making units that determine systems' condition and behaviour hence they are critical to the entire sustainable financial system. Accordingly, dealing with the challenges relating to sustainable financing without taking into account the role of relevant stakeholders may lead to suboptimal solutions.

2.2.2 Feedback mechanism

van Egmond and de Vries (2015) defined a sustainable finance model as a system that "indeed" links the physical system to the financial system and money. Accordingly, as a system, continuous feedback mechanisms and adjustment processes are always at work to achieve a steady-state (van Egmond & de Vries, 2015). Financial sustainability is achieved when the steady-state between the physical system and the financial system is reached. Problems within the physical system will lead to uncertainties among other things, which affect financing hence the existence of the financial barriers. This is the case because uncertainties will cause the market risk to be perceived as high by the actors within the financial system (financiers and other investors) which lead to high cost of capital (IRENA, 2012B). As a result, potential investors and other supply chain players are unwilling to invest since achieving reasonable return on investment becomes a big challenge. Thus market based financing become a challenge to get, this leads to reliance on government or donor assistance (grant financing).

It is also important to note that since the behaviour of the financial system is driven by the physical system, some financing barriers are not barriers in their own right but a natural reaction to unfavourable condition of the physical system – the physical system barriers generally called "non-financial barriers". Although these physical system barriers are called "non-financial" they are thus called due to their nature, however, considering the financing impacts that they have on

sustainable financing model, they must be recognised in dealing with the financing challenges and indeed in designing sustainable financing models.

2.2.3 MHPs sustainable financing model

Using van Egmond and de Vries' sustainable financial model, the study disaggregates the MHP financing system into two: MHP physical system and MHP financial system. **Figure 2-1** presents the schema of the modified version of MHP sustainable finance model that was used by the study.

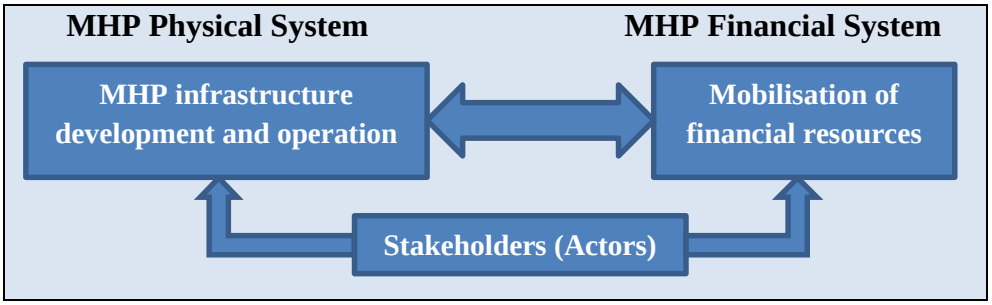

Figure 2-1: MHP sustainable finance model
(Source: van Egmond & de Vries, 2015)

Accordingly, MHP physical system is responsible for the development of MHP infrastructure – that is the "productive aspect" of the physical system. The development of these infrastructures consumes resources (i.e. the consumptive aspect). The MHP financial system facilitates mobilisation of financial resources in response to the demand created by activities in MHP physical system. The efficacy of the financial system is affected by the condition of the MHP physical system, in that the higher the level of uncertainties leads to raising of the risk profile of the project hence financiers demand higher returns on their investment, this in turn create greater challenges for developers to mobilise resources. Stakeholders are various actors within the systems or the human element that facilitates action.

In order to understand the constituent elements within the MHP sustainable financing model, their behaviour and the influence that they have on each other and ultimately on financing of MHPs, systems theory and life cycle analysis were employed.

2.3 Systems theory and life cycle analysis

RE markets are described as a highly complex, "living systems" that have a variety of stakeholders at different stages of development (IRENA, 2012B). Further to that IRENA (2012B) observed that each stage of development tends to present its distinct financing needs. Accordingly in order to understand the totality of financing needs of RE technologies it is imperative to understand each stage and its corresponding financing requirements. In harmony, Liebreich (2005) also noted that RE projects are subjected to different types of risk throughout their "life-cycle", each of which requires active management in order to attract financing. This is the case because RE projects are typical example of "new economy enterprises" that demand a financial system that is sufficiently flexible to provide them with different financial mechanisms as required by the particularities of their "life cycle" (Thiel, 2001). Thus within the context of van Egmond and de Vries' sustainable financing model, the study employed systems theory and life cycle analysis in order to determine critical components of the MHP physical system and their interactions, behaviour and their influence on the MHP financial system.

Life cycle analysis was used to identify life cycle activity phases [i.e. the stages of development of MHPs], map of stakeholder involvement, and develop context-specific indicators that helped visualisation of the [physical] system (Thabrew & Ries, 2009). On the other hand, systems thinking assisted in facilitating collective analysis of system enabling consideration of cascading effects, inertia, and other systemic features related to sustainability issues and sustainability problem-solving frameworks (Wiek, Withycombe & Redman, 2011). Therefore life cycle analysis allowed disaggregation of the MHP system into major components, while systems thinking allowed the researcher to think both holistically and in parts simultaneously (Claesson & Svanström, 2013).

Basically life cycle thinking is a way or method that assists mapping of issues over the life cycle of a product, services, or project in order to ensure that improvements are applied at the right points leading to implementable sustainable solutions (Thabrew & Ries, 2009). The application of life cycle analysis to MHP development and operation allowed revelation of critical points over the life cycle of the development and operational processes of MHPs that present significant challenges to financial sustainability, in turn leading to difficulties in developing sustainable

financing models. Using the model, life cycle phases of the MHP development and operation were identified and the MHP life cycle model was derived that revealed the major activities and phase, interrelations, stakeholders and the distinct financing needs of each phase. This was possible because life cycle analysis allows revelation of activities and their interconnectivities, associated costs and benefits, and the stakeholder involvement in development and operation (Thabrew & Ries, 2009). The process of disaggregating the MHP system enhanced the knowledge of the MHP development and operation and placed the researcher in a better position to comprehend the importance and necessity of the major activities, the resources required, individual as well as collective roles of stakeholders, and resulting individual and collective benefits in committing to the [MHP] sustainable development process (Thabrew & Ries, 2009). The use of the life cycle model allowed the development of a holistic view of the approaches that can contribute to minimizing uncertainties and promoting consensus among multiple stakeholders (Thabrew & Ries, 2009). These processes were critical elements to the study as MHPs are multi-stage, multi-stakeholders and context-specific technology.

Complementing life cycle analysis was the systems theory. According to the theory, systems are made of separate but interdependent parts that interact with each other (Agyepong, Aryeetey, Nonvignon, Asenso-Boadi, Dzikunu, Antwi, Ankrah, Adjei-Acquah, Esena, Aikins & Arhinful, 2014). Accordingly intervention in one part of the system will almost always have ripple effect in other parts triggering self-organization and adaptation based on the experience (Agyepong *et al*., 2014). This understanding highlighted to the study the important influence that the condition and behaviour of one part or elements may have on the others and the system's search for a steady-state. Besides, systems theory provided the insight of the need to understand the importance of collective action of stakeholders and interrelations. Basically the interactions between stakeholders of the system (such as banks, regulators, governments, financial instruments, and supply chain players) matter more than the specific behaviour of a particular actor (Mainelli & Manson, 2011).

Systems theory supported well the sustainable finance model due its ability to facilitating disaggregation of larger system into smaller, more discrete and redundant systems (Mainelli & Manson, 2011). As already noted the disaggregation allowed holistic study of not only the

individual constituents but also their inter-linkages and the relationships with the wider system (Zokaei *et al*., 2010). Underlying this systemic approach is the idea that additional characteristics tend to emanate from the whole which may not be attributable to any particular part of the system; in other words, the system is more than just the total sum of its components (Zokaei *et al.*, 2010). Accordingly considering the behaviour of the constituents in isolation can hardly be the best way in order to have holistic understanding and suitable and sustainable solutions. According to Anderson and Johnson (1997), important principles characterizing systems thinking include:

1. Thinking of the "big picture";
2. Balancing short-term and long-term perspectives;
3. Recognizing the dynamic, complex, and interdependent nature of systems;
4. Taking into account both measurable and non-measurable factors; and
5. Remembering that each part of the system has influence and is influenced by the other.

Thus the usage of systems theory allowed comprehensive analysis of MHP development and operation with recognition of the critical components, interconnectivities and interdependencies within the MHP physical system and with MHP financial system and the resultant behaviour based on the van Egmond and de Vries' sustainable finance model.

The use of life cycle analysis and systems thinking was not problematic as the two models are complementary and hence they easily fit together. Basically a well-documented life cycle model enables application systems thinking in managing the system through all of its phases and in evaluating both the success and the value of both the system and the results that the system produces (Archibald, Di Filippo & Di Filippo, 2012).

2.4 Summary

The aim of this chapter was to provide the theoretical framework on which this study is based. Accordingly the chapter has presented the van Egmond and de Vries' sustainable finance model as the primary model and the life cycle analysis and the systems theory as supporting models. The primary model facilitated the disaggregation the MHP development and operation into

physical and financial systems while the supporting models assisted in disaggregating the MHP physical system and deciphering the major phases and activities, stakeholders, interrelationships and the influences critical to financial sustainability and hence in understanding the factors have a bearing on the development of sustainable financing models for MHP development and operation in Malawi. The next chapter presents the research methodology that was employed in the investigation.

Chapter 3 : Research Methodology

3.1 Introduction

This chapter describes the research design and research methods that were employed in this study. According to Bryman and Bell (2003) a research design is the structure that guides collection and analysis of data whereas research methods are the techniques that are used in collecting the data. The chapter begins by discussing the research design.

3.2 Research design

A research design is crucial to any research as it represents the researcher's plan of how to proceed to gain an understanding of the subject matter (Ary, Jacobs & Sorensen, 2010). According to Bryman and Bell (2003) the choice of research design should reflect the priority being given to a range of dimensions of the particular research process. Since this study was attempting to broaden and/or deepen understanding of social phenomena [i.e. sustainable financing models of MHPs] in their real life context [i.e. Malawi] (Hancock, Ockleford & Windridge, 2009), its nature was therefore qualitative hence it employed a qualitative research design. Unlike the quantitative design which strives for testable and confirmable theories to explain phenomena, qualitative design seeks to understand and interpret human and social behaviour as is lived in a particular social setting (Ary *et al.*, 2010). Furthermore, unlike quantitative approach that relies on a hypothetico-deductive model of explanation and is typically numerical, qualitative design evolves as research gets under way hence uses no priori hypotheses and is largely non-numerical (Ary *et al*., 2010). Qualitative design was also ideal to this study due to low theory development on the subject. Existing literature hardly discusses factors underlying the absence of sustainable financing models for MHPs and renewable technologies in general. Accordingly, the study used an explorative non-positivist approach utilising the grounded theory methodology. According to Goulding (2002), researchers adopt grounded theory when the topic of interest has been relatively ignored in the literature or has been given only superficial attention, which is the case with the problem being addressed in this study.

The unique feature of grounded theory includes its ability to allow theoretical ideas to emerge out of data (Bryman & Bell, 2003). Its basic aim is to build a theoretical explanation of the conditions that gave rise to the problem (Corbin & Strauss, 1990). Grounded theory focuses on gathering data in a particular context and then inductively building a theory from the bottom up

(Ary *et al*., 2010). It moves beyond description to generate or discover a theory that emerges from the data and provides an explanation about a process, action, or interaction (Ary *et al*., 2010). Thus the grounded theory was suitable as the study was aimed at not only uncovering conditions of interests [i.e. the factors underlying the problem] but also to analyse the response of the actors to the conditions and the consequences of their actions (Corbin & Strauss, 1990). This was critical in order to develop understanding of the sources and interconnectedness of the barriers and their influence on MHP financial sustainability in Malawi. Using the grounded theory, it was possible to approximate the context of interest (i.e. phenomenon, the actors, their interactions, interrelationships and influence), and consequently conveying a conceptual understanding of issues that make up their naturalistic worlds (Van Maanen, 1979). Thus the grounded theory matched with the theoretical framework for the study presented in the chapter two.

It is imperative to note that the strength of the grounded theory is dependent on the researcher's ability to capture and interpret the ideas and perceptions of those actively engaged in the research and combine these with her/his observations' and experiences' of the setting into a written research report (Fitzpatrick, 2008). Goulding (2002) observed that researchers employing grounded theory tend to use their own disciplinary background to provide a perspective from which to investigate the problem (Goulding, 2002). This was accomplished in this study as researcher has strong disciplinary background in the field of finance being a qualified accountant.

3.3 Data collection and analysis

According to the principles of grounded theory, data can be collected from various sources and the typical data collection procedures include interviews, observations and review of the usual sources of information such as government documents, newspapers, letters, and books and anything that might shed light on the subject matter in question (Corbin & Strauss, 1990). Based on the nature of the phenomenon under study (i.e. sustainable financing models), observation was not possible, therefore the study used interviews and literature review to collect data.

In grounded theory, data collection and data analysis are closely related and are carried out in constant alternation (Bitsch, 2005; Kent, 2007). Data analysis begins as soon as the first bit of

data is collected; this is necessary at the outset of a study because that is what directs the next step of the data collection process (Corbin & Strauss, 1990). The systematic and sequential carriage of the procedures of data collection and analysis tends to expand the research process to capture all potentially relevant aspects as soon as they are perceived (Corbin & Strauss, 1990). According to Corbin and Strauss (1990) this process is a major source of the effectiveness of the grounded theory approach and which allows it to ground the theory generated in reality.

Figure 3-1 presents a schematic view of the research process that was utilised in the study. The process is a modified version of the one that was employed in Fernández, Martin, Gregor, Stern & Vitale (2011).

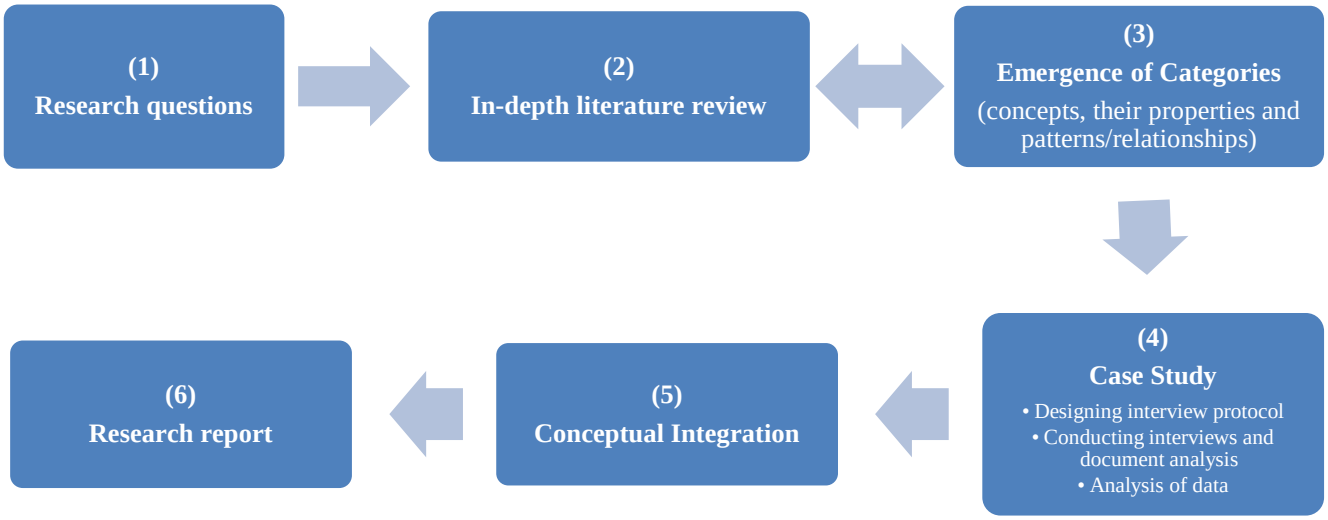

Figure 3-1: Flow chart of the research process
(Source: Adapted from Fernández *et al*., 2011)

The research was propelled by the research questions presented in chapter one of this report. The questions guided the search of relevant data from literature that led to the emergence of categories, their nature and patterns that provided theoretical explanations to the research

questions. Since MHP is a context-specific technology and the purpose for the study was targeted at Malawi, a case study of a Malawian MHP scheme was undertaken in order to test the applicability of the theoretical explanations and to uncover specific factors within the naturalistic context (Malawi).

Data was thus collected primarily through in-depth literature review and case study in successive order. The research process was divided into two phases: Phase one involving in-depth literature review and Phase two involving a case study.

3.3.1 Phase one: In-depth literature review

In grounded theory, literature can be used as a source of further data rather than simply as background to a particular research design (Kent, 2007). Thus Phase one involved carrying out of an in-depth literature review which was conducted across empirical studies conducted worldwide (Fernández *et al.*, 2011), however much focus was on the literature from developing countries and the Sub-Saharan African region. The analysis also involved review of government documents, legislations, policy, articles and anything that could shed relevant light (Corbin & Strauss, 1990).

According to the principles of grounded theory methodology, data collection was done in alteration with data analysis. Analysis involved coding the data and identifying the underlying themes and relationships (Ramage, 2009; Ary *et al*., 2010). **Figure 3-2** below illustrates the activities that were carried out in Phase one (the literature review phase). Being guided by research questions, extant literature was sampled and analysed until theoretical saturation was achieved (Bryman & Bell, 2003). In other words, sampling of literature continued until successive literature review no longer showed any new theoretical elements; hence no need to continue with data collection in relation to a particular category or cluster of categories (Bryman & Bell, 2003; Kent, 2007).

Figure 3-2: Phase 1 Research process
(Source: Bryman & Bell, 2003)

In line with Van Maanen (1979), from the research process the components of the physical system of the MHP sustainable financing model, relationships and the influences on financial system were approximated. Further to that the key actors were identified, together with their roles, interactions, influences on each other and on the entire system. The outcome of the process led to the development of theoretical insights of key factors underlying MHP sustainable financing system and emergence of analytical frameworks for understanding specific contextual elements.

3.3.2 Phase 2: Case Study – the Bondo Micro hydro Scheme

In order to understand specific issues relating to Malawi, the theoretical insights that emerged out of literature (in Phase one of the study) were validated through a case study. Normally case study research is useful when there is not a lot of theory available and when "context" is very important (Dul & Hak, 2008). Case study was therefore appropriate to this study as there is low theory development on the subject and MHPs are generally contextual in nature (Kolk & van den Buuse, 2012).

A case study can focus on a single unit (single case study), such as one individual, one group, one organization, one program and any unitary arrangement or a number of units (comparative case study) (Ary *et al*., 2010; Dul & Hak, 2008). Dul and Hak (2008) explain that the former is appropriate when data from one case is adequate to achieve the research objectives, where the latter is used where data from two or more cases are required to achieve. Based on the research objectives, the study used a single micro-hydro scheme; some more details regarding why this case was suitable are given below.

3.3.2.1 Case study selection

According to Ary *et al*. (2010) there are three types of case studies: intrinsic case study which is conducted to understand a particular case that may be unusual, unique, or different in some way; instrumental case study, where a case is selected because it represents some other issue under investigation and the researcher believes this particular case can help provide insights or help to understand that issue; and multiple or collective case study that uses several cases selected to further understand and investigate a phenomenon, population, or general condition. In case of this study, the case study selected was of an instrumental type; it was selected because it best represent the issues under investigation (i.e. the challenges and the search for financial sustainability) hence had the qualities to help broaden understanding of typical issues characterising MHP sustainable financing in a naturalistic environment, Malawi.

The Bondo Micro-hydro Scheme represents the potential of micro-hydro technology in Malawi and is the only micro hydro scheme in the country that is being developed following the commercial (market based) approach to financing following the modern trend to RE financing. Its developmental objective is to provide affordable and sustainable energy for local people (Business Innovation Facility, 2012; McKinnon, 2013). The objective therefore presents a sustainable financing challenge which is to ensure that energy is provided at affordable prices while ensuring long term sustainability of the plant (Klune, 2011).

In its nine year life, the scheme has received considerable support technically and financially and it has a business model that it is following. However, in spite of that the critical challenge facing the scheme was to reach the scale and operational financial sustainability whilst adhering to its founding principles of providing affordable, available, sustainable electricity to consumers (McKinnon, 2013). Interviews with current managers of the scheme also confirmed that this remains the key challenge. Thus in spite of all the efforts and the support, uncertainties still abound and financial sustainability remains a critical goal to be achieved. Against this background, the Bondo Scheme presents a classic case regarding the challenges to sustainable financing of MHPs in Malawi.

3.3.2.2 Data collection

A semi-structured interview protocol was designed based on results of phase one of the study (i.e. the in-depth literature review) (see **Appendix 1**). The protocol was developed to ensure a consistent approach was undertaken in the interviews (Fernández *et al*., 2011) whilst at the same offering some flexibility to ensure completeness of data.

The interview protocol consisted of five set of questions as follows: question one dwelt with identification of the key financing challenges faced by the scheme; second question, was aimed at exploring on impact of "MHP market development" (one of the two major components of MHP physical system) on financing. Question three asked the informants to point out the specific financial impact of the elements of MHP market development based on the following options: (1) resource consumer; (2) facilitator of resource mobilisation; (3) both; or (4) none of above (options that emerged out of Phase one). Question four explored on the significance of major stages in "MHP development and operations" (the second major component of MHP physical system) on financing. Question five asked the informants to situate the financing impact of the stages over MHP life cycle. Finally question six asked the informant to explain the role and the current level of engagement of stakeholders in the scheme. The interview protocol was sent in advance and before the interview was conducted, the interviewees were requested to ask questions where they needed clarification to ensure that every aspects covered by the instrument were clearly understood.

The interviewees were purposively selected based on their involvement, role and knowledge of the Bondo Scheme and rural electrification in Malawi. Consistent with Ramage (2009), the researcher made an interview request by contacting Mulanje Electricity Generation Agency (MEGA) management by e-mail with explanation of the research objectives and an invitation to participate, together with an introductory letter (see **Appendix 2**). MEGA is a small entity with five employees including two managers, a finance and administration officer, office assistant and driver. The organogram of company has three managerial positions of the General Manager, Generation Manager and Power Distribution Manager (see **Appendix 3**). At the time of the interviews the positions of Generation manager was vacant and was being acted upon by Power Distribution Manager. At the time of the interview, there was also a manager from MuREA who

was attached to MEGA to promote productive use of energy. The manager had been connected to the scheme since the early year of project. Accordingly interviews were undertaken with the three managers namely the General Manager, Power Distribution Manager and the Manager from MuREA.

Besides, interviews with the current managers of MEGA, interviews were also held with two other informants. The first one was with a consultant and researcher on MHPs in Malawi, who carried out the baseline survey on Mulanje Mountain and was part of the team that developed a MHP elsewhere within the country. The informant had also been connected to the Bondo Scheme since its inception. Another interview was undertaken with a rural electrification practitioner who was responsible for implementing the Malawi Rural Electrification Programme (MAREP). The two were engaged to provide an outlook on successes and contextual challenges in MHP development and operation in Malawi and the rural electrification programme generally.

The interview data collected was then triangulated with archival data that was subsequently collected in form of a video, progress reports and other commentaries which were specifically produced in relation to the scheme. Much of the data was collected from website of Practical Action, an organisation with vast experience in developing MHPs in developing countries such as Peru, Zimbabwe, Sri Lanka and Kenya, which was also an implementing partner of the phase one and two of the Bondo Micro-hydro scheme (Mutubuki-Makuyana, 2010).

3.3.2.3 Analysis of case study data

Ary *et al.* (2010) described two kinds of analysis appropriate for case studies: holistic analysis which involves analysis of the entire case; and the embedded analysis which focuses on specific aspects of the case. In line with the objectives, the study used embedded analysis by focusing only on the impact of MHP physical system on MHP financial system. This was the case because the purposes of the analysis were to develop a picture of the specific contextual factors underlying the challenges towards MHP sustainable financing in Malawi. Content analysis was thus employed which involved analysing and interpreting the interviews and the archives collected (Ary *et al.,* 2010).

3.3.2.4 Strengths and weaknesses of case study

It is important to note that case study method has both strengths and weaknesses as such the study results should be considered in light of them. The main strength is that it endeavours to be comprehensive, and involves describing and analysing the full richness and variety of events and issues relating to the subject in question (Jankowicz, 2000). On the other hand, it is argued that although case study may have depth, it inevitably lacks breadth as the dynamics of one individual or one social unit may bear little relationship to the dynamics of others (Ary *et al*., 2010). However Ary *et al.* (2010) noted that in spite of the differences what we learn in a particular case can be transferred to similar situations with the reader, rather than the researcher, arguing that it is the reader who determines what might apply to his or her context.

3.3.2.5 Reliability

To ensure reliability of the study, the interview protocol was adhered to and the interviews were digitally recorded (Ramage, 2009). Further follow ups using the telephone were made for clarity and confirmation of interpretation. Furthermore the interview data was triangulated with data collected from the archives of the Bondo Micro Hydro Scheme.

3.4 Ethical considerations

In order to ensure that ethical principles were followed, some measures were taken. Prior to the interviews, the informants were informed of the objectives of the study and were approached with respect. Participation was voluntary; informants were not pressured in any way to provide information. No deception of any form was used and data was used in a way that was responsible, fair and legal (Mulili, 2011; Kent, 2007).

3.5 Summary

The chapter has provided the description of the methodology that was employed in the study in order to answer the research questions. The chapter has indicated that due the nature of the study, a qualitative design was employed utilising grounded theory orientation. The main data collection methods were literature review and case study supported by in-depth interviews and documentary analysis. Basically the study was conducted in two phase: in-depth literature review phase and case study phase. The next chapter provides the results of the Phase One of the study.

Chapter 4 : MHP Sustainable financing: A theoretical review

4.1 Introduction

This chapter presents the findings and discussion of the Phase One of the study. The Phase One was undertaken through an in-depth literature review which was premised on the van Egmond and de Vries' sustainable finance model supported by systems theory and life cycle analysis. Using the grounded theory methodology theoretical insights emerged that provides understanding of the critical aspects of sustainable financing of MHPs. The insights were organised into the following schema; an MHP life cycle model, a holistic view of MHP financing needs, a stakeholder involvement pyramid and finally a framework linking physical and financial systems of MHP development and operation as is facilitated by various stakeholders. The chapter begins by giving a background of energy supply situation in SSA region and Malawi and the consequent challenges.

4.2 Energy challenges in Sub-Saharan African region and Malawi

4.2.1 The energy supply situation

Sub-Saharan Africa (SSA) is one of the least-developed regions globally. It has one of the highest percentages of people living in extreme poverty (Simmons, 2015). This is in spite of the abundance of natural resources that the region possesses, the various poverty alleviation programmes being undertaken and a strong economic growth that has been witnessed over the past decade (IMF, 2014; Shanker, 2013; Simmons, 2015). One of the contributing factors to this slow rate of development is lack of modern and reliable energy services (IMF, 2014). The region is currently in a power crisis characterized by inadequate, unreliable, and costly electricity supply (IMF, 2014). While the rest of the world has improved in the last two decades, the region's per capita electricity production has remained low and largely stagnant (IEA, 2014; IMF, 2014; KPMG, 2014). IEA (2014) reported that:

> "more than 620 million people in the region (two-thirds of the population) live without electricity, and nearly 730 million people rely on dangerous, inefficient forms of cooking…..and average electricity consumption per capita is not enough to power a single 50-watt light bulb continuously."

In harmony KPMG (2014) observed that:

> "The region is characterized by ageing power infrastructure that is unable to meet current power demands and therefore suppresses the power demand….Power consumption, at 124 kilowatt hours (kwh) per capita per year and falling, is only a tenth of that found elsewhere in the developing world, which is barely enough to power one 100-watt light bulb per person for three hours a day."

Excluding South Africa, the entire installed generation capacity of the region is reported to be equivalent to that of Argentina (World Bank Group, 2013). Accordingly, the current available electricity in the region is less than adequate to support sustainable economic and social development of sources of production and of the basic social services (Shanker, 2013). Therefore making reliable and affordable energy widely available remains critical to the development of SSA region (IEA, 2014).

The energy supply situation is far much worse in rural areas (Gaul *et al*., 2010; IRENA, 2012A). According to the global regional aggregates (see **Table 4-1**), rural electrification rate in SSA is 16% which is the lowest globally, and this is seconded by other developing countries at 64%. The rate disparity is sobering, indicating the gravity of the problem in the in the rural areas in SSA. This further explains why acute poverty in the region is mostly concentrated in rural areas (Alkire & Housseini, 2014).

Table 4-1: Global regional access to electricity aggregates

Region	**Electrification rate %**	**Urban electrification rate**	**Rural electrification rate**
Developing countries	76%	91%	64%
North Africa	99%	100%	99%
Sub-Saharan Africa	32%	59%	16%
Developing Asia	83%	95%	74%
Latin America	95%	99%	82%
Middle East	92%	98%	78%
Transition economies & OECD	100%	100%	100%
Source: IEA (2014)			

Malawi like the rest of the countries in the SSA region is experiencing serious challenges in the energy sector characterised by inadequate capacity to generate electricity and intermittent supply (Government of Malawi, 2012). The national census revealed that only 7% of the population use electricity for lighting and 2% for cooking (NSO, 2013). In the rural areas where 85% of the population lives, the situation is even worse as the access rate to electricity has stagnantly remained at less than 3% (African Development Bank Group, 2011; NSO, 2013; Taulo *et al.*, 2015). Thus the energy supply situation for Malawi is worse even at regional level as the electrification rates lies below SSA regional averages as presented in **Table 4-1**.

4.2.2 Factors contributing to poor rural electrification rate and related solutions

The contributing factor to the poor state of electricity access, is the fact that the traditional way of providing electricity through grid extension has proven to be technically challenging and prohibitively expensive due to geographical barriers (i.e. distance and terrain) and initial low demand for electricity in the rural areas (Gaul *et al*, 2010; Klunne, 2011; Kaunda *et al*., 2012). Kaunda *et al.* (2012) noted that the remoteness and sparseness of most of the rural settlements makes transmission and distribution costs of electricity expensive and prohibitive. Besides, grid extension work has been noted to be slow, extending many decades (Lindsay, n.d.). The problem is further made worse by the existing "weak, damaged or underdeveloped electricity distribution infrastructure" (KPMG, 2014), that is not even adequate to serve the urban population. In Malawi over 50% of the power generation plants is reported to have passed their expected lifespans and hence require frequent maintenance as a way of improving the efficiency of the machines (Taulo *et al.*, 2015). As a result, grid extension does not offer immediate and effective solution to energy problem in the rural areas. This according to Taulo *et al.* (2015) calls for an innovative model for rural energy access beyond the grid extension. Thus development of alternative and cost-effective means of supplying energy is a matter of necessity.

In principle, UNIDO (2006) intimated that this will involve designing programmes that enables provision of energy supply in a sustainable manner. Which according to Santiago and Roxas (2012) should involve electrify the rural communities through installation of off-grid power facilities that take advantage of the indigenous natural resources. In support, KPMG (2014)

observed that these off-grid power solutions are ideal as they involve installation of small generators more closely to the end-user thereby mitigate transmission challenges. Furthermore these off-grid facilities can be implemented more quickly due to their shorter licensing processes and construction times, thus speeding up the electrification process (KPMG, 2014). Besides they represent the cheapest way to expand energy access to remote communities (IRENA, 2012B).

The assertions above are in harmony with Shanker (2013) who proposed the use of the so called highly diversified "technological toolbox" in accelerating rate of electrification. The toolbox allows for a more targeted response to the characteristics of rural demand (Shanker, 2013). According to Shanker (2013), the toolbox includes three-pronged strategies to accelerating electrification which are:

> "…[1]grid extensions to areas with strong demand, thus justifying the high investment cost in the power lines; [2] mini grids with local thermal or hybrid production – if the resource is available – in areas that have corresponding levels of demand; [3] small-scale (stand-alone) generation geographically distributed for very remote communities and small villages."

Accordingly, strategy number three is the most ideal to most rural areas in SSA region and Malawi in particular considering the major challenges on the ground (i.e. geographical barriers and low initial demand). Thus renewable energy technologies present an ideal solution to rural electrification in light of the challenges (Gaul *et al*., 2010). In fact renewables turn some of the impeding factors of grid extension to rural areas (such as terrain) into opportunities for relative cheap means of energy access to the areas.

Accordingly renewable energy technologies are described as promising alternative to the traditional energy sources, specifically critical to remote communities in SSA region (Painuly & Fenhann, 2002; KPMG, 2014; IEA, 2014). The potential opportunities they present will include helping the region to diversify energy mix, increase security of supply, meet environmental and climate change goals, reduce reliance on imported fuels, fasten electrification process and provide local employment for deployment and maintenance of the same (WACCI, 2007; Nelson

& Shrimali, 2014; IEA, 2014). These benefits are therefore for the SSA region to enjoy as it is endowed with vast untapped renewable energy resources that can enable it to provide electricity to all across the continent of Africa at an affordable cost (IRENA, 2012A).

Amongst the renewable energy alternatives such as geothermal, bioenergy, hydro, wind, solar and marine; this study focused on micro hydro plants (MHPs). This was so because they are recognised as a one of the proven and more promising option in the SSA region (Gaul *et al*., 2010; Klunne, 2011). As already noted in chapter one, they are applauded for fulfilling the technological, environmental, economic and social sustainability criteria in remote and isolated areas (Gurung *et al.,* 2011). Besides providing flexibly and reliably power to homes and communities in areas not served by national electricity grid, micro-hydro installations offer also an opportunity for the production of clean and affordable energy from a sustainable energy source (GVEP-International, 2010).

Like the rest of the countries in SSA, Malawi is endowed with huge untapped potential for small hydropower which is spread out across the country (Taulo *et al.,* 2015). It is estimated that the gross theoretical potential for the small hydro plants stands at 150 MW of which only 4.5 MW of the economically feasible potential has been developed (MEM, 1997). A classic example of MHP project currently being implemented in Malawi is the Bondo Micro-hydro Scheme. Taulo *et al.* (2015) observed that exploitability of small hydro plants in Malawi is limited by their projected costs. Furthermore, the country's legislations and policies have done little to deal with the situation particularly to help to reduce the cost and attract private investment. For instance, the legislations are inflexible and bureaucratic; moreover they do not accommodate the operations of independent power producers (IPPs) (McKinnon, 2013). The implementation of the Bondo Scheme bears testimony to that and also of the challenges that MHPs face towards financial sustainability and the urgent need to address them.

4.3 MHP's sustainable finance model: The physical and the financial systems of MHP

Based on van Egmond and de Vries' sustainable finance model, the MHP physical system was derived from the review of the literature. The physical system is critical to financial sustainability of MHPs since according to van Egmond and de Vries (2015); it is the part of the sustainable

finance model that dictates the behaviour of the financial system. Thus understanding the physical system condition helps to provide insight on the behaviour of the financial system.

4.3.1 Typical components of the physical system

Using grounded theory methodology two critical components of the MHP physical system emerged namely: "market development" and "infrastructure development and operation". Accordingly these are the major components that significantly determine the behaviour of the financial system both in short and long-term.

4.3.1.1 Market development

Market development is the first component of MHP physical system. Basically any technology without a strong market is not viable. It is therefore more important to think about markets, rather than simply about the technologies themselves (Martinot, Chaurey, Lew, Moreira & Wamukonya, 2002). This is the case because successful deployment depends on many other factors including acceptability and affordability by its users rather than simply its robustness. With that in mind, it is important to highlight the differences between "market potential" and "actual market" in the context of RE technologies. Market potential refers to the quantity of RE development that can be supported in a particular area given the available resource, and the technical, economic, and market constraints (Kreycik, Vimmerstedt, & Doris, 2010). On the other hand, the actual market incorporates market acceptance considerations such as demand, supply, commodity prices, regulations, incentives, barriers, investments, and consumer response (Kreycik *et al*., 2010). It is possible simply to have the market potential, when actual market is non-existent. Actual market exists when there is effective demand i.e. purchasing power and willingness to pay for the services and suitable investment environment. If actual market (and not simply market potential) exists in a particular area, the technology can be deployed easily. However where there is only market potential, market creation or stimulation should be undertaken (Haselip, Nygaard, Hansen, & Ackom, 2011) as a matter of necessity.

Market development for REs involves research and development of policy and regulations (i.e. macro-elements), and education of consumers and promotion of new income generating activities in the area (i.e. micro-elements) (Glemarec, 2012). The macro-elements are meant to create and

promote a suitable investment environment, while the micro-elements are to enhance the willingness and purchasing power of the end-users to ensure affordability of energy services (Glemarec, 2012). Market development activities contribute to the long-term sustainability of technology, in that they turn the market potential into actual market. It is the existence of an actual market (and not simply market potential) that ensures financial and commercial viability of the MHP project, hence guaranteeing long-term sustainability.

4.3.1.2 MHP infrastructure development and operation

MHP infrastructure development and operation is the second component of MHP physical system. It is involved with planning, building and operating the MHP. **Figure 4-1** and **Figure 4-2** present the MHP life cycle that emerged out of literature. As exhibited, MHPs pass through seven distinct stages that can be categorised into three phases: pre-construction (conceptualisation, feasibility, designing and regulatory approval); construction (project implementation); and post-construction (operations and/or extension-of-useful life and termination).

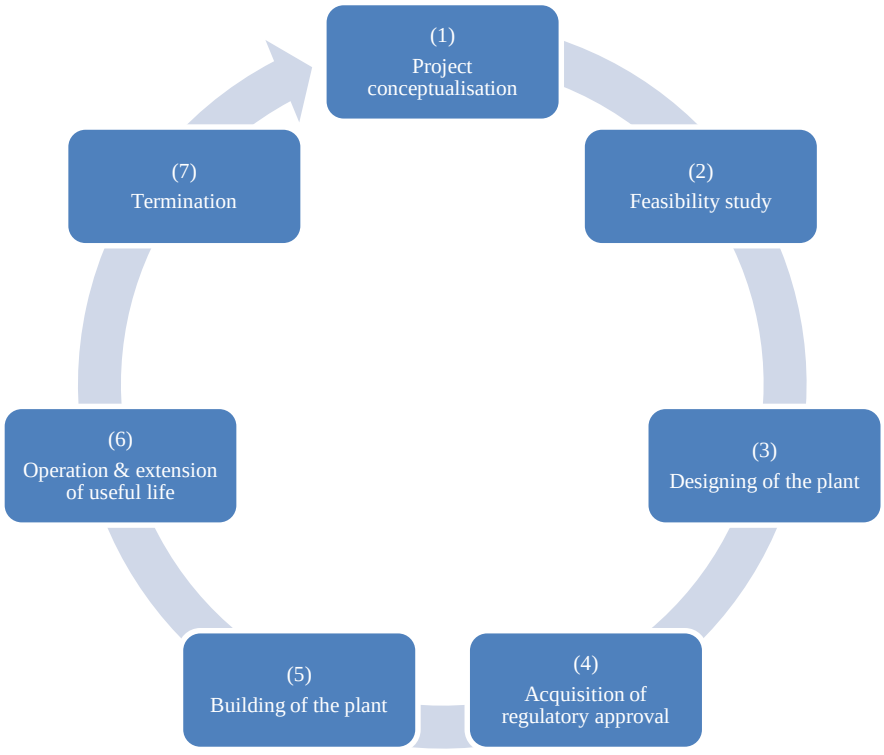

Figure 4-1: MHP life cycle stages
(Source: Based on analysis from literature review by the researcher)

The **pre-construction phase** is divided into four main stages namely: project conceptualisation; feasibility study; designing of the plant; and acquisition of regulatory approval. The typical activities under this phase include identifying and planning to eliminate energy needs, site selection, assessment of resource availability, establishment of a legal framework for the project and acquisition of regulatory permits (Management-hub; Jager & Rathmann, 2008; Pierpont *et al.*, 2011).

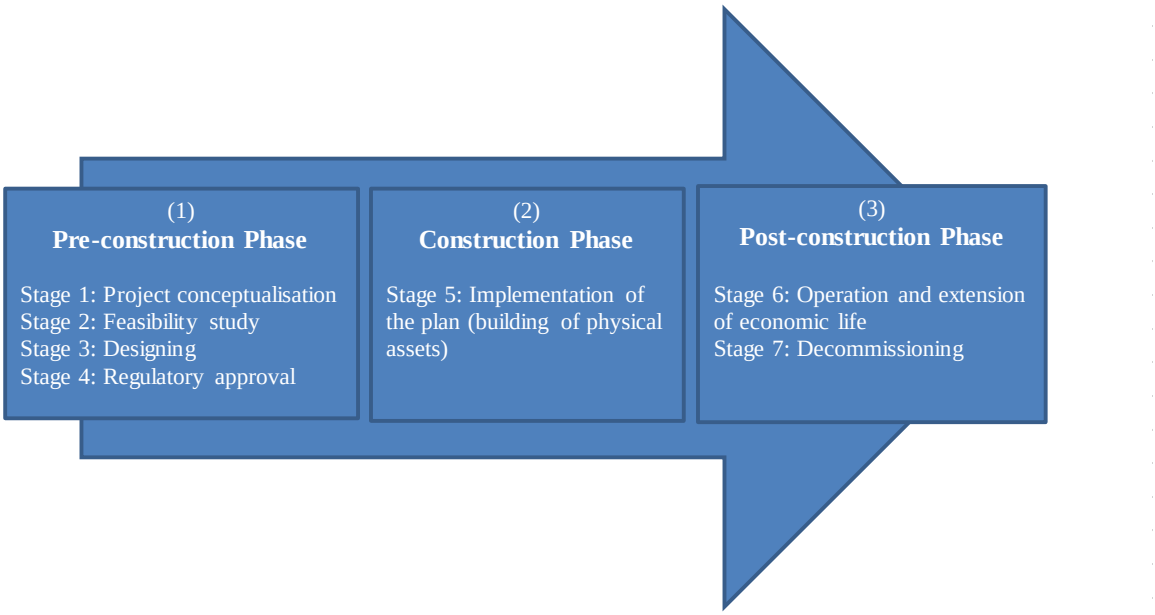

Figure 4-2: MHP life cycle model
(Source: Based on analysis from literature review by the researcher)

The choice of the construction site is considered as one of the most important steps, as it largely determines the amount of energy production and complexity of site development Razan, Islam, Hasan, Hasan & Islam, 2012). Much care is needed as this predetermines the quantity of capital expenditure during construction and the future income generating capacity of the MHP. Feasibility study involves assessing whether to proceed with the project or not, and that involves the conduct of environmental assessment, hydrology assessment, preliminary designs, and preparing detailed cost estimates (Razan *et al.*, 2012). According to Kaunda *et al.*, (2012) feasibility study is undertaken in two sub-stages: the initial desk study – involving a confirmatory

assessment of the availability of energy generation potential; and the comprehensive study – involving the quantification of energy potential in order to determine whether the project is worth the investment. Favourable results of the desk study leads to comprehensive feasibility study which is undertaken by visiting the site and taking actual measurements of head and flow rate (Kaunda *et al*., 2012).

Upon the conclusion of the feasibility study, an appropriate design for the MHP is developed based on the information gathered through the study. Each MHP project is unique (ICAST, 2011), as such, designs are site-specific. After the design is developed, regulatory approvals can then be secured in order to proceed to the construction phase; as such, at this stage, the regulatory policies become particularly important (Pierpont *et al.,* 2011). In Malawi, the Rural Electrification Act requires possession of three separate licences (i.e. generation, transmission and distribution licences) order for one to fully engage in any rural electrification activity (Malawi Government, 2004). Other applicable legislations include, the Electricity Act, Energy Regulation Act, Environment Management Act and Water Resources Act. Familiarity with the legal framework is therefore of great importance.

Pre-construction phase is generally developer-driven and covers activities required for realising a financial closure of the project, hence, all the elements must be carefully implemented in order to come to an investment decision (Jager and Rathmann, 2008). Since the phase focuses on planning rather than building, the capital requirements are comparatively low (Pierpont *et al*., 2011). However the phase has significant long-term implications on capital requirements of other two phases. The major challenge currently faced by developers in SSA at pre-construction phase is the fact that most prospective sites are either ungauged or has insignificant data for design analyses (Kaunda *et al.,* 2012); as such developers tend start from scratch which further increases the cost of investment.

The second phase is the **construction phase** that involves actual construction of the physical asset (Jager & Rathmann, 2008; Pierpont *et al.,* 2011). The activities at this stage include acquisition of the land, preparing and securing necessary contracts with suppliers of equipments and various services (Jager & Rathmann, 2008; Pierpont *et al*., 2011). The construction work is

carried out by various service providers such as construction contractors, equipment suppliers, assemblers, transporters, technicians, and local non-skilled labour. The typical components of an MHP system that are developed or acquired include the civil works (i.e. settling basin, canals, forbay tank and penstock), turbines, generator, switchgear protection and transmission (ICAST, 2011). At this phase much of the capital expenditures are incurred and government incentives really matters in countries like Malawi that imports most of the required capital equipments. Besides, if the activities under the pre-construction phase were superficially undertaken (particularly the feasibility study), the lead time for this phase is lengthened as implementing the project becomes difficult due to unexpected discoveries which in turn negatively affect the project costs.

The **post-construction phase** is the longest phase that can be divided into two stages: operational and/or renewal stage; and termination stage. Operational activities involve putting the newly constructed MHP to use for the benefit of the intended users; accordingly it is concerned with generation and distribution of the intended electrical power. The phase is management-oriented as much of the work is maintenance related. One of the advantages of MHP technology is that it is designed to operate as a passive system requiring less extensive maintenance (ICAST, 2011). The typical routine maintenance work involves removing debris build up in the civil works structures which comprises raking screens, mucking out settling basins or repairing leaks in canals (ICAST, 2011). Thus major work is generation of electricity, monitoring that the system is working effectively, connecting new users and collection of fees if it is fee-based (ICAST, 2011).

It is at this operational stage that the importance of existence of actual market is felt. The MHP needs not mere consumers, but those with the willingness and capacity to pay for the energy services. Operational costs incurred are supposed to be met by the income generated by the MHP itself. Besides the income generated should further be adequate for reinvestments to maintain and/or expand the operational capacity of the MHP facility. Moreover, after the initial operational life, the MHP may need extension of its economic useful life which may be referred as "renewal". The renewal process involves overhauling the plant to restore the generation capacity lost through depreciation; thus major rehabilitation of the civil works and the replacement of

some major equipment may be required. Consequently substantial financing may be needed to accomplish renewal otherwise the facility is decommissioned.

Thus the final stage of the post-construction phase and of MHP life cycle is the termination stage which is the end of the economic useful life of MHP. Activities under this stage include dismantling and disposal of the generation equipment and restoration of the site in accordance with the laws of the country. The risks of the decommissioning the plant are generally low as in many cases the scrap value of the installations is higher than the decommissioning costs (Jager & Rathmann, 2008). The termination stage marks the end of the economic useful life of the MHP.

Presented above are the constituent parts and activities in the physical system of MHP development. They represent the productive aspect of the MHP physical system; out of them the physical MHP "infrastructure" is developed and operated. Understanding of these physical stages helps in appreciating the elements that drives financing of MHP. Basically the activities undertaken in development and operation of MHP consume resources (representing the consumptive aspect of the MHP physical system), thus they determine the quantity of finances that need to be mobilised by the financial system. Each stage in MHP life cycle has its own distinct financial requirements (IRENA, 2012B), that must be understood in order to control them. Exhibited on **Table 4-2** are typical costs relating to each phase of the MHP life cycle.

Table 4-2: Typical MHP development and operational costs

Pre-Construction	Construction	Post-Construction
• **Initial Costs** include costs for ➢ site selection; ➢ feasibility studies; ➢ environmental impact assessments; ➢ engineering design; ➢ project management; ➢ permits and licencing;	• **Construction Costs** include costs for ➢ civil works; ➢ access roads; ➢ transmission lines; and ➢ others related to setting up the project. • **Service costs** include costs for: ➢ Workforce and service contractors required to build the plant such as hiring engineers, managers, and labourers, also providing them other facilities like food, lodging, and so forth.	• **Annual operating Costs** include ➢ Operation and maintenance costs for the complete project and include administrative costs such as salaries, rentals, and fees. • **Decommissioning costs** include cost for

➢ obtaining land rights; ➢ financing fees; and ➢ energy purchase agreements.	• **Costs for Equipments** include costs for: ➢ purchasing various equipments like protection system, control system, turbine, generators, and so forth; ➢ transportation and installation of these equipments.	dismantling, site restoration and other related costs
Source: Jager & Rathmann (2008), ICAST (2011), Usman *et al.* (2012) and Razan *et al.* (2012)		

It is important to note that the total cost of MHP projects is site specific; it varies greatly depending on the remoteness of the site (Anup, Ian & Sang-Eun, 2011). Since most MHP potential sites are in remote parts of Malawi and this too applies to most SSA countries, the development costs are likely to be relatively higher. Furthermore, the costs presented in **Table 4-2** do not include market development costs; they only relate to the development and running of the MHP.

4.3.2 Influence of the physical system on the financial system

In this section a review of specific elements within the two major components of the MHP physical system is presented together their condition focusing on the impacts that they have on financing that have ultimate impact on the MHP financial system.

4.3.2.1 Market development component

Market development involves undertaking research and development of policy and regulations, education of consumers and promotion of new income generating activities (Glemarec, 2012). The product of market development activities includes development of four basic instruments namely: clear policy statements and targets; consumer education and community participation; standardization of equipment; and research and development (Glemarec, 2012).

These instruments may influence financial resource mobilisation (the MHP financial system) as "resource consumers" – by determining the quantity of the finances to be mobilised; and/or as "facilitators" of financial resource mobilisation process. Development of these market instruments requires sufficient planning, consultations and undertaking of activities that involve significant expenditure of time and effort of several stakeholders (such as practitioners, consultants, and government officials) consequently the process consume substantial amount of resources. On the other hand, when investors, lenders and other stakeholders find these

instruments (policy, regulations, and incentives) to be inadequate, unreliable, or too risky, they increase the cost of capital and that in turn affects the overall project cost (Jager & Rathmann, 2008). Furthermore market instruments tends to affect the investment environment by influencing the allocation of costs, revenues and risks, and the business practices and technology choices of investors and project developer (Pierpont *et al.*, 2011). Absence of the instruments increases uncertainties resulting in difficulties in development of attractive funding proposals. This in turn makes accessibility of finances by the developers a challenge. Accordingly, in order to secure support from funders they is a need to ensure that these market instruments are present, adequate, coherent, consistent and conducive otherwise their absence or inadequacy will make it difficult for the private and industrial sector to operate effectively and expand their investments (UNIDO, 2009).

Currently these market instruments are not well developed within the SSA region and Malawi in particular (Klunne, 2012; Glemarec, 2012; Gamula *et al.*, 2013). Further to that at micro level, the typical end-users of MHPs have very limited purchasing power suggesting the need for comprehensive market development in order to enhancing the same. Efforts have been made; however the major challenges faced by the process include the existence of considerable uncertainties and need for large financial outlays (Glemarec, 2012). There has also been lack of clarity of the essential elements that need to be developed and how they are to be financed (Khennas & Barnett, 2000). Due to uncertainties, the market risk is perceived to be relative higher, leading to high costs (IRENA, 2012B) and consequently private capital is scarce (Glemarec, 2012). On the part of the developers and operators instead of concentrating on development and operation of MHPs, they are forced to address the absence or the inadequacy of market instruments by developing special programmes and these require additional planning and implementation of interventions thus incurring extra costs (Thabrew & Ries, 2009).

It is worth noting that in spite of the importance of the existence of actual markets to successful deployment of MHPs, the extant literature poorly recognises the need for adequate market development investment in areas with market potential yet with non-existent actual market. Furthermore the absence or inadequacy of the market elements is shallowly recognised as simply the presence of “non-financial barriers”. Besides the impact of the absence or underdevelopment

of the market elements on MHP financing is hardly discussed. Further to that financial barriers are discussed without highlighting that they may arise directly or indirectly due to the absence or underdevelopment of essential market elements. The common practice in literature is to present financial barriers simply as one of several other major barriers to MHP deployment. Thus the recognition that the structure and condition of MHP physical system can dictate the behaviour of the financial system is hardly given any attention.

4.3.2.2 MHP infrastructure development and operation

Developing an MHP requires substantial investment relative to other RE technologies (Department for International Development, 1999; Pierpont *et al*., 2011), however their running costs are relatively lower (Kaunda *et al.*, 2012). Due to the need for huge investment, the cost of electricity production is much higher as compare to both fossil fuels and other RE technologies (Haselip *et al.*, 2011; Ivanova, 2012; Kolk & van den Buuse, 2012; Glemarec, 2012). As such, MHPs produce relatively expensive energy that requires charging of a premium in order to cover costs of production (Ivanova, 2012) and generate reasonable return on investment. Thus the very nature of MHPs poses a financing challenge. This problem is compounded and becomes more challenging by the poor financial capacity of the end-users (Kolk & van den Buuse, 2012; Liu *et al.*, 2013) – an effect of market development. Typical MHP energy services consumers are the poor residents (i.e. poor peasants, tenants, landless and other disadvantages group) of remote rural areas, who are at the bottom of the economic pyramid (Anup *et al.*, 2011). The majority have poor purchasing power and that requires charging of low tariffs to make the produced energy affordable them (Gurung *et al*, 2011) and this in turn impacts negatively on the financial viability of MHPs. Basically MHPs require increased load factor of 20-25% to be financially viable, however such increased load factor makes them commercially unviable, necessitating heavy subsidy by aid groups of between 60% and 80% (Department for International Development, 1999). The aid groups resemble, in a sense, to ‘‘business’’ customer (Kolk & van den Buuse, 2012). In the absence of these aid groups, governments are supposed step in, otherwise the MHPs’ long-term existence is severely affected.

4.3.2.3 Linking physical and financial systems of MHPs: a holistic view

Financing issues need not to be considered in isolation. They must be considered together with the non-financial issues in order to adequately address them. This calls for comprehensive understanding of MHP financing within its context. Accordingly this backs the assertion by Foster-Pedley and Hertzog (2006) of the need for holistic approach in order to develop appropriate financing models for RE technologies.

Figure 4-3 presents that holistic view of the underlying financial architecture of MHPs over their life cycle that emerged as a result of analysis. The **Figure** provides visual presentation of basic links of the physical aspects and activities of MHP development to financing and their consequent contribution to long-term productive and financial sustainability.

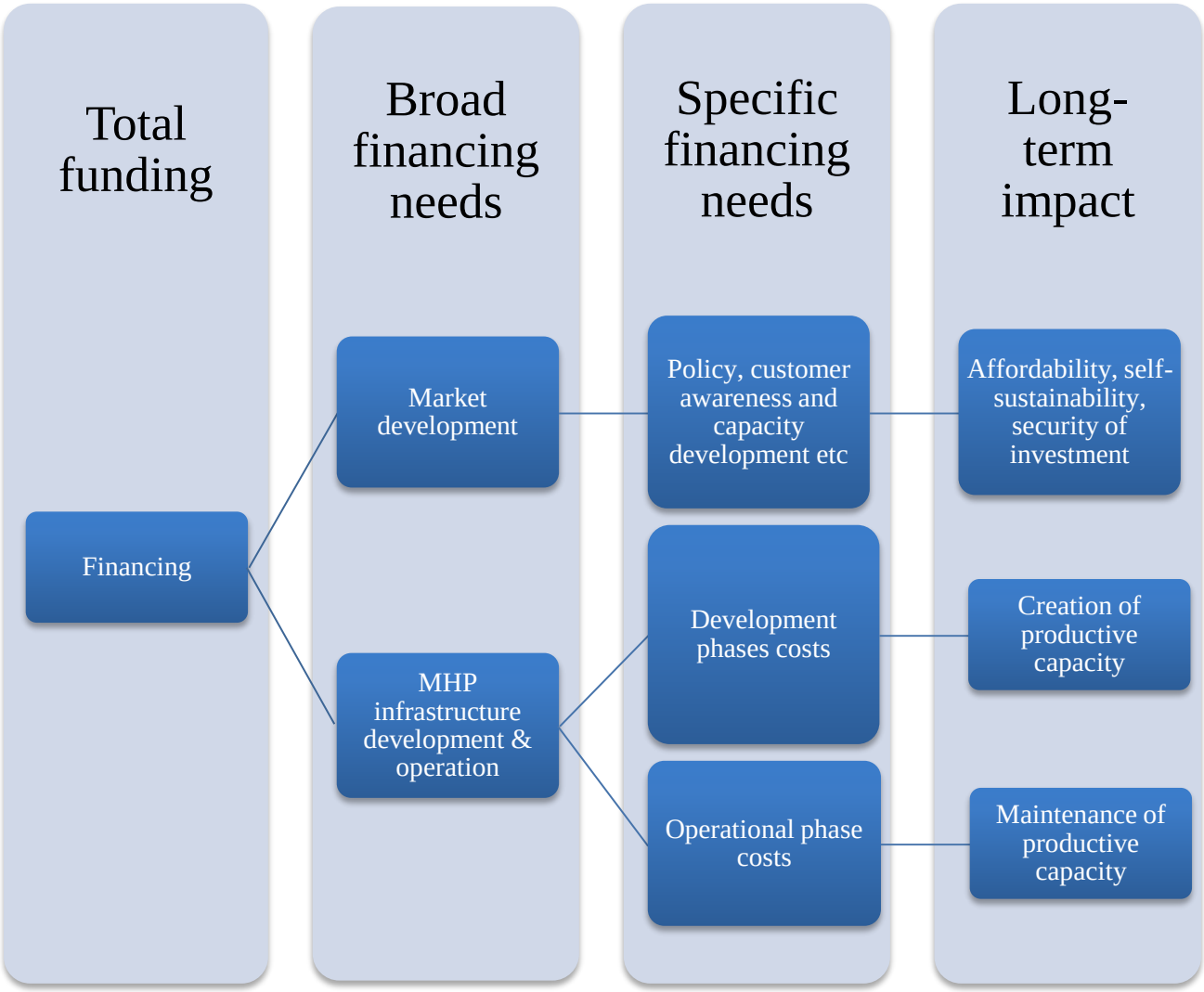

Figure 4-3: Holistic view of financing needs for MHPs
(Source: Based on analysis from literature review by the researcher)

As is exhibited in **Figure 4-3**, MHP financing needs can be categorised into two broad groups based on the major components of MHP physical system namely: market development financing needs and MHP infrastructure development and operation financing needs. **Figure 4-3** shows that each category is critical and has a significant long-term purpose towards sustainability of the MHP. The key purpose of market development is to enhance affordability of the energy services by empowering end-users through promoting and strengthening their capacity and willingness to pay. Besides, market development ensures security of investment by developing investments safeguards (such as policies, regulations and incentives) that attract investors and other stakeholders to engage in MHP projects. These in turn contribute to self-sustainability of MHPs, in that, developers are able to mobilise adequate funds the construction of MHP infrastructure

with ease and subsequently the developed MHPs are able to generated locally adequate income sufficient to cover all costs and give reasonable return on investment through the sales of electricity to the empowered end-users. On the other hand, the key purpose of MHP infrastructure development and operation is to create and maintain and/or expand the productive capacity of MHP.

Accordingly, while the market development is aimed at achieving long-term financial and commercial viability, on the other hand, infrastructure development and operation, is aimed at ensuring long-term operational/productive viability. Thus both market development and MHP development and operation are critical to the effective deployment of MHPs; neglecting one aspect put the sustainable finance model of MHP in un-steady state. Currently extant literature puts much emphasis on MHP infrastructure development and operation only, thus there has been a gap in understanding of the need to consider their underlying long-term symbiotic relationship and their effect on long-term sustainability of MHPs.

4.3.2.4 Shift in financing approach of RE technologies

Superficial attention given to MHP market development undermines the importance of the commercial aspects of MHPs and that has impact on financial sustainability. This is not in tandem with the current trend in financing of RE technologies. According to Wohlgemuth (n.d.) there is shift from the traditional government-and subsidy-centred approach for promotion of RE to the new, market-oriented approach in which consumer-side financing or fee based service is the central factor. Supporting the assertion, Parajuli (2011) also observed the evolution in approach in the field of micro-hydro from "technology push" to "market pull". Parajuli (2011) explained that initially micro-hydro installations in developing countries were made to test their technical viability and acceptability which has since been established, hence the shift to market pull approach which is facilitated by demand based mechanisms i.e. the customers purchasing power and willingness to pay. The shift calls for the need to economic empower the consumers by promoting rural based micro-enterprises and other economic activities (Parajuli, 2011). This is in order to enable consumer-based financing as the typical end-users have poor financial capacity.

It is worth noting that market development will be comparatively low in areas with already existing actual markets. In such areas, MHP market development activities may only focus on customer awareness and education in preparation of intended MHP development. On the other hand, failure to undertake market development in areas with non-existing actual market leads to the need for continuous assistance in form subsidies to ensure sustainability of the MHP during operational stage. Rational investors and financiers will be discouraged to enter into the sector in this situation. At the moment, SSA countries have a huge market potential for MHPs that needs stimulation into actual market. The challenge is on who will finance market development as private financiers are unlikely to venture into such. The market development aspect of the physical system of MHPs needs special attention and quick resolution from stakeholders promoting MHPs especially in developing countries.

4.3.3 Challenges with the traditional forms of MHP financing

Another area worthy serious consideration relates to the challenges presented by the traditional forms of financing. Typically they are three main forms through which capital may be raised for MHP projects namely: equity, debt, and grant financing (Nasab, 2012). Equity financing entails purchasing of ownership interest in the MHP project whereas debt financing involves giving a loan to the project. On the other hand, since most of RE projects cannot compete with conventional fossil power technologies, governments and other donor organisations offer some fiscal incentives and grant financing to increase the margin of profitability of the projects (Nasab, 2012). The providers of funds for these alternative forms may be private financiers, banks, government, donors, and end-users (i.e. communities themselves).

The current challenges faced by each form include the following. The providers of equity and debt expect reasonable returns on their investment; hence the project must either be intended to operate at a profit or at least be able to pay back the initial investment. This presents a major obstacle to accessing these forms of financing as currently profitable MHPs are difficult to develop because of the limited size of the local market (Rodgers, 2009). Besides, the projects often have a payback period exceeding seven years, yet debt financing is often not available for longer than 5–6 years, and equity finance is also rare due to high equity requirement which on average is 40% (Flavin, Gonzalez, Majano, Ochs, da Rocha & Tagwerker, 2014). Further to that,

the economic analysis tend to give insufficient credit for the exceptionally long lifetime and low running costs of micro-hydro because of the widespread short-termism of the modern business world (Paish, 2002). Again, due to the absence of sufficient collateral, banks and investors are not willing to provide loans (at affordable interest rates) in view of long payback periods and problems with cost recovery in general (Kolk and van den Buuse, 2012). Besides, because RE technologies are relatively new market players compared to fossil fuel technologies, financial institutions are yet to fully adapt to their unique financing requirements (Flavin *et al*., 2014), as a result, there is lack of suitable financing instruments for these technologies.

On the other hand, one of the major challenges in case of grant financing include the fact that these energy access programmes have to compete with other priority programmes for the scarce domestic and international public resources (Glemarec, 2012). This is the case because, besides energy access, developing countries have enormous challenges in the areas of education, health, social services, food and human security, basic infrastructure, and disaster risk management (Glemarec, 2012). As a result, government and donor funding is limited (Santiago & Roxas, 2012; UNIDO, 2006; Liu *et al*., 2013). Other challenge is to do with the current general donor fatigue and differences in priorities, which is resulting in the traditional donor and international agencies advising developing countries to strive for self-financing. For instance, International Monetary Fund (IMF) bluntly advised Malawi to stop relying on donor assistance and come up with long-term self-financing measures; the fund noted that donors have their own challenges and priorities that differ to those of Malawi hence continuous assistance is not guaranteed (Nyasatimes, 2012). The same sentiments were echoed by Britain another major donor for the country (Kambuwe, 2013). This suggests a need for a strategic review of financing landscape generally and designing the financing models that should be taken into account the current concerns and motives of the targeted financiers.

4.3.4 Stakeholders: the facilitators of the sustainable financing system

4.3.4.1 Nature of stakeholder engagement in MHP development

Facilitators of both physical and financial systems of MHP sustainable financing model are the various stakeholders from across many sectors (IRENA, 2012B). The stakeholders are the actors and the decision making units within the systems. Woerlen (2011) categorised the stakeholders

into four groups: users of the technology, supply chain players (for example local manufacturers, assemblers, shops and maintenance technicians), policy makers and financiers. According Foster-Pedley and Hertzog (2006) stakeholders include: policy makers, international agencies, philanthropists, banks, venture capitalist, 'angel' investors, and pressure groups. The other groups of stakeholders are: project developers, planners, managers, engineers, private sector, utility companies, rural entrepreneurs, consumers, community groups, financial sector, and government entities (Martinot *et al*., 2002; Usman, Isa, & Ojosu, 2012; Klunne, 2012). The study by Nfah and Ngundam (2012) in Cameroon, apart from revealing some more groups of key stakeholder, and also provided some empirical support to their key roles. It identified local management committees, microfinance institutions, Non-Governmental Organisations (NGOs), Renewable Energy Enterprises (REEs) and universities as key stakeholders behind the successful RE applications in Cameroon. It further identified the different roles of the stakeholders as follows: the local management committees – supervision, operation and maintenance of installed systems as well as revenue collection; microfinance institutions – granting of loans for the acquisition of financially and economically viable off-grid RE systems to communities; NGOs – providing technical assistance for the conception of community projects, procurement of funding from cooperation partners and realization of projects; REEs – sizing, installation and post-installation maintenance of RE equipment and, universities – training the technicians and engineers used by NGOs and REEs.

4.3.4.2 Levels of stakeholder engagement

The participation and cooperation of the relevant stakeholders in different levels is of paramount importance and is what really determines behaviour with the physical system and consequently that of the financial system. Due to the multiple activities needed in the process of developing an MHP, it is recognised that none of the stakeholders or stakeholder groups can alone transform sector, hence the support of each of the stakeholder groups is necessary (Glemarec, 2012)..

Currently in SSA there is lack of empirical knowledge of the key stakeholders that need to be engaged at all costs in the development of MHPs. Furthermore there are few stakeholders who are active and others are either unaware that they are stakeholders or find the sector unattractive. It is therefore crucial that the key stakeholders be identified, categorised and actively engaged. Due to the multiplicity of the stakeholders, the categorization is necessary in order to expedite

smooth stakeholder engagement. It is important to recognise that some stakeholders may have diverse roles at different levels at the same time. That is, it is possible that stakeholders that are affected by problem situation can have the ability to actively influence the situation, and/or possess means needed to implement solutions (Enserink, Koppenjan, & Mayer, 2013). For instance economically empowered rural communities (end-users) may have the ability to initiate, implement and operate an MHP project, whilst governments can fall in many stakeholder groups i.e. policy maker, regulator, financier, implementer, and operators.

It is also important to recognise that multiplicity of stakeholders in MHP sector entails complexities in the implementation of any required measure; hence the need for agreement and cooperation amongst the stakeholder groups (Foster-Pedley and Hertzog, 2006). Besides, as a system, consideration must be taken of the influence that one stakeholder may have on the other stakeholders. Of particular importance is the identification of the driver of the sector. This is particularly crucial since active participation of the driver triggers active engagement of other stakeholders resulting in sector growth and vibrancy. On the other hand, passivity of the driver frustrates determined stakeholders and scarce off other stakeholders – the cascading effect within the system. A study by Glemarec (2012) provides some empirical support of the cascading effect that can be borrowed in development of RE sector. Glemarec (2012) stated that important lessons can be learnt from the growth of the mobile phone industry, which suggests to the RE sector that:

> "…with the right regulatory environment and business models, the poor [end-users] have the capacity and the willingness to fully or partially pay for services that provide clear, immediate and substantial benefits. Similarly, the private sector has the capacity and appetite to invest in new service delivery mechanisms provided that there is commercially viable unmet demand."

In other words, active involvement of the policy actors (i.e. through provision of clear policies, regulations, incentives, and public awareness and education) and the developers (i.e. by developing acceptable business models), these can positively influence the financing stakeholders (i.e. private sector) and actuate acceptance and willingness amongst the end-users. Thus Glemarec (2012) stressed for an integrated approach considering the facilitative impact of some

stakeholders (especially at macro-level) that if well managed can spur new business models and accelerate the commercialization of RE sector. This approach needs to be holistic by being stakeholder inclusive, role and motive-sensitive and sector-wide. Foster-Pedley and Hertzog (2006) observed that:

> "By looking at the industry in a holistic manner and bringing all the motives, barriers, stakeholders and investment opportunities together in one system, a renewable energy entrepreneur can approach a bank or other commercial financier with a financial proposition that may be better targeted to their investment motives or better suited to a given risk profile."

Furthermore, Foster-Pedley and Hertzog (2006) asserted that there is a need for rigorous analysis of stakeholders, payoffs and complementarities noting that this is what can provide valuable insights to different funding formulae. Unfortunately, literature, suggests lack of integrated analysis in SSA region, no wonder the sector is beset with a lot of uncertainties and barriers. Compounding the problem is also the lack of appropriate framework to aid the same. Accordingly the study attempted to organise insights gained about stakeholder involvement into a framework taking into account the degree of the facilitative effect of a stakeholder or stakeholder group on the other stakeholders or stakeholder groups. The framework is termed the stakeholder involvement pyramid.

4.3.4.3 Stakeholder involvement pyramid

Figure 4-4 presents the pyramid which synthesise the various roles and functions, levels and impacts of various groups of stakeholders in the MHP sector. The pyramid is based on the recognition of the facilitative roles and influences of various stakeholder groups.

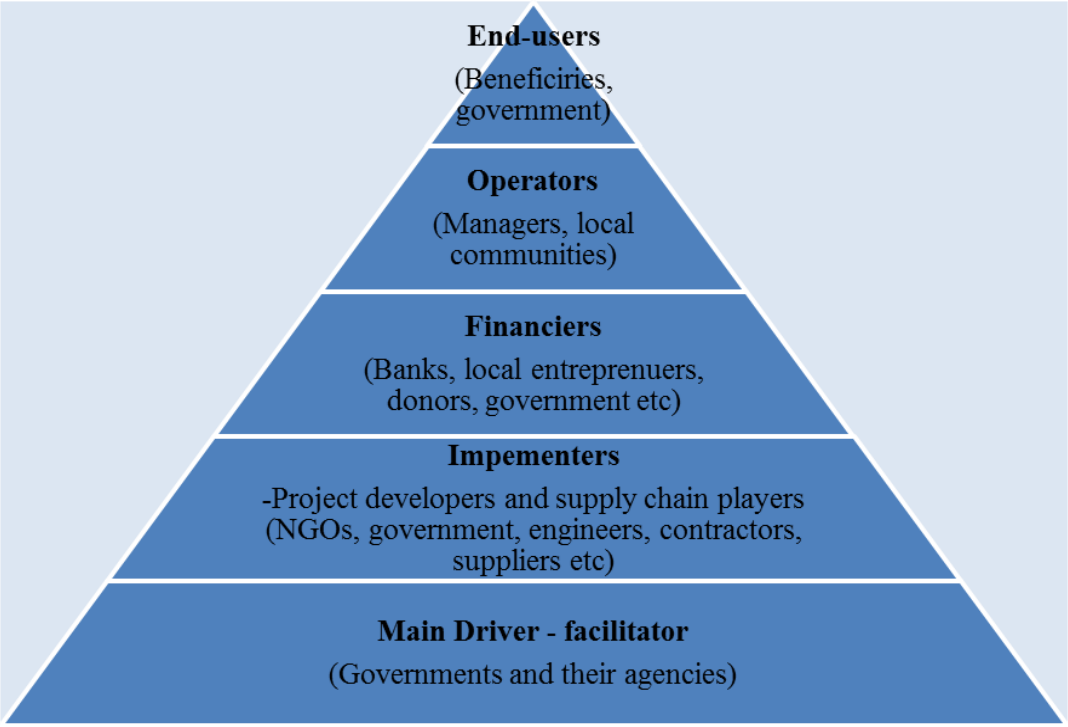

Figure 4-4: Stakeholder involvement pyramid
(Source: Based on analysis from literature review by the researcher)

According to the pyramid the government have the basic driving role to the MHP sector through formulation of clear policies, regulations, provision of incentives, maintenance of updated and easily accessible database of the potential sites and opportunities and conducting public education and awareness among other duties. The government through its agencies provides the backbone that supports the entire sector. No other group of stakeholders may assume these roles better than the government. It should be noted that the other stakeholder groups may at best lobby and assist the government in delivery and monitoring the same.

Implementers get attracted to the sector and become effective in project planning and implementation based on the robustness of the facilitative instruments established by the government. Through these they are able to operate viably and develop better funding proposals to project financiers on the other level of the pyramid. Financiers will respond favourably if they perceive that both the facilitative instruments by the government provide enough security to their investment and the business models presented by the implementers are robust. Further up the pyramid, effective management of the MHP during operational stage by the operators will be

affected by actions of the stakeholder groups below them in the pyramid. Operators will be affected by the facilitative instruments made by governments (for example in terms of the easiness in pricing and price adjustments, availability of spare parts and clear operational standards), implementers' decisions during planning and building of the MHPs and the financiers' terms and conditions. Finally the end-users are at the receiving end of the pyramid; however they may have lobbying influence on the other stakeholders and if they are economically empowered may also assume other roles such as of implementers, financiers and operators.

4.3.5 Consolidated view of MHP financing system

It is the actions and inter-actions of the stakeholders within the MHP physical system that determines the MHP financial system behaviour. On the other hand, inactions of one or more stakeholders, leads to system imbalance or unsteady-state. In other words failure to "indeed" link physical system and financial system (van Egmond & de Vries, 2015) hence the absence of appropriate sustainable financing models. At the moment, steady-state of the sustainable financing system is yet to be reached in SSA region, and contributing to this is lack of cohesion and inactions of most stakeholders. Analysis of the key barriers of MHP deployment suggests that they (barriers) are simply "inadequate/inappropriate actions or lack of actions" of stakeholders within the MHP physical system. This is the reason why the barriers are categorised as policy, regulation, institutional, information, behavioural, technical and financial (Glemarec, 2012; UNIDO, 2009) and they can be traced to the actions or lack of action of stakeholders. Together these barriers throw the sustainable financing system into unsteady state. The underlying symbiotic relationship that exists between the physical and financial system should therefore be recognised in order to deal with the financial sustainability challenges of MHPs.

Figure 4-5 presents a framework that provides a visual display of underlying connections between stakeholder groups (the decision-making units), market development and MHP infrastructure development and operations (the physical system) and financing models (the financial system). The arrows indicate the direction of relationship and the numbers (1 to 7) point to the narrative that giving examples of the typical activities (or influence) that are supposed to be provided (or exerted) by the stakeholders that if not provided they become barriers to MHP deployment.

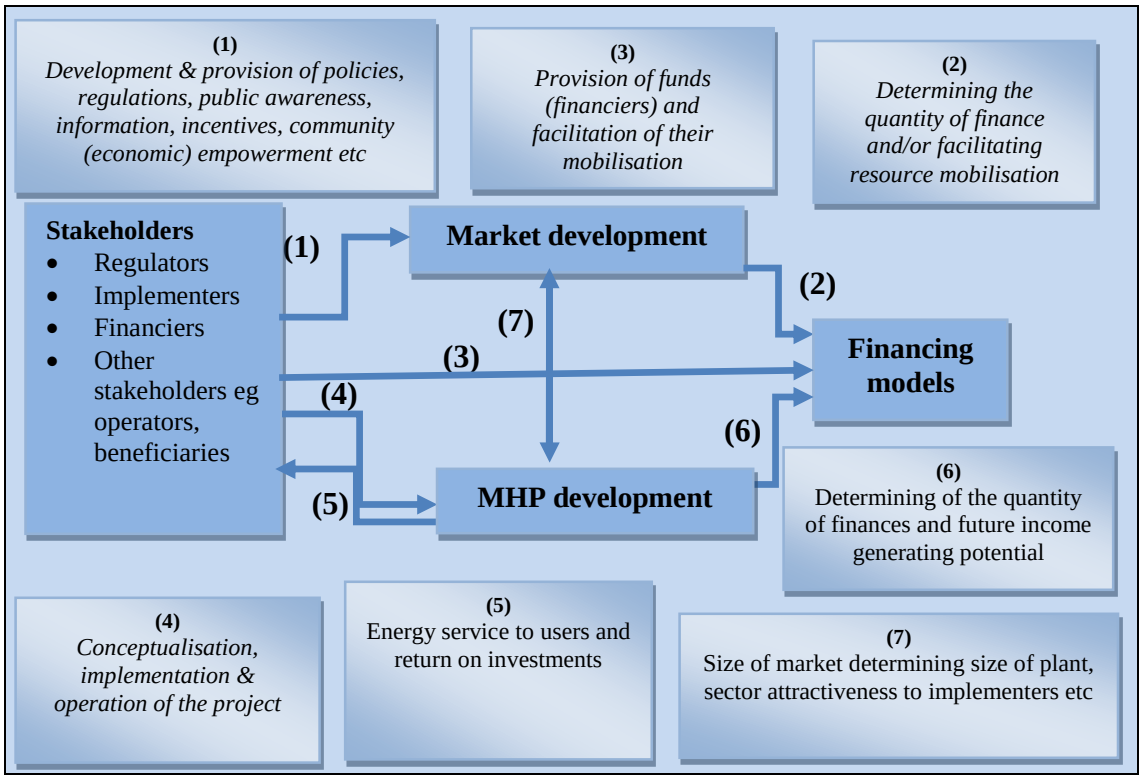

Figure 4-5: Physical and financial systems linkages
(Source: Based on analysis from literature review by the researcher)

The framework provides a simplified display visualizing the underlying relationships and interconnections and their ultimate influence on financing of MHP critical to the designing of the lowest cost, long-term financing models. The framework exhibits important elements in the process of development of MHP and points of influence that are responsible for the behaviour of financial system. Understanding these points is important as it is recognised that although there is no "right way" to design a programme for lowering the total cost, thoughtful analysis of each of decision points can help in designing an effective financing programme (Nelson & Shrimali, 2014). The study has endeavoured to disaggregate MHP sustainable financing system in order to uncover the key decision points to that effect.

The framework serves a numbers of purposes in understanding MHP financing and development of sustainable financing models; it contributes to thoughtful analysis in four main ways. Firstly, by revealing and visualizing the impacts of MHP physical system activities on financing. As is exhibited, market development and MHP development and operation activities typically define

the quantity of finances to be mobilised but they also in long-run facilitate the process of mobilizing resources. For example, construction work of MHP consumes resources thus determining the quantity of finance, however in long-run; the constructed MHP becomes a source of income through energy sales. Similarly policy formulation and implementation consume resources; but on the other hand, existence of clear policies facilitate the creation of suitable investment environment that attracts financiers, entrepreneurs and other supply chain players to the sector, thus enabling mobilization of resources to cater both the development of MHP and its running. This suggests that MHP physical system's activities have both immediate financial impact – through the costs incurred during the development process of MHPs and/or long-term financial impacts – through the costs that will be incurred in running the facility (on the expenditure side) and in facilitating resource mobilisation from investors and financiers and income generated from energy sales.

Secondly the framework provides insight into the role of the stakeholders both in creating and eliminating the barriers to MHP deployment. As highlighted, most barriers are as a result of the actions or inactions of stakeholders. If all stakeholders were actively involved as they should be, policy, regulatory, information, technical barriers would have been significantly mitigated. Since financial system behaviour is dictated by the physical system, mitigation of these physical systems barriers would have in turn led to mitigation of financial barriers.

Thirdly, the framework suggests two efficiency-oriented avenues through which investment costs for MHP development may be lowered namely (1) streamlining physical system activities; and (2) ensuring active engagement of all relevant stakeholders. As exhibited on the framework activities define the quantity of finances, hence in order to lower the costs; activities should be targeted. Thus, in search of lowest-cost models for MHPs, cost effective means must be found for undertaking activities. This calls for the search for better but cheaper ways of developing MHPs. On the second way, if the all relevant stakeholders can be actively engaged in the MHP sector: there will be "costs and risks sharing" among a wide number of stakeholders, which may not be significantly felt by each one of them as most of the activities are already part of their normal activities. Further to that, activeness of all relevant stakeholders will tend to remove uncertainties

that characterise the sector, which in turn will lead to overall risk reduction, hence lowering the cost of capital.

Currently, the costs and risks burdens of developing MHPs in the SSA region are borne by a few stakeholders namely: developers, donors, NGOs and government. In many cases the developers bears much of the burdens, that include, lobbying formulation of policies and regulations, conducting public awareness and education, empowering local communities, pushing for incentives, convincing donors and other financers, over and above undertaking the actual work of MHP development from conceptualisation to operation. If however, the various agencies of the governments were proactive and they were cooperatively were working with other stakeholders in formulation of clear policies, provision of incentives, conducting comprehensive feasibility studies on all potential sites, conducting public education and awareness, and undertook to do other activities such as construction of access roads, the burden would have been significantly reduced on the developers and the uncertainties that abound could be cleared, this would have significant positive impact on total financing.

The fourth contribution of the framework is the confirmation of the importance of various key stakeholder groups, hence the need to promote active stakeholder engagement and cooperation amongst themselves. As already mentioned a few stakeholders cannot on their own transform the market for RE technologies (Glemarec, 2012). Moreover no one stakeholder or stakeholder group can carry the financing burden for development of MHPs in the current state of things. It is therefore crucial to strive for the growth of the network of stakeholders in order to overcome the barriers and design suitable sustainable financing programme (IRENA, 2012B). Review of extant literature from SSA region suggests poor stakeholder engagement; in fact majority are inactive. In addition, the few active ones lack coordination and information sharing (Gamula *et al.*, 2013). This have resulted in constant repetitions of setbacks already encountered by others, difficulties in financing projects, weak industrial back-up, high information costs and long lead times that hampers the emergence of entrepreneurs (Gamula *et al.,* 2013; Brunnschweiler, 2006). Thus exchange among stakeholders in to be encouraged in order to facilitate circulation of feedback on market activity and anticipation of factors that may impact them (IRENA, 2012B). Furthermore regular engagement among local technology innovators, academics, entrepreneurs, investors and

public administrators should also be fostered in order to promote formation of strategic relationships and build a critical mass of RE development capability (IRENA, 2012B).

4.4 Summary

Although underemphasised, efforts to understand the holistic nature of MHP development and the underlying symbiosis between stakeholder engagement and financing is crucial to the development of sustainable financing models. This chapter has attempted to analyse the challenges underlying the absence of sustainable financing models based on the van Egmond and de Vries' sustainable finance model with support from systems theory and the life cycle model from literature point of view. The chapter has highlighted the significant role of the physical system of MHPs in dictating the behaviour of the MHP financial system. According to the study most of the financial barriers do not originate from the MHP financial system itself, but they are as a result of a combination of MHP physical system challenges presided by stakeholders' inadequate actions. Furthermore the chapter has presented a framework that helps in visualising the sustainable financing system. It reveals the MHP development process bringing together MHP market development, MHP building, stakeholders and influences that the processes exert on financing. The review suggests that without the effort to motivate key stakeholders into action, the problems of sustainable financing are likely to persist. Therefore promoters of MHP sector in Malawi and SSA region at large should strive to grow the network of the stakeholders, ensure role awareness and secured their action.

Finally the review also suggests that though some barriers are "non-financial" in nature (such as policy, information, and regulation); they however have significant underlying influence on financing. Accordingly measures to develop sustainable financing mechanism must be companied by and coordinated with non-financial measures (IRENA, 2012B) for them to achieve desired goals.

Chapter 5 : Case study analysis on MHP sustainable financing in Malawi

5.1 Introduction

The second phase of the study involved undertaking a case study based on the theoretical insights that emerged out of in-depth review of literature in phase one. This chapter presents the results and discussion of case study of the Bondo Micro-Hydro Scheme. It starts by providing a description of the case – the Bondo Micro hydro Scheme.

5.2 Description of the case study

The Bondo Micro Hydro Scheme is a classic example of the potential of MHP technology in Malawi and it further represents a commercial approach to off-grid power in rural Malawi (McKinnon, 2013). The developmental objective of the scheme is to provide affordable, sustainable energy to off-grid low income households (Business Innovation Facility, 2012; McKinnon, 2013). The scheme is being developed with the expectation that it will be running commercially generating income from electricity tariffs that will be reinvested to cover operating costs (Business Innovation Facility, 2012). Thus the scheme is being established on the modern market based approach to MHP financing. It is the first scheme of the kind in Malawi and hence it is being applauded to be a signal for a new era in the country's community energy sector (Malcher, 2013). The key challenge for the scheme that in part emanate from its developmental objective is to reach the scale and operational financial sustainability whilst adhering to its founding principles of providing affordable, available, sustainable electricity to the consumers (McKinnon, 2013). It is yet to discover a sustainable financing model which according to Klune (2011) facilitates provision of energy to customers at affordable prices while ensuring sustainability of the scheme.

The scheme was established by the Mulanje Mountain Conservation Trust (MMCT) through its energy agency, the Mulanje Renewable Energy Agency (MuREA) (Mutubuki-Makuyana, 2010; Mhango, 2015). MuREA then established a company called Mulanje Electricity Generation Agency (MEGA) to be responsible for the development and operations of the Bondo Micro-Hydro Scheme. Effectively MEGA became the first Independent Power Producer (IPP) in Malawi. MEGA was established to be managed by the General Manager supported by the Generation Manager and Power Distribution Manager based on its current organogram. However

currently the position of Generation Manager is vacant as such the Power Distribution Manager is acting on that position too, accordingly there are two managers only. At the time of the study there was a third manager attached to MEGA from MuREA who was engaged to promote productive use of energy.

The scheme is based on Lichenya River whose source is the Mulanje Mountain. According to energy capacity estimates, when the whole scheme will be fully developed and operational, it is expected to generate about 75 kilowatts of power (Kalonga, Munyoro-Katsi, & Nyathi, 2013; Mhango, 2015). This is targeted at a potential market of 520,000 people around the area, of which 9,600 households (42,420 men, women and children) are expected to be directly connected while the rest of the community members will benefit indirectly through better healthcare, education and access to various business opportunities (Business Innovation Facility, 2012; McKinnon, 2013).

The scheme is being implemented in phases. The first and second phases (which are called lower and upper Bondo respectively) were completed, however due to massive floods that hit Malawi during 2014/15 rainy session, the upper Bondo suffered significant damage; rebuilding work started but could not be completed due to the lack of funding. As a result, only lower Bondo is operational, providing electricity directly to 275 households, 8 general dealer shops, 2 schools, a church and a clinic. A maize mill is also connected however due to poor quality of the milling equipments; it is yet to be operational.

5.3 Findings and discussion

5.3.1 Scheme's key financing challenges

The scheme faces a number of challenges that impact greatly on financing. The first challenge is the high cost of capital required to have the scheme operating at the expected optimal level. It is projected that there is a need to develop at least four sites for the scheme to reach a level where it can sustain itself. Based on the resources consumed to date to develop lower Bondo to its current level, huge capital investment is needed for the development of the other sites. The second challenge is the difficulty to project the required level of funds due to the volatility of the operating environment in Malawi. One example that was cited is the volatile rate of exchange of

the country's currency that makes planning difficult due the lead time between the time of financial proposal development and use of the funds. Worse still some fees such as licence fees are charged in dollars. The other example was the low levels of education that makes obtaining critical labour locally difficult.

The third challenge is the lack of strong support from the government (i.e. various government agencies) that renders development and operation of MHPs in Malawi cumbersome and too expensive. The study revealed that there is lack of coordination between various departments and further to that energy policies are not clear and policy implementation is either inadequate or not at all line with the letter. For instances although RE materials are supposed to be imported tax-free, Value Added Tax (VAT) is charged with a promise that it will be refunded later on. To the dismay of the developers the claims for refunds are hardly honoured. The other example cited on this was that regulations do not provide for flexibility in relation to size of the operators hence they are enforced alike on small and big, new and older players; this creates a heavy overhead burden on small and new players. For instance the licence fees are the same in spite of the size of the operations. The fourth challenge that was given was the uncertainties over the financial capacity of the end users. The income of the targeted customers for the scheme is seasonal; they largely depend on farming, hence requiring empowerment in order to ensure that they should have enough income through the year.

These are the challenges that were cited by the informants as critical that render the scheme commercially and financially unviable leading it to donor dependence for existence. For the eight years that the scheme has existed both development and operations are largely financed by the donors. The first and second phases were funded by European Union (EU) and Scottish government through Practical Action and MMCT. The rebuilding of upper Bondo and the third phase are expected to be funded by Global Environmental Facility (GEF) and Scottish government through the partnership of the Malawi Government and United Nations Development Programme (UNDP). The beneficiaries' contribution has been in kind through provision of labour in the construction work, some materials such as sand, quarry and other naturally available resources and donation of land on which the canals and the transmission lines pass (Kalonga *et al.*, 2013; Malcher, 2013).

Thus financing of the scheme has largely been external and philanthropic. Accordingly the scheme is running based on philanthropic model as opposed to a commercial model in line with the modern trend for RE financing and the desire of the developers of the scheme. However the developers are said to be using the philanthropic model in transition to the commercial model; moreover the current funders have committed only to providing funding for the initial developmental phases (Smith, 2012). Their expectation is that in post-construction phases (i.e. operation and future expansions) the scheme will be funded by income generated from electricity tariffs (Smith, 2012). The developers are still in the process of attracting more investment to multiply micro-hydro stations around the mountain; some of it is expected to come through the donors, however, the ultimate plan is to attract commercial investment (Smith, 2012). Thus the major challenge is for the scheme to be established as a viable business (Smith, 2012).

As things stand at the moment, philanthropists remain critical to the success of the scheme; measures should therefore be put in place to maximise inflow of aid. Unfortunately the current operating environment (in terms of policies, regulations, incentives and the financial capacity of the end users) is not competitive enough even to attract more and more philanthropists to invest in Malawi. Although philanthropists do not expect a monetary return, however they have some other motives such as to support environmental purposes, to assist start-up ventures, and to encourage energy diversification (Foster-Pedley & Hertzog, 2006); that they expect to see coming to fruition within a reasonable period. Due to regulatory hurdles and indecisiveness (as one informant put it) projects take too long to take sharp as a result, Malawi is losing out on many opportunities. Thus even success of the philanthropic model depends also on the better operating environment. However the task becomes even more challenging in order to attract private investors for the commercial model to work.

According to the informants, government support has largely being in words whilst on the ground there has been limited action. As already mentioned, some factors cited that evidences poor supports from government include lack of coordination among government agencies, in that whilst other agencies/departments attempt or have seemingly strong desire to push, they are either constrained by the legislations or their effort is impeded by on the implementation level by

another agency/department. Secondly lack of proper structures at local level to coordinate and support development and to ensure awareness and community empowerment. A specific example cited is the absence of energy officers at district levels. Consequently there is no one to promote and translate the energy policy at the local level, moreover in line with the situation on the ground. Thirdly indecision, the systems in Malawi is too bureaucratic; there are too much documentation this result in delays in getting approvals to start and implement projects. Furthermore decisive actions, such as revising the policies and regulations take too long to be taken. As a result the country has instruments that are not responsive the dynamism of the environment for example the energy policy was adopted in 2003 up to now it has not been revised. The fourth factor which is connected to the third is that although admittedly the regulations are suboptimal they are however rigidly enforced. The regulatory bodies seem to have their hands tied, in that they are unable to exercise discretion in the enforcement of the regulations to the peril of small and new players in the sector.

These factors present an unattractive picture for commercial investment in the scheme. Admittedly grant financing (under the philanthropic model) is presently the only option unless significant transformation is wrought. However grant financing is not sustainable in long term as it equally comes with some strings and is basically for initial development not extending to post-construction period. Moreover an informant asserted that market for grant financing is very small compared to private financing (under the commercial model). All in all, for long-term financial sustainability of MHPs, private financing should be the goal to be attained. The analysis suggests that the factors underlying the financing sustainability challenges are beyond the control of the scheme and require radical transformation of the operating environment.

5.3.2 Evaluation of the physical and financial systems of Bondo Scheme

Based on the theoretical insights that emerged in the first phase of the study, an assessment was made on the current condition of the scheme's physical system and the influence of the same on its financial system. It was undertaken by asking the informants to describe: (1) the importance of elements of market development and their consequent financial impact on development of the scheme; and (2) the importance of each MHP life cycle stage and situating the financial impact of each stage.

5.3.2.1 Market development

Two questions were asked aiming at assessing the importance and the influence of the six elements of market development (national policies, regulations, incentives, public awareness and education, availability of information and community empowerment) on financing of the scheme.

5.3.2.1.1 Importance of the market elements

In relation to national policies, it noted that currently Malawi does not have a specific policy on RE technologies; she only has a single energy policy called the National Energy Policy 2003 (NEP 2003). The policy is the first ever integrated energy policy (IEP) in the country, designed to guide all developments in the country's energy sector (Phiri, 2014). The problem with the policy is that it deals with issues concerning RE technologies as one entity called Other Renewable Energy Sources (ORES); accordingly it does not outline specific policy instruments that deal with improving access to the specific RE technologies that are to be followed (Phiri, 2014). Furthermore it does not address unique challenges that are specific to each form of RE technologies. Besides, an informant observed that policy is out-dated requiring revision in line with current conditions and make it forceful enough to attract private investors

With regard to regulations, the investigation revealed that MHP development and operations are well regulated by a number of regulations that include the Rural Electrification Act, Electricity Act, Energy Regulation Act, Environment Management Act, Water Resources Act among others. The regulations were noted to have some significant gaps. For instance they were developed without the thought of the operations of IPPs, as such; the regulations do not provide enough regulatory directions that cause many delays in the operations of the scheme. It was noted that complying with these regulations requires outlay of resources. Examples of costs normally incurred in the process of compliance that were cited include travelling costs for the interviews with regulators and payments for legal services offered in the process and the costs for the licences to operate. Furthermore meeting the technical standards set by the regulators demands maintaining the level of quality that also requires outflow of resources.

In terms of public awareness and education, the investigation confirmed the importance of drumming up support among the beneficiaries – end-users. Which apart from helping the public in making informed decisions on RE, is crucial in providing the knowledge that enhances marketability of the technologies (Phiri, 2014). Although the NEP 2003 requires Government of Malawi to carry the awareness campaign that was not the case at Bondo. The developers themselves had to undertake the awareness activities which increased their burden since they involved expenditure of time and resources. Since demographic factors in the areas played important role in determining the means of communication, Bruessow (2012) observed that due to low education level and literacy skills amongst the beneficiaries, as well as limited access to TV and radio, there was limited the use of written communication as a result oral communication was found to be the best choice. In spite of that, communication did not represent a high financial cost however it proved to be time-consuming (Bruessow, 2012). Due to lack of any deliberate awareness program, the locals had poor knowledge of the energy potentials that had remained untapped for years. Informants observed that Bondo is not unique on this as much of the awareness in Malawi about RE potential has been at higher levels of the government with very little trickling down to rural masses.

The study also confirmed the importance of incentives to the scheme. This is particularly the case because most of the capital equipments are imported. At the moment, RE equipments are imported tax-free as an incentive to accelerate wide spread adoption of RE technologies within the country. The incentives are acknowledged to have the potential for cost savings that can help in reducing the total financial outflow for the scheme. However informants bemoaned that the incentives remain a grey area in that although they are provided on paper it becomes tough (a burden) to access them. Furthermore for some items, incentives are given in a reactive manner, in that one has to ask in order to get them. There is therefore lack of comprehensiveness as a result the actual impact of incentives on the scheme seems to be minimal.

Information availability was also confirms to be critical to the development of the scheme. However key information about the potential sites was not available, as such; developers had to collect data and process it themselves and this continues to be the case. The government has had no deliberate program to make necessary information handy in advance. Accordingly time and

resources were expended towards the data collection and processing that otherwise could have been directed towards actual development of the scheme. Informants noted that generally there is lack of detailed information about the MHP potential sites in Malawi, besides awareness of the same amongst relevant stakeholders has not been adequately done although there have been some attempts by the government. An informant faulted the attempts and described them as "fragmented" and not holistic.

Finally, regarding community empowerment, the study confirmed that the targeted customers have very uncertain financial capacity as their income is generally seasonal. The majority of the targeted users are smallholder farmers who depend on income from tea and other cash crops as pineapples and bananas. As a result, to ensure constant flow of income for them to be able to pay for the electricity through the year there is a need to boost their financial capacity through deliberate economic empowerment programmes targeted at diversifying their income. Due to lack of interventions from other stakeholders on the same, the developers plan to offer some soft loans to the users. That programme will further increase the capital investment requirement and the effort of the developers. It is important to note that enhancement of financial capacity of the users is significant not only because the users' low income capacity but also due to high production costs of electricity that requires charging of a relatively higher tariff. Informants observed that reasonable price to the scheme should be higher than what is currently charged by the Electricity Supply Corporation of Malawi (ESCOM); hence the end-users will need empowered to afford the higher price.

As a way of enhancing capacity of the users, informants highlighted the need to promote productive use of energy, which involves developing small industries in the areas; that will create sustainable and effective demand for the MHP facility (strong actual market) as opposed to mere consumptive use in households. The Bondo areas has considerable potential for productive use as it is rich in agricultural crops such as bananas, sugarcanes; avocado pears, pineapples, tomatoes and varieties of citrus fruits (Mhango, 2015). Presently the people are lose much of their produce that should been processed right in the area if there had sufficient electricity power (Mhango, 2015). The challenge however is that such initiative can be too much for the developers to

undertake singlehandedly. Therefore this calls for cooperation with other stakeholders such as the government and other non-governmental organisations.

5.3.2.1.2 Financial impact of the market elements

Findings of phase one of the study suggested that market elements can be "resource consumers" and/or "facilitators of resource mobilisation". Accordingly a question was posed aimed at getting the specific financial influence of each element to the Bondo scheme. The informants were asked to determine whether a particular element was a: resource consumer, a facilitator of resource mobilisation, both or none of the above. **Table 5-1** below gives the summary of the result:

Table 5-1: Financial impact of elements of market development

Elements of market development	Financial impact(s)
National policies	Facilitator
Regulations	Both a consumer and facilitator
Public awareness and education	Both a consumer and facilitator
Incentives	Facilitator
Availability of information	A consumer
Community empowerment	Both a consumer and facilitator

The responses confirmed that each market element has a direct impact on financing of MHP development either or both as resource consumer and facilitator of resource mobilisation. The findings confirm that development of the market elements requires outlay of resources on one hand, and on the other, their presence is crucial to resource mobilisation in that they reduce market uncertainty which in turn provides conducive environment to investment. The absence of these elements adversely affects resource mobilisation, consequently developers tend to face greater challenges to get the required resources even though the market potential exists. Knowing the importance of the market elements, developers are forced to develop them themselves or tend to spend time and effort to lobby for their development as an MHP without an actual market is not viable; unless the facility is developed to run purely based on philanthropic model in which case the plant subsists on donations during development and on subsidies over its useful life. However, based on the objectives of the Bondo scheme, market stimulation is essential; so far the developers have carried much of the burden. This keeps on increasing development costs raising further the breakeven point for the scheme. Since no one stakeholder can alone afford to carry the

burden of MHP development, there is a need for greater involvement especially of the government agencies not only when enforcing compliance to the regulations but also in carrying its operational share of burden by developing the appropriate and adequate elements of the MHP market. Furthermore, there is also a need for the growth of the stakeholders' network for the scheme. Government agencies that provide skills development services, microfinance institutions and other non-governmental organisations need to be come in to assist in areas of public awareness and education and community empowerment and in lobbying and helping the government in developing better policies and regulations.

5.3.2.2 MHP infrastructure development and operation

Development of physical facilities of generally passes through stages to which many resources are consumed. According to the theoretical insights that emerged in phase of the study, these stages to a greater extent define the financing level of MHPs. The major interest of the study was to identify the critical stages and activities in the development of MHPs that significantly define the distinct financing requirements. Accordingly the informants were asked to describe the significance of each of the seven stages of the MHP cycle to total financing in the context of Bondo Scheme and the existing critical challenges. Furthermore they were also asked to indicate the expected duration of financial impact over the life cycle of the scheme – that is whether the stage has long or short term impact on financing.

5.3.2.2.1 Significance and Impact of the stages of MHP life cycle

The analysis revealed the following impacts as well as the challenges that compounded the impacts adversely:

- Project conceptualisation: this is the first stage in MHP cycle whose main aim is to clearly identify the problem (necessitating the need for MHP) and ways of dealing with it. The process requires several considerations, consultations and analyses by experts in order to develop the project concept. The study confirmed that the process consumed time and resources of the developers. Furthermore it needed services of foreign experts as the developers were not knowledgeable of how a MHP could be developed. The stage however did not consume many resources.

- The second stages – feasibility study add significant costs to cost of developing MHPs as it takes much time and involve engaging the services of specialised experts in the field. The study confirmed that the stage involved conduct of pre-feasibility and feasibility studies. This stage was noted to be one of the stages that can be targeted to relieve part of the burden of developers. An informant noted that in countries where MHPs have been a success story, governments have been proactive in identifying potential sites and carrying out the pre-feasibility and comprehensive feasibility studies. This reduces significantly the work and costs borne by developers, accordingly Malawi can wholly or partly adopt the same.

- Designing of the plant requires expert knowledge in architecture as such resources are expended in engaging experts. The problem in Malawi is that the availability of appropriate human and technical capacity is a challenge (McKinnon, 2013). As a result, foreign experts were also engaged; again this increased the outlay of resources for the stage. This accordingly a further call for development of local expertise.

- The regulatory approval process involves engaging lawyers, attending interviews with the regulators and payment of licence fees. According to the country's regulations (Section 24 of the Rural Electrification Act, 2004), one is supposed to have a licence to carry out any sort of rural electrification activity. Further to that separate generation and distribution licences must be obtained in order for one to able to fully operate and charge the customers. The major challenge encountered by the scheme was that the licencing framework was too rigid (McKinnon, 2013) and expensive for new and small scale operators. The generation and distribution licences' fees are 5000USD and 2500USD respectively; these are high for small operators. An informant noted that this kind of licensing framework makes Malawi relatively less competitive for private investment. An example was given that in Zimbabwe small scale operators up a certain level are exempted from paying licence fees as an incentive, a thing that Malawi can adopt as one way of promoting the sector. Motivated by desire to improve people's living status, the developers have had to work diligently with government to agree a new licensing model (McKinnon, 2013); something that should not be the case if the country is to attract

investment in the sector. Thus licensing framework needs revision to enable IPPs to operate easily (McKinnon, 2013).

- The building of the plant (physical MHP facilities), involved acquisition of various equipments and services and undertaking of civil works that required significant outlay of resources (estimated to be about seventy percentage of the total resource base). Due to lack of equipment manufacturing capacity within the country, most of the equipments were imported; as a result, the scheme faced upfront high infrastructure investment which was also largely charged in US dollars (McKinnon, 2013). This was a significant challenge considering that the potential tariffs are charged in Malawi Kwacha (McKinnon, 2013); a relatively weak currency. Importation of equipments and services also caused significant delays in procurement, which in turn, slowed down the construction and commissioning of the scheme (McKinnon, 2013). Thus localizing the manufacturing of the equipments and sourcing of services was identified as a way that can greatly reduce the costs of MHP development and the lead-time for the construction to commissioning.

- With regard to the operational stage of the plant, it was confirmed that it basically involves monitoring of the system, dealing with customer issues, connecting new members and carrying out maintenance works. These activities do not consume much resource, however it was noted that maintenance sometimes mat require replacing of some parts. Due to lack of local manufacturing capacity they need to be imported which increases the operational costs. Another important issue at this stage had been the issue of pricing. Negotiations had to be undertaken with the government to agree on the tariff. The tariff regime is strictly regulated. Tariffs are set, administered and revised in accordance with the Electricity Act and with the approval from MERA (Section 25 of the Rural Electrification Act, 2004). Although Act allows tariffs to be set at the levels that are sufficient to allow the licensee an opportunity to recover his costs of service, including a reasonable return on capital and encourage efficiency (Section 18(1) of the Electricity Act, 2003), in reality this had been a challenge. So far the government was more oriented towards achieving social objectives, hence used to be reluctant to permit an appropriate fee according to the cost of production. This orientation has so far changed shifting

towards balancing the social and profit objectives. Accordingly MEGA was issued with a distribution licence and was allowed to charge a tariff that is higher that of ESCOM; this is a tremendous shift in policy on the part of the government.

- Finally, with regard to the termination stage, although literature suggests that the plants gets decommissioned after its usefulness, informants could not be drawn to indicate the impact and challenges that that process would have on financing of the scheme. This was due to the fact that the scheme is still in development stage and there is lack of experience.

All in all, the analysis confirmed the importance of each stage of the MHP life cycle and its impact on financing except for the termination stage because the scheme is still in infancy. Furthermore analysis highlighted several areas requires radical improvements. It also shows the need for government agencies to be proactive in order to lessen the burden of the developers. Therefore there is an urgent need for government action at both macro level in developing appropriate and relevant policies and regulations and micro levels by providing assistance to developers to lessen cost burden.

Finally, the analysis suggests the need for localization of the process of designing of MHP facilities, manufacturing of equipments and spare parts used in building and maintenance of MHP infrastructure. Basically the country needs to develop appropriate local expertise with regard to RE operations. This is one of the means to reduce the costs for developing MHP in Malawi. Thus localization adds an important dimension on the efficiency-oriented ways for lowering the costs for MHP development.

5.3.2.2.2 Situating the financial impact

The findings of the phase one of the study, suggested that the financial impact of the stages of life cycle can be immediate (short-term impact) or can extend over the life of the plant (long-term impact). Knowing the duration of impacts is important because sustainable financing has long-term orientation. In order to ensure financial sustainability, the stages with significant long-term financial impacts (both in term of resource consumption and resource mobilization) are supposed to be identified and properly managed. Accordingly the informants were asked to identify the stages according to the longevity of their financial impact. Three options describing the impact

were provided namely: (1) only during occurrence of phase activities; (2) over operational lifetime of the plant; and (3) not at all. Option one, denoted immediate or short-term impact suggestive that the stage may require less attention in designing sustainable financing models, while the second option denoted that the stage has a long-term impact hence very critical. **Table 5-2** presents the results in relation to Bondo Scheme.

Table 5-2: Financial impact of stages of MHP development over time

Stages	**Financial impacts**
Project conceptualisation	Immediate impact
Feasibility study	Long-term impact
Designing of the plant to be built	Immediate impact
Regulatory approval	Immediate impact
Building of the plant	Long-term impact
Operation of the plant	Long-term impact
Decommissioning of the plant	Not applicable

As is exhibited on the **Table 5-2**, project conceptualisation, designing of the plant and regulatory approval were said to have immediate financial impacts, whereas feasibility study, building and running of the facility as having long-term impacts. It is worth noting that, the stages with long-term impacts happens also to be those that consume considerably much of the resources and have significant impact on the other stages. Besides, any material errors that can be committed when undertaking them can be costly to rectify and if not rectified, the long-term productivity of the facility will be adversely affected. As such, they are critical stages and avenues that should be targets for cost containment and management in general.

5.3.2.3 Stakeholder engagement

The last question dealt with stakeholders of the scheme. The question was aimed at assessing extent of stakeholder engagement in the development of the Bondo Scheme. According to literature developing and operating MHPs require various groups of stakeholders to act cooperatively. As per results of literature review in the previous chapter, where there are fewer stakeholders actively engaged in the development process, more impediments are faced that in turns makes designing of appropriate sustainable financing mechanisms to be difficult.

The study found that there have been few stakeholder groups that have been active over the life of the scheme. **Table 5-3** presents stakeholders that have been active in the development of the scheme up to the current level.

Table 5-3: Current active stakeholders

Stakeholders	**Roles**
Mulanje Mountain Conservation Trust (MMCT)	Promoter
Mulanje Renewable Energy Agency (MuREA)	Technical experts
Practical Action	Technical experts
SGURR Energy	Technical experts
European Union (EU)	Financiers
Global Environmental Facility (GEF)	Financiers
Sukambizi Trust	Financiers (rehabilitation works)
Malawi Government	Regulator, advisor, policymaker
United Nations Development Programme (UNDP)	Development partner
Local communities	Beneficiaries, financiers in kind
Contractors	Suppliers of various services
Mulanje Electricity Generation Agency (MEGA)	Operators

On the top of the list of stakeholders is MMCT which is the initiator and principal developer of the scheme and majority shareholder of MEGA. It is a conduit of the funds to the scheme. MuREA which is the energy arm of MMCT provides technical RE expertise to the scheme. On the other hand, Practical Action was the technical partner of MMCT during the development of the lower and upper Bondo; it also supplied the scheme with the equipments that kick started the project. SGURR Energy, a Scottish RE consultancy, that is also providing engineering and technical advisory services to the scheme. On the part of financiers, EU, Scottish government and GEF were the key funders of the first and second phases. The third phase is going to be funded by Scottish government and GEF in partnership with the government of Malawi and UNDP. A financier of interest is Sukambizi Trust which has been providing funds for the rehabilitation works of upper Bondo. The trust belongs to Rugeri Tea Company which operates tea estates in the area and provides the funds to the scheme as part of the company's social responsibility. The government through its local and national agencies is a key stakeholder that has been providing various essential assistances to the scheme. The key agencies being the Department of Energy (DOE) in the Ministry of Natural Resources, Energy and Environment and MERA – the regulatory body of the energy sector in Malawi.

Local people are the beneficiaries and have also been playing various roles including contributing capital to the scheme in kind. Basically the river and the land on which the scheme is situated are communal resources that were donated it; further to that the community acts as scheme guardians, electricity consumers and suppliers of labour and building materials such as sand and quarry stones (McKinnon, 2013). It should be noted that due to the scale of the scheme, the labour and the basic supplies were a huge requirement, thus community contribution is estimated to be about twenty-five per cent of total capital requirement of scheme (McKinnon, 2013; Kalonga *et al.*, 2013). As consumers, communities started paying for the electricity supplied to them from 14th January 2016 after MEGA was granted the distribution licence. The income being realised is expected to be reinvested in the running of the scheme, at the time of writing, the income being generated was not enough to cover all the operational costs, which justifies the need for development of other sites. Finally, several contractors of services and materials were engaged in building of the physical facilities and some continues to be used as the scheme is running. Electrical contractors are a good example of those that continues to be engaged to do electrical installations in the houses of the beneficiaries.

The importance of collaboration among the stakeholders to the success of the scheme is well acknowledged. Bruessow (2012) reported that success achieved at Bondo was dependent on a comprehensive institutional arrangement through the participation of local communities as consumers, part-owners and implementation partners, the participation of development partners who assisting the scheme financially, carrying out of studies and assessing the business development potential, and the participation of technical partners through the provision of design, implementation guidance, operational instructions and maintenance. Stakeholders that were specifically acknowledged as critical included MERA for their licensing and oversight function, Department of Energy for providing national leadership and policy guidance and the donors (Bruessow, 2012).

Finally, amongst these active stakeholders, government was identified as the driver by the informants. This was so because every bit of the development of the scheme was expected to follow strict regulations provided by the government. Besides, activities of all other stakeholders were premised on the policy direction provided by the government. Furthermore most of the

challenges faced and improvements to be made are within the control of the government and its agencies.

Using the stakeholder involvement pyramid that emerged out of the literature review in phase one of the study, stakeholders indicated in **Table 5-3** were categorised in terms of their role and degree of influence as is exhibited by **Figure 5-1**.

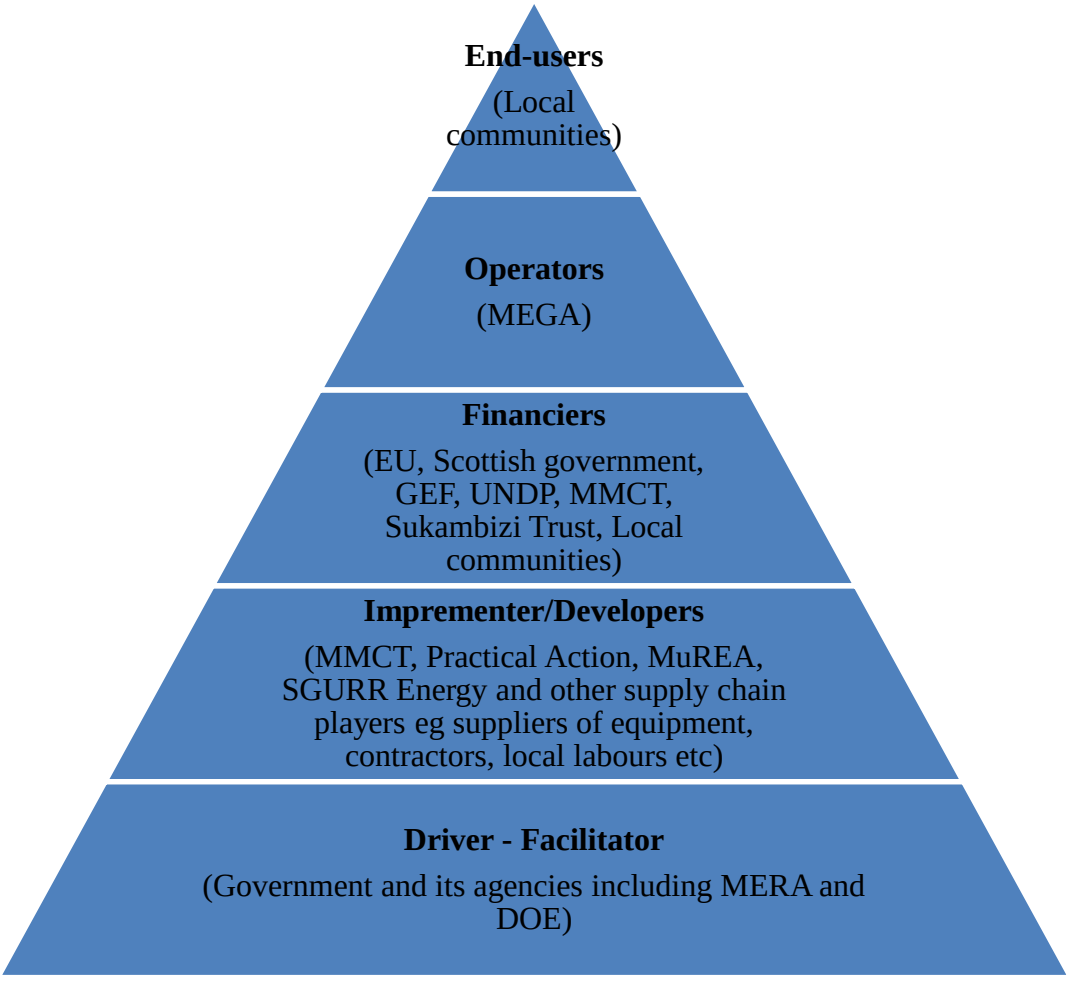

Figure 5-1: Stakeholder involvement pyramid for Bondo Micro-Hydro Scheme
(Source: Based on analysis by the researcher)

5.4 Sustainable financing in the context of Bondo scheme

The findings of the case study support the theoretical insights emerged in phase one of the study. They confirmed the importance of the MHP physical system on MHP financial system. The results indicate that market elements are not well developed and the stages of development are

riddled with several challenges that have brought significant uncertainties. As a result, despite the scheme having a business model, there is still uncertainty whether that is going to lead to long-term financial sustainability. The business model projects that significant donor funding is still needed to develop five to ten sites in order for the income generated through electricity tariffs to be sufficient to cover operating costs (Business Innovation Facility, 2012). It is expected that the scheme will be supported philanthropically with the hope of graduating later on to market based financing; accordingly market elements need to be seriously developed if that is to materialise.

Furthermore, considering that MHP development requires involvement of a lot of stakeholders, the number of stakeholders actively involved at Bondo seems to be low, as such, developers are left with a heavy burden to bear. Instead of putting all effort and resources on MHP development and operation, they are also engaged in market development. For instance the developers have been busy lobbying for a better licencing framework, conducting public awareness and education, gathering relevant information and they are planning to start offering soft loans to the consumers to enhance their ability to pay. Worse still in spite of the efforts, the developers' goodwill seems not to be appreciated in that they still find the going tough as it is not easy for them to move the government into action. Furthermore, at operational level, developers face frustrations due to lack of support from other stakeholders including the government. For example, McKinnon (2013) reported that at one time MEGA and the communities lacked of funds to wire government owned school buildings. In spite of the willingness on the part of MEGA and the desire by the local school management, the wiring costs could not be covered and the Department of Education – a government department – was not forthcoming either with assistance; the situation created frustration and confusion.

On regulatory point of view, the government seems to be too much focused on enforcing regulations however in a suboptimal manner. Regulations are applied without considering the conditions existing on the ground; furthermore they are strictly enforced on the side of developers, and less on the side of the government itself in relation to the duties the very regulations impose on it. Worse still the regulations themselves have some serious shortcomings that require amendments to make Malawi competitive in term of attracting private investment. Thus instead of the regulations being facilitators, they are impediments to development.

Therefore there is a need for the regulations to be revised in order to make them responsive to Malawian conditions. Besides, the government should not only strictly honour its role of enforcement of regulations but should strictly undertake duties that the laws and energy policy impose on them (such as carrying out public awareness and education). Moreover the government has the moral duty to ensure that the laws that are enacted provide favorable environment for development and that every stakeholder including the government itself abide by them. Government as a driver has a lot of work to do in order to facilitate a speedy growth and development of the scheme and the RE sector as a whole. Informants asserted that the private sector has sufficient funds and commitment to invest in projects that make economic sense. The contextual challenges characterising the operating environment for MHP projects renders them less attractive for private investment, hence reliance on the philanthropists. These are some of the key areas that the government and its agencies and other stakeholders could have promptly addressed in order to ensure financial sustainability for the scheme.

5.5 Summary

The Bondo Micro Hydro Scheme provides a classic example of the potential of MHPs in Malawi. Furthermore the challenges it faces provide insights of the key challenges impeding exploitation of MHPs in the country. Since the scheme is an attempt to commercialise the technology in a typical rural setting, it presented an interesting case as this is in tandem with the modern trends in financing of RE technologies. The chapter has highlighted the contextual challenges that beset scheme that are having an adverse impact its long-term financial sustainability. Due to these challenges, although the scheme has a business model, uncertainties still abounds of its effectiveness. Consequently they present barriers to private investors leading to the scheme' survival being at the mercy of philanthropists. The case study provides insights of the importance of the MHP physical system on the MHP sustainable financing. This suggests the critical need to deal with physical (contextual) challenges as a way of addressing the challenges of the financing of MHPs.

Chapter 6 : Conclusions, Recommendations and Implications

6.1 Introduction

This final chapter presents the conclusions, recommendations and implications of the study. It also discusses key limitations to the application of the findings.

6.2 Conclusions

The study has investigated and analysed the challenges underlying the absence of sustainable financing models of MHPs in Malawi. Guided by the van Egmond and de Vries' sustainable finance model and supported with systems theory and life cycle model, the study endeavoured to answer four main questions. The summary below presents whether or not the objective were met.

6.2.1 Summary of findings

6.2.1.1 What are the main components of MHP physical system that dictates the behavior of the MHP financial system?

The study found two main components of the MHP physical system that dictates the behaviour of MHP financial system namely: market development and MHP infrastructure development and operation. Further to that the components were disaggregated to highlight their critical constituents. Under market development the key elements identified were national policies, regulations, incentives, information, public awareness and education and community empowerment. While in relation to MHP infrastructure development and operation, the key elements identified were the seven life cycle stages namely: project conceptualisation, feasibility study, designing of the plant, acquisition of regulatory approval, building of the MHP facility, operations and expansion of useful life and termination.

6.2.1.2 What is/are the underlying impact/(s) of the components of MHP physical system on MHP total financing?

The study found two underlying influence of the components of MHP physical system on MHP total financing; these are (1) determining the quantity of finances that need to be mobilized; and/or (2) facilitating resource mobilisation. Furthermore, some elements of the physical system were found to have immediate or short-term financial impact while others their financial impacts extend over the economic useful life of the MHP. It is therefore imperative for developers,

operators and other promoters of the sector to pay closer attention to the elements with long-term financial impact, since sustainable financing has a long-term orientation.

6.2.1.3 What are the critical areas (i.e. key decision points) that present the potential sources for MHP cost lowering?

The study found that there are two efficiency-oriented ways through which the actual costs of MHP development may be lowered in the search of the "lowest cost, long term financing models". The ways are (1) streamlining and localising of the MHP physical system activities; and (2) ensuring active engagement of all relevant stakeholders. Physical system activities are best targets of MHP development cost reduction since these are the main factors that determine the quantity of finances. Some activities and stages are more expensive due to importation of equipments or services accordingly significant costs can be saved if they are localised. Therefore activity based management principles may need to be applied in management of the development process of MHP. On the other hand, active engagement of relevant stakeholders would lead to "risks and costs sharing" thus reducing the burden that is currently being borne by the few active stakeholders, particularly the developers.

6.2.1.4 What are the roles of stakeholders towards financial sustainability of MHPs?

The study noted that the stakeholders are the active element within both the MHP physical system and MHP financial system. The study observed that the barriers to MHP deployment are basically "inadequate/inappropriate actions" or "lack of actions" by one or more stakeholders; hence removing them will to a larger extent require the stakeholders to act and act right in their respective roles. A stakeholder involvement pyramid emerged out of the study provides a visual display of the key roles of various stakeholders groups and degree of their influence on each other and on the wellbeing of the development of MHPs. The government was found to be the driver of MHP development. Due to "inaction" or "inadequate action" of stakeholders, market elements are poorly developed and the process of MHP infrastructure development and operation is faced with challenges that make it not easy for developers to operate and the operations to be very expensive. This creates unfavourable environment to investment which in turn scarce off private investors leading the developments to be dependent on philanthropists.

6.3 Recommendations

Based on the findings of the study the following recommendations are made in order to address the problem of financial sustainability of the MHPs in Malawi. The principle underlying these recommendations is the need for stakeholders, more especially the policy makers and developers, to recognise that achieving financial sustainability for MHPs is a function not only of the financial factors but also of non-financial ones. The particularities of the nature and the context of MHPs and their development process need to be carefully considered in addressing the problem of sustainable financing for MHPs, as these determine the quantity of capital requirements and the easiness in the mobilisation of resources. Thus the effectiveness of the financial interventions that may need to be implemented depends on vibrancy of the physical system.

The study recommends following actions to be taken in Malawi:

1. Designing of deliberate programmes to stimulate the market for MHPs in the sites with market potential. Market development is an important component of MHP system with a critical impact on sustainable financing. Stimulating the market will ensure commercial viability of the technology which is a key factor to financial viability and to the modern approach to RE financing. It is an aspect that private financiers are keen to establish before committing their funds and it is also of interest to philanthropists as they expect the MHP to self-support itself during the operational stage.
2. Development of cost reduction measures to address the issue of high capital investment requirements to develop MHPs in Malawi. The measures may include streamlining and localisation of MHP development process. Relevant stakeholders need to cooperatively work together, as the task of too huge for a few to accomplish meaningful progress.
3. Deliberate effort to economically empower communities in order to enhance their financial capability not only to enhance affordability the services, but more importantly to enhance their ability to finance development of the MHPs themselves using their resources. This will enhance adoption of community model that has been a success elsewhere but a challenge in Malawi due to poor financial capacity of the communities.

Further to the above recommendations, the following operational measures are also recommended, some of which were made by the informants:

1. There must be a radical revision of policy and regulatory instruments in order to make them clear, responsive and flexible to current and future developments in the RE sector and to the dynamism of the operating environment. The process should also include identification of major RE resources available in Malawi and their specific particularities to be incorporated in the instruments.
2. The government should set up and/or implement a system of monitoring the relevance of policy and regulatory instruments to ensure that they remain current and effective at all times. The system should have a mandatory minimum period at the end of which a complete review of the instruments should be done.
3. The government should consider recruiting energy officers at district level to be responsible for identifying opportunities and championing energy issues.
4. The government should ensure that its various departments are acting consistently and cooperatively in implementing RE related policies.
5. Stakeholders, more especially NGOs, microfinance institutions and government agencies that deal with skills development such as TEVET and community colleges should join the developers in economically empowering communities.
6. Local capacities in developing MHPs should be developed, in order to localise sourcing of equipments and services.

All in all an integrated approach that incorporate relevant stakeholders need to be implemented in Malawi in order to eradicate barriers in physical system, that have a telling impact on the financing of the MHPs.

6.4 Implications

6.4.1 Implications to theory

The study extends theoretical understanding of sustainable financing of MHPs and has endeavoured to organise the theoretical insights into frameworks that can be used in analysis. These frameworks include MHP life cycle model, a holistic view of MHP financing needs, a stakeholder involvement pyramid and the consolidated view of the impact of physical system on

financial system. Furthermore the study addresses financial sustainability of MHPs an area though critical but has so far been superficially covered in extant literature. Thus the study enriches the body of knowledge by bringing together financing issues that has so far been shattered.

6.4.2 Implications for policy and practice

The insights and knowledge revealed in the study are useful to various stakeholders in practice and policy development. The study confirms the roles of different stakeholder groups and the implication of their actions or lack of action on the MHP physical system, consequently on MHP sustainable financing. It redefines understanding of the barriers to MHP deployment as "inadequate action" or "inaction" of stakeholders. The study further reveals the driver to MHP development in Malawi and the facilitative roles of the same on the activeness of other stakeholders. Moreover the study highlights the fact that the government in its driving role has a lot of work to do in order to ensure growth and development of the MHPs. Specific improvements that are needed include; refining the licencing frameworks; updating the current energy policy to incorporate clear measures that take care of the unique features of various alternative RE technologies. Furthermore, as a way of reducing the burden on the developers, the government should be proactive by undertaking some critical preliminary activities on all potential sites such as feasibility studies. Besides the government can undertake to assist in carrying out some activities such as public awareness and education using its machinery that is spread across the country. Furthermore the government should consider recruiting energy officers at district levels to champion energy issues.

Other practical implication is the revelation of efficiency-oriented measures can assist in lowering the total cost of MHP development and operation in Malawi. These should go together with the recognition of the stages of the MHP development and operation with long-term financing impact namely feasibility study, building and operation of the plant. These are areas that require effective management (based on ABM principles) in search of the lowest-costs, long-term financing models for MHPs.

6.5 Limitations and implications of future research

The major limitations include the fact that the study largely theoretical and was based on a case study that is still in the developing stage. Furthermore informants were engineers by training hence they are more oriented on the technical aspects of MHP than on the commercial and financial aspects. It appears that most of the people promoting MHP deployment are engineers. Due to these limitations, some practical questions may not be answered and the study may have limited generalisation potential. It should however be noted that the limitations were justified due to low theory development on the subject and the fact that literature on the subject was shattered. Furthermore the case (Bondo Scheme) is the only one in country with a business model is in line with modern trend in RE financing approach, accordingly it fitted well with the objective of the study. Besides, researcher provided necessary clarifications to the informants to minimise the problem of understanding.

For the future, the study recommends:

1. Empirical studies to further test the theoretical frameworks that emerged in the study.
2. Study on the extent to which MHP activities can be localised as a way to cost reduction.
3. Comprehensive stakeholder analysis within the context of MHP financial sustainability.
4. Comparative studies between the SSA countries with other developing countries where MHPs has been a success story such as Nepal and India.

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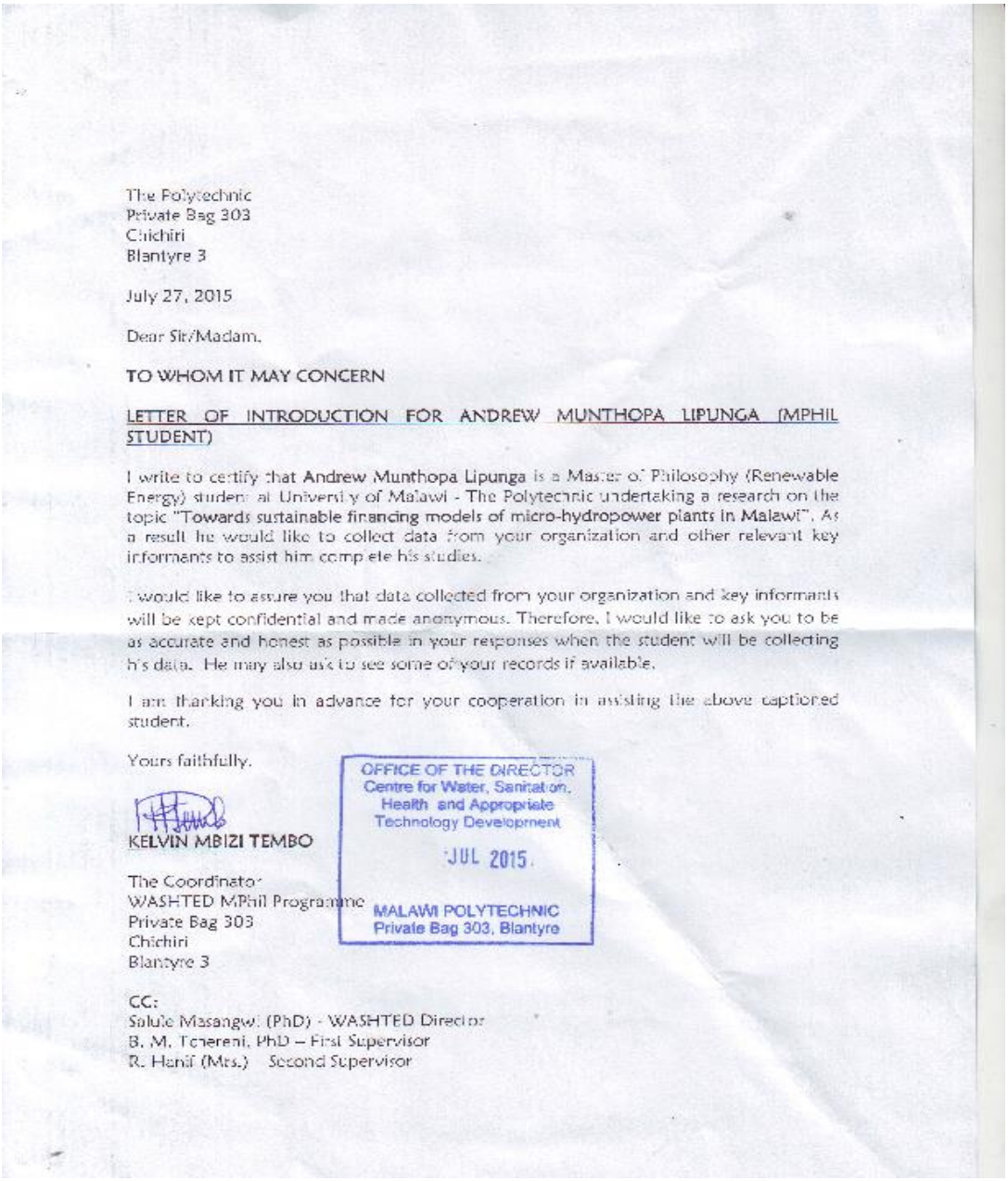
Appendices

Appendix 1: Introductory Letter



The Polytechnic
Private Bag 303
Chichiri
Blantyre 3

July 27, 2015

Dear Sir/Madam,

TO WHOM IT MAY CONCERN

LETTER OF INTRODUCTION FOR ANDREW MUNTHOPA LIPUNGA (MPHIL STUDENT)

I write to certify that Andrew Munthopa Lipunga is a Master of Philosophy (Renewable Energy) student at University of Malawi - The Polytechnic undertaking a research on the topic "Towards sustainable financing models of micro-hydropower plants in Malawi". As a result he would like to collect data from your organization and other relevant key informants to assist him comp ete his studies.

I would like to assure you that data collected from your organization and key informants will be kept confidential and made anonymous. Therefore, I would like to ask you to be as accurate and honest as possible in your responses when the student will be collecting his data. He may also ask to see some of your records if available.

I am thanking you in advance for your cooperation in assisting the above captioned student.

Yours faithfully,

KELVIN MBIZI TEMBO

OFFICE OF THE DIRECTOR
Centre for Water, Sanitation, Health and Appropriate Technology Development
JUL 2015
MALAWI POLYTECHNIC
Private Bag 303, Blantyre

The Coordinator
WASHTED MPhil Programme
Private Bag 303
Chichiri
Blantyre 3

CC:
Salule Masangwi (PhD) - WASHTED Director
B. M. Tchereni, PhD – First Supervisor
R. Hanif (Mrs.) Second Supervisor

Appendix 2: Interview Protocol

Semi-structured interview Protocol

Towards sustainable financing models for Micro hydro plants in Malawi

Interview date:
Time:
Position:

Introduction

The interview is part of a Master of Philosophy (Renewable Energy) research investigating factors underlying the absence of sustainable financing models for Micro hydro Plants in Malawi.

With your permission, I would like to record the interview to ensure that I don't miss any important points.

Do you have any questions before we commerce the interview?

Question 1	Notes
What are the key financing challenges faced by Bondo Micro-hydro Scheme project?	

Question 2	Notes
What is the impact of the following elements on financing of the Micro-hydro project? 1. National policies 2. Regulations 3. Public awareness and education 4. Incentives 5. Availability of information 6. Community empowerment	

Question 3	Notes
1. **How would you describe the following elements in relation to Micro-hydros at <u>project level</u>?** (Using following options: **Options**: **1**. resource consumers, **2**. Facilitator of resource mobilisation **3.** Both **4.** none of the above) 1. National policies 2. Regulations 3. Public awareness and education 4. Incentives	

5. Availability of information 6. Community empowerment	

Question 4	**Notes**
What is the significance of the following activities to the total financing of the Micro-hydro project? 1. Project conceptualisation 2. Feasibility study 3. Designing of the plant to be built 4. Regulatory approval 5. Building of the plant 6. Operational running of the plant 7. Decommissioning of the plant	

Question 5	**Notes**
Where would you situate the impact of following activities on the financing of the Micro-Hydro Plant? (Options: 1. Only during occurrence of the activity, 2. Over operational lifetime of the plant, 3. both) 1. Project conceptualisation 2. Feasibility study 3. Designing of the plant to be built	

4. Regulatory approval 5. Building of the plant 6. Operational running of the plant 7. Decommissioning of the plant	

Question 5	**Notes**
1. Who are the key stakeholders to Bondo Micro-hydro Scheme? **2. Amongst the stakeholders mentioned, who are the driver(s)?** **3. How would you describe role awareness among the stakeholders?** **4. How would you describe the current level of engagement of the stakeholders?**	

Thank you

Appendix 3: Organogram of MEGA