FINANCIAL SUSTAINABILITY OF MINI-GRID ELECTRICITY DISTRIBUTION COMPANIES IN UGANDA

A Dissertation

Presented to

The **Development Finance Centre (DEFIC)**
Graduate School of Business
University of Cape Town

In partial fulfilment
of the requirements for the Degree of
Master of Commerce in Development Finance

by

Isaac Vivian Kinhonhi

KNHISA001

March, 2018

Supervisor: **Prof. Ralph Hamann**

Dr. John Fay

PLAGIARISM DECLARATION

I know that plagiarism is wrong. Plagiarism is to use another's work and pretend that it is one's own. I have used a recognised convention for citation and referencing. Each significant contribution and quotation from the works of other people has been attributed, cited and referenced. I certify that this submission is my own work.

I have not allowed and will not allow anyone to copy this essay with the intention of passing it off as his or her own work.

Isaac Vivian Kinhonhi

Signed by candidate

ABSTRACT

This study investigated the financial sustainability of electricity Mini-grids in Uganda. The challenges of sustainability of Mini-grids were recognised by Tenenbaum Bernard, Greacen Chris, Siyambalapitiya Tilak (2014) as well as Payen, Bordeleau and Young (2016), with a focus on developing countries, particularly in Asia. There is, however, no literature that was found on similar challenges in Uganda. The specific objectives of this study were to examine the profitability, liquidity, efficiency and operational sustainability of Mini-grids in Uganda.

The study focused on four Mini-grids as case studies: Ferdsult Engineering Services Limited (FESL), Bundibugyo Energy Cooperative Society (BECS), Kilembe Investments Limited (KIL) and West Nile Rural Electrification Company (WENRECO). The research objective was addressed by analysing audited financial reports for the respective Mini-grids from 2010 to 2015 and other operational information published by the electricity regulator.

The study established that Mini-grids in Uganda were not financially sustainable despite having steady growth in sales revenue and customer numbers. The main factors that affected the sustainability of Mini-grids include a higher growth rate in operational and maintenance costs compared to the sales revenue. In addition, operational efficiency challenges were observed, including energy losses, imprudent financial management practices and poor liquidity. These shortfalls consequently showed that the Mini-grids are not financially sustainable.

Despite the fact that Mini-grids are not financially sustainable in Uganda, their benefits go beyond electricity provision. The other benefits of Mini-grids are socio-economic in nature, including support for health services and enhancement of economic activities and the livelihoods of the poor. The socio-economic benefits from access to electricity in these rural areas may far outweigh the financial limitations observed. It is therefore important that Mini-grids continue to get the necessary support until such a time as they become sustainable.

It is recommended that the Government of Uganda should provide financial and operational support through subsidies or other support systems to ensure continuity of the Mini-grids and, ultimately, their financial sustainability in the medium term in order to enhance access to electricity and the knock- on benefits that come with this access. In this regard, governance and technical skills enhancement remain key in order for these -grids to move forward. Further research should establish the optimal size and internal operational parameters that will ensure the sustainability of the Mini-grids, the amount of government subsidy required and the time it would prudently take to attain sustainability.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS AND ACRONYMS

BECS	Bundibugyo Energy Cooperative Society
ERA	Electricity Regulatory Authority
ESI	Electricity Supply Industry
GoU	Government of Uganda
IEA	International Energy Agency
KIL	Kilembe Investments Limited
KIS	Kalangala Infrastructure Services
kV	Kilovolts
kW	Kilowatts
MEMD	Ministry of Energy and Mineral Development
MW	Megawatts
NPA	National Planning Authority
REA	Rural Electrification Agency
REB	Rural Electrification Board
REF	Rural Electrification Fund
RESP	Rural Electrification Strategy and Plan
SDG	Sustainable Development Goal
UBOS	Uganda Bureau of Statistics
UEB	Uganda Electricity Board
UEDCL	Uganda Electricity Distribution Company Ltd
UETCL	Uganda Electricity Transmission Company Limited
WENRECO	West Nile Rural Electrification Company

ACKNOWLEDGEMENT

I would like to acknowledge the Electricity Regulatory Authority that sponsored my studies for the Master of Commerce in Development Finance degree out of which this research report was prepared. Great thanks also go to my academic supervisors, Prof. Ralph Hamann and Dr. John Fay, who expertly and gracefully guided me to the completion of this report.

My sincere thanks go to my wife, Faty, and my children, Isaac, Hannah and Ham Ethan, as well as my colleagues at work.

CHAPTER ONE

1.1. Introduction

The provision of modern energy services is recognised as a critical foundation for sustainable development (Bazilian, 2010). There are up to 1.4 billion people around the world that have no access to electricity. Eighty-five per cent of these are located in rural areas. It is further reported that if no other intervention is made by the year 2030, the number of households without electricity will only reduce to 1.2 billion (OECD, 2010; IEA, 2011; Barnes, 2011).

According to the Uganda Bureau of Statistics (UBOS, 2016), only 20% of Ugandans had access to electricity. Even with that level of access, the distribution was highly skewed to the urban areas, with 55% of urban households reporting that they had access to electricity, while only 5% of rural households reported having access to electricity.

Ezor (2009) indicated that the absence of electricity greatly impacted the lives of Ugandans. Electricity, if limited, stifles the community's ability to engage in economic activities aimed at poverty eradication. There is a genuine need for electricity in the rural communities that can be used to engage in income-generating activities, improve health care as well as increase lighting.

Countries that have started to provide electricity to their poorest nationals face some challenges. One of the challenges is how to make existing policies support rural electrification as an objective (Barnes, 2011; UNDP, 2009). Some already established electricity companies generally serve the urban consumers and are, therefore, reluctant to extend the services to the rural communities. This is because increasing electricity supply to the rural areas may require setting up other institutions within the electricity companies.

Mini-grids can provide a solution to electrifying rural areas and increasing electricity access. The past shows that grants can help to establish Mini-grids though this is not an option that can solve the problem for the over 1.4 billion people that still do not have electricity. In order to guarantee sustainable energy supply, business models that are profitable for all players involved have to be developed (Gaudchau, Gerlach, Wasgindt, and Breyer, 2013).

Scholars define Mini-grids in different ways. Nagpal (2012) defines a Mini-grid as "an electricity distribution network operating at less than 11 kV, which is sometimes connected to the wider utility grid". In other cases, it is defined as a small-scale power system with a total capacity not exceeding 15 MW (i.e. the sum of installed capacities of all generators connected to the Mini-grid is equal to or less than 15 MW), which is not connected to a national or a regional grid (IEA, 2013; Möller and Al, 2014). Mini-grids can also operate as off-grids in rural areas which use local renewable energy sources like wind, solar power, biomass and run-of-river hydro, which ultimately reduces local and global pollution (Deshmukh, Carvalho, and Gambhir, 2013).

Off-grids are electricity power systems that provide electricity utility services that do not integrate with the public electricity network. Electricity is provided by these sources where there is no access to the grid or it is unreliable (Kempener et al., 2015). This kind of system is often called the "Stand-Alone Power Systems" (SAPS), or "Remote Area Power Systems" (RAPS) (Off-Grid Energy Australia, n.d).

This study considered a Mini-grid as a company or utility operating an electricity distribution network at not more than 33 kV, and with a distributing capacity not exceeding 15 MW. The distribution network may be managed by a consortium of people or a legally registered entity.

Uganda has also used Mini-grids and off-grids to help solve the distribution gap and to attain the seventh Sustainable Development Goal (SDG): to ensure access to affordable, reliable, sustainable and modern energy for all (Orlandi, Tyabji, Chase, Wilshire, and Vickers, 2016). This was as a result of failure of the national grid to serve the increasing demand for electricity by the urban and rural communities. Mini-grids in Uganda rely on extending grid-connected generation capacity and off-grids rely on fossil fuels such as diesel.

Both the private and public sectors have come up with a number of innovations to ensure an acceleration of access to energy in a reliable and cost-effective manner. However, there is need for more work to be done to ensure financial sustainability of new innovations for business models that can accelerate development towards access to modern energy, especially in developing economies. Financial sustainability is considered achieved if a utility is able to provide sufficient electricity and make investments to meet the changing future demand while generating adequate revenues to cover costs (Bridle and Wooders, 2014).

The Government of Uganda (GoU), in a bid to accelerate access to electricity in the country, supported the establishment of smaller electricity distribution companies (Mini-grids) through the Rural Electrification Agency (REA). This support that government provided to the Mini-grids was in the form of subsidies on capital towards the establishment of the distribution grid, provision of fuel for energy generation, and subsidised customer connections, among others. By the end of 2015, Uganda had eight Mini-grids existing alongside the main distribution utility, Umeme Ltd (ERA, 2015).

Limited effort has been made to assess the financial sustainability of the Mini-grids as a medium to long-term remedy for electricity access, especially in the rural areas. The most common studies focused mainly on measuring the level of access to electricity and electricity infrastructure challenges (see, for example, Schillebeeckx, Parikh, Bansal & George, 2012, and Mawejje, Munyambonera & Bategeka, 2013).

Relatively limited information has been identified particularly highlighting the operational trends and financial performance of Mini-grids in Africa let alone Uganda. However, it is critical to assess the financial performance and sustainability of these Mini-grids. This would inform the policymakers and all proponents of the electricity industry considering Mini-grids as one of the key drivers that foster access to electricity, especially in developing countries. It is important, therefore, to establish the financial sustainability of these Mini-grids in Uganda.

1.2. Problem Statement

Lack of energy is a major challenge in the world today which affects every area of our lives. Access to modern energy has a dramatic impact on health services and widens the gap between the poor and the rich. In addition, vulnerability of the poor is worsened with the recent challenges of climate change and volatile energy prices, among others (UNDP, 2009). According to Gollwitzer, Ockwell and Ely (2015:8), "[Mini-grids represent a compromise between scale and adaptability to exploit local resources. They allow community scale electrification, centralisation of maintenance and repair responsibilities, and have been used with varying degrees of success around the world".

The GoU undertook deliberate measures to increase electricity access through Mini-grids located in remote areas alongside the main distribution grid, Umeme Ltd. By 2015, eight mini-grids were already operating with support from the government. There is, however, need for the government to determine a cut-off point for financial support to these Mini-grids at a time when the Mini-grids are financially sustainable.

A power sector is considered financially sustainable if it is able to provide sufficient electricity and make investments to meet changing future demands while generating adequate revenues to cover costs and operating according to environmental and social norms (Bridle and Wooders, 2014). Managing a Mini-grid in a way that can provide electricity access to poor people creates considerable technical, economic, socio-cultural and political challenges, with failure rates ranging from 50 to 100% (Greacen and Greacen, 2004).

Whereas there have been studies around Mini-grids in Uganda, no study was found addressing the financial sustainability of Mini-grids in the country. It is also important from a policy perspective for the policymakers to ascertain that Mini-grids actually achieved the financial sustainability that was anticipated. This study, therefore, sought to establish the financial sustainability of electricity Mini-grids in Uganda.

1.3. Purpose of the Study

The purpose of this study was to investigate the financial sustainability of Mini-grids in Uganda. Particular focus was put on Mini-grids that either generate their own power or purchase power from a third party, i.e. the Uganda Electricity Transmission Company Ltd (UETCL), and supply it to their customers. The study thus examined the sustainability of rural grid-connected utilities and off-grids/isolated grids.

1.3.1. Specific objectives of the study

The study specifically sought to:

(i) Assess business growth in the respective Mini-grids in Uganda.

(ii) Examine the level of profitability of Mini-grids in Uganda.

(iii) Assess the adequacy of liquidity of the Mini-grids in Uganda.

(iv) Examine the efficiency and operational sustainability for each of the Mini-grids in Uganda.

1.4. Significance of the Study

Since 2003, the GoU, through REA, has supported the development of Mini-grid distribution networks in the country. The government did this with the hope that these Mini-grids would attain financial sustainability between three and five years. Since Uganda is resource-constrained, it remains important to ascertain the sustainability of the electricity Mini-grids for better resource management and national strategic decision-making.

The results of the study will also inform and provide guidance to decision-makers of the electricity regulator in Uganda as they assess the most plausible Mini-grids financing structure and the extent to which the decisions made, particularly on tariffs and the financing structure, impact these Mini-grids.

1.5. Scope of the Study

The electricity industry is part of the wider energy spectrum and it is composed of three segments: generation, transmission and distribution/access. The intention of this study was mainly to establish the financial sustainability of the small distribution grids in Uganda. While literature continues to highlight the challenges of access to electricity and the use of Mini-grids to bridge the gap, our focus was on the possibility of medium- to long-term existence of Mini-grids. Particular emphasis was on the general historical performance of the Mini-grids, both in terms of operations and finances of the companies. This included income, overall expenses and operational efficiency.

In order to gain an insight into the subject matter, the performance of four Mini-grids, i.e. BECS, KIL, WENRECO and FESL, was analysed. This ensured some degree of homogeneity across distribution companies as well as some diversity in geographical location, shareholding and source of electricity. Financial diagnostic tools were adopted for this study, focusing on the financial performance reports submitted by the Mini-grids to the regulator.

1.6. Organisation of the Report

Chapter One presents the introduction to the study and highlights the background, statement of the research problem, objectives of the study and significance of the study. Chapter Two has an overview of Mini-grids in Uganda. Chapter Three presents a review of relevant literature about financial viability, electricity Mini-grids and operation of electricity Mini-grids as well as how these variables relate to each other. The methodology used in this study is presented in Chapter Four, while the findings are presented and discussed in Chapter Five. Chapter Six presents the summary of findings, the conclusion, the recommendations and suggested areas for future research.

CHAPTER TWO

AN OVERVIEW OF THE ELECTRICITY MINI-GRIDS IN UGANDA

2. Introduction

This chapter provides an overview of Uganda's Mini-grids, the background of each and their general status.

2.1. An Overview of Uganda's Electricity Supply Industry

Following the enactment of the Electricity Act of 1999 (Mawejje et al., 2013), the existing vertically integrated utility, Uganda Electricity Board (UEB), was unbundled into the segments of generation, transmission and distribution. Consequently, the unbundling led to the registration of the three successor companies, namely: the Uganda Electricity Generation Company Limited (UEGCL); Uganda Electricity Transmission Company Limited (UETCL); and Uganda Electricity Distribution Company Limited (UEDCL).

In the interests of the GoU, tapping into the benefits of the private sector, the generation assets of UEGCL were leased to Eskom Uganda Ltd, a private company, in 2003 (Mawejje et al., 2013). Similarly, the distribution assets of UEDCL were leased to Umeme Ltd in 2005. For strategic reasons, the transmissions network and the role of the system operator remained in control of the government-owned company, UETCL. Further, an independent regulator, the Electricity Regulatory Authority (ERA), was formed to oversee the activities of the electricity industry. As indicated earlier, the electricity industry in Uganda is divided into three independent entities responsible for the distribution, transmission and generation of electricity and governed by the Electricity Act. The industry structure, therefore, has many generators and distributors with a single utility that takes the role of system operator and Transmission Company. The structure of the Electricity supply industry is shown in **Appendix 1.**

In the same Electricity Act of Uganda (1999), the Rural Electrification Fund was provided to be managed by the Minister responsible for energy. The fund was to be financed through a levy on energy purchased from electricity generation plants. This fund was managed by REA, which was set up by the Ministry of Energy and Mineral Development (MEMD). The government, through REA, supported the establishment of other Mini-grid distribution utilities in an effort to increase access to electricity in the country as well as break the monopolistic tendencies presented by a single distribution company, Umeme Ltd.

2.2. Overview of Mini-grids

In the Rural Electrification Strategy 2002-2011 as well as that for 2013-2022 (Rural Electrification Agency Uganda, 2013), the main strategy of increasing electrification in Uganda, was focused on the Mini-grid system. It was projected that these Mini-grids would be supported for between three and five years before they would be expected to be self-sustaining. **Table 1** shows the Mini-grid distribution utilities that exist alongside the main distribution grid.

Out of the eight Mini-grids, WENRECO and KIS operate off-grid systems that generate and sell their own electricity. The rest of the Mini-grids operate their own networks but purchase power from the national grid transmission company, UETCL. UETCL is the only utility that is permitted by law to buy electricity from generators and sell it in bulk to distributors.

Table 1: Description of electricity Mini-grids in Uganda by 2015

Mini-grid	Description
Ferdsult Engineering Services Limited (FESL)	The first licence was awarded to the company in 2007 by ERA for a period of 10 years. FESL is maintained as a small distribution grid that purchases power from UECTL, the single supplier in the country. The company was mainly financed through REA as its concessionaire. It operates in Kibale, Kyenjojo, Rukungiri, Kanungu, Ntugamo, Isingiro, Rakai and Masaka districts. According to the regulator, FESL had 23,735 customers by the end of 2015.
West Nile Rural Electricity Company (WENRECO)	In 2003, WENRECO was awarded a licence by ERA to operate the distribution network in the north-western districts of Koboko, Maracha, Zombo Arua, Paidha, Nebbi and Yumbe. It operates an independent 3.5 MW Nyagak hydropower plant serving 8,199 customers as at December 2015.
Bundibugyo Energy Cooperative Society (BECS)	This utility was formed through a cooperative society in Bundibugyo district in 2009. The cooperative has a 10-year lease agreement with REA. By the end of 2015, the company had 5,764 customers.
Pader Abim Community Multipurpose Energy Cooperative (PACMECS)	This cooperative is located in northern Uganda in the district of Pader. The cooperative was awarded a 10-year concession to operate a 130 km 33 kV distribution line in 2010. The utility had 2,357 customers by 2015. It does not generate its own power but purchases it from UETCL.
Kilembe Investments Limited (KIL)	The company operates a 10-year concession for the distribution and sell of electricity in Kasese district. By 2015, the company had 8,116 customers on its network. The company also purchases its power from UETCL, the bulk seller.

Mini-grid	Description
Kalangala Infrastructure Services (KIS)	KIS was licensed in 2009 to construct, own and operate an electricity generation plant on the islands of Kalangala district. The company started operations in 2014 using a hybrid solar-diesel-powered plant with a capacity of 2.5 MW. By the end of 2015, KIS had 1,958 customers connected to the network.
Kyegegwa Rural Electrification Cooperative Society Limited (KRECS)	The cooperative started the distribution and sale of electricity in 2014. The cooperative was licensed by ERA for 10 years. The utility does not have its own generation but purchases power from UETCL. The company had 2,068 customers during the same period.
Uganda Electricity Distribution Company Limited (UEDCL)	UEDCL was licensed in July 2014 for the operation of four service territories, namely: Lira Service Territory (LIST); North-North West Service Territory (NNWST); North-East Service Territory (NEST); and Mid-West Service Territory (MWST). In total, the company had 9,297 customers across all the service territories.

Source: ERA ESI Report, 2015

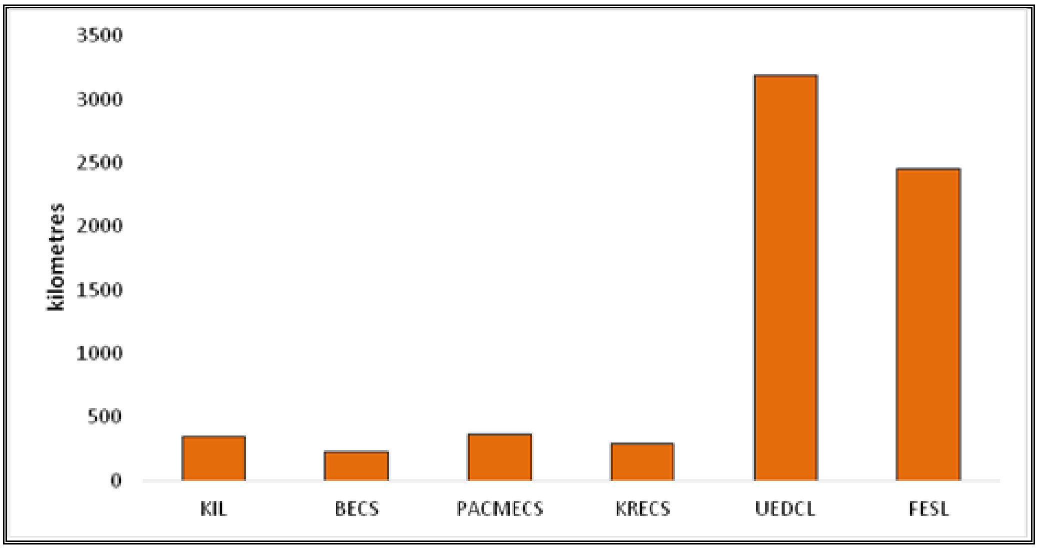
2.3. Grid-Connected Mini-grids

This section describes the Mini-grids that purchase their energy from UETCL/third parties and the off-grids.

2.3.1. Distribution network length

UEDCL had the longest length of network, which was 3,195 km of line, by the end of 2015. This is mainly because it operates four service areas. This was followed by FESL, which had 2,456 km in the same period. The shortest network length was reported by BECS, with 225 km. The rest of the network length is shown in **Figure 1**.

Figure 1: **Mini-grid distribution line length by 2015**

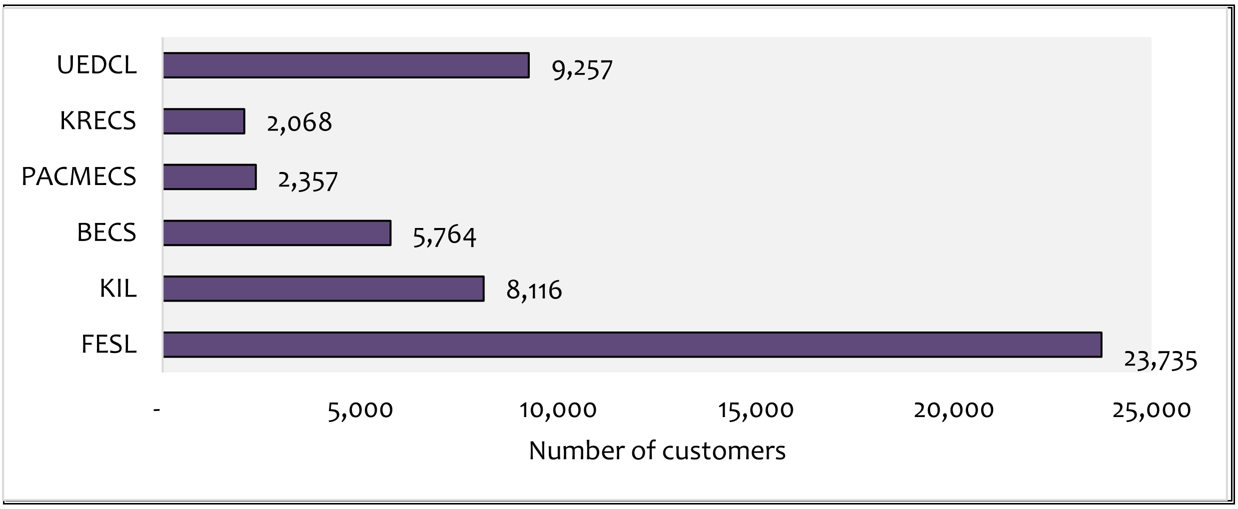


Source: ERA ESI Report, 2015

2.3.2. Customer connections

At the end of 2015, FESL had the highest number of customers, at 23,735. This was followed by UEDCL, which had 9,257 customers. KRECS registered the lowest number of customers, which was 2,068, as shown in **Figure 2** .

Figure 2: Number of customers by 2015



Source: ERA ESI Report, 2015

2.3.3. Customer categories

Overall, the domestic customers made up 97.8 % of the total number of customers of Mini-grids as at the end of 2015 (ERA, 2015). Commercial consumers made up 2% of the total number of customers of the Mini-grids as at the end of 2015. The industrial consumer category made up 0.2% of the total number of customers. This category had the lowest in absolute number terms. The main industrial activities in these rural concessions during the period were tea processing, fish processing, coffee processing and large-scale maize milling.

2.4. Off-grid Distribution Companies

KIS and WENRECo operated as off-grid distribution companies in Kalangala district and West Nile (Arua, Adjumani, Koboko districts) respectively. WENRECo runs a hydroelectricity dam of installed capacity 3.5 MW whilst KIS runs a hybrid thermal and solar PV generation facility of total installed capacity 2MW. The WENRECO network line length was 468 km in 2015 while that of KIS was 155 km during the same period. The total number of WENRECO's customers was 8,199 in 2015. On the other hand, whereas KIS commenced operations in 2015, the company had connected 1,952 customers in the same year.

2.5. Conclusion

This chapter presented an overview of the electricity supply industry in Uganda as well as key facts on the existing Mini-grids. It can be observed that the Mini-grids have diverse characteristics but with a similar purpose, i.e. to increase access to electricity in the country. An additional growth in size for all the Mini-grids as well the establishment of more new ones is highly likely.

CHAPTER THREE

LITERATURE REVIEW

3. Introduction

This chapter highlights literature related to this study area and the related concepts that have been developed by other scholars. The chapter is sub-divided into seven sub-sections, including the introduction, conceptual framework, overview of the Ugandan electricity supply industry, Mini-grids electrification, and electricity access for the poor and, in the final section, the conclusion of the chapter.

3.1. Conceptual Framework

In terms of the conceptual framework of this study, there is a bi-direction flow of electrical energy and payment. Accordingly, Figure 3 can be explained by moving from the right-hand to left with energy and left to right with payment.

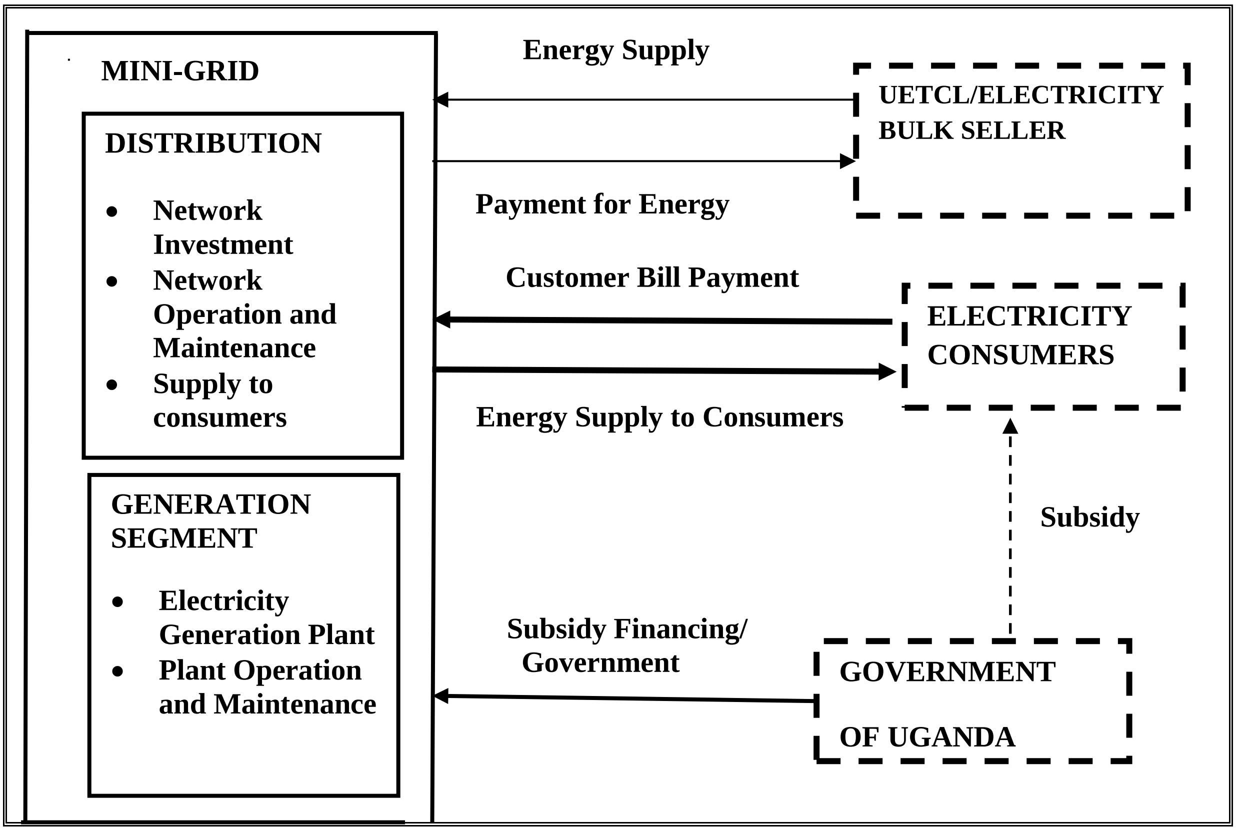
As described in ERA (2015) annual report, utilities where energy was acquired from UETCL, the Mini-grid received the power and then distributed it to the consumers. The same flow was followed by payment where the customer paid their electricity bill to the Mini-grids and then the Mini-grid would pay the electricity bill to UETCL for the energy received.

In cases of off-grids or isolated grids where the Mini-grid had their own generation, the Mini-grid generated and distributed the energy to the consumer. In this case, the Mini-grid did not have any transaction with UETCL either in terms of energy or payment.

Given the challenge of financing the sustainability of the Mini-grids, there are cases where the government directly subsidises the consumer and, therefore, the benefits go from the government to the consumer directly. The direct subsidies include free customer connection and distribution of equipment for efficiency. In other cases, the government provides infrastructure or technical assistance to the Mini-grids. In this case, the consumer will benefit through the Mini-grid pricing or efficiency.

In all cases, the cost of delivering electricity to the consumer must be equal to the payment made by the consumer to the Mini-grids and the subsidy provided by the government or any other support agency. If this equilibrium is not achieved, then the sustainability of Mini-grid is in jeopardy. This is the basis for the review of the financial sustainability of the Mini-grids in Uganda.

Figure 3: Flow of electricity and payment in Mini-grids



Source: Author

3.2. Definitions

Mini-grids rely on generation technologies which use local renewable energy sources like biomass, solar, wind and run-of-the-river hydro, that ultimately avoids local and global pollution (Deshmukh et al., 2013).

Off-grids are electricity power utilities which are not connected to the public electricity network. The off-grids provide electricity in places with no grid or where it is unreliable (Kempener et al., 2015). This kind of system is often called the "stand-alone power system" (SAPS) or the "remote area power system" (RAPS) (Off-Grid Energy Australia).

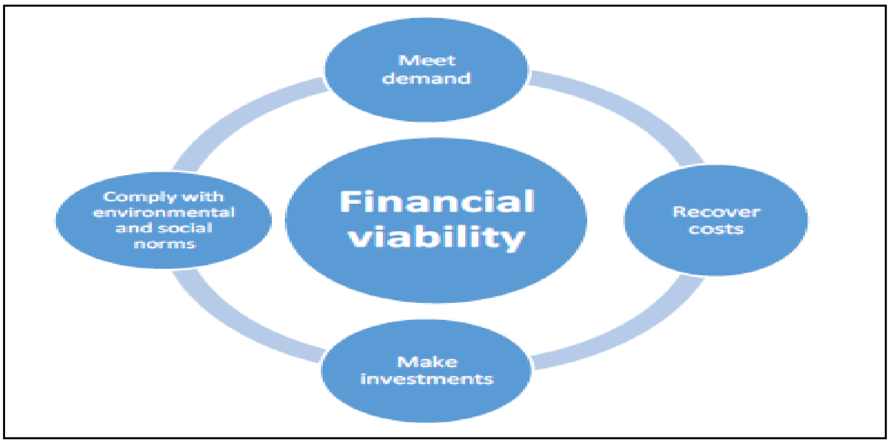
The main components of a Mini-grid include the synchronisers, power source(s), transformer(s), switchgear, inverters, the software balancing load and supply, and wiring.

While it is noted that Mini-grids serve the purpose of providing electricity to households and other related consumers, there is no single design of Mini-grids, as each Mini-grid will be adjusted to fit the context of its location (Blum et al., 2015; ESMAP, 2007).

In a study by Verryn (2014), quoting Saltzman et al. (1998, "Sustainability defined as the degree to which an organisation, in affecting its target market, 'covers the costs of providing financial services after adjustments to its profit and loss statement'"

Bridle and Wooders (2014) contend that the power sector is considered financially sustainable as long as it has sufficient electricity and makes enough investments to meet changing future demands while generating adequate revenues to cover costs. How they illustrate the sustainability is shown in **Figure 4**.

Figure 4: Indicators of power sector financial viability



Source: Bridle and Wooders (2014)

Arunachalam, Chen and Davey (2016), quoting PWC (2006), define financial sustainability as the ability to control the expected financial requirements as well as risks over the long term without using expenditure measures or disruptive revenue. Similarly, Fiscal Star (2009) defines financial sustainability as the ability to continue in operation only "if any operating deficit, infrastructure backlog or excessive net financial liabilities could be corrected without having to resort to substantial adjustments to its existing revenue and/ or expenditure".

3.3. Rural Electrification

Crousillat, Hamilton and Antmann (2010) list a number of reasons why closing the electricity access gap remains an unfinished agenda. These include: high costs of supplying rural and peri-urban households; lack of appropriate incentives; weak implementing capacity; electricity generation shortage; and population growth.

Poor and isolated households cannot afford to pay for electricity. It is, however, noted that affordable amounts may not be the same across households and this affects the financial viability of electrification (Tamir, Urmee, & Pryor, 2015). It is further reported that common uses for electricity include lighting, battery charging and agricultural processing. Despite diversity, opportunities exist to improve rural economic welfare through increased electricity access.

Rural electrification in Uganda is financed through money appropriated by Parliament, a 5% levy on transmission bulk purchases of electricity from generation stations, and loans and grants from development partners such as the World Bank/IDA, SIDA, JICA, the Government of Norway, GEF, KfW and GTZ (Mutambi, 2011). Mutambi adds that the increase in rural electrification is made through grid extensions that are concessioner out as well as off-grids.

3.4. Rationale for Mini-grids

Mini-grid technology started in the early 1980s in developing countries at a time when authorities in energy noted that a centralised electrification approach was not the most efficient solution to electrifying remote areas (Peskett, 2011).

Inversin (2000) reports that the benefits of electrification were well known and demand for electricity service was widespread. The established utilities were often preoccupied with meeting the needs of the vocal and economically attractive urban areas and with maintaining the existing systems. As such, many utilities were unable to address the needs of rural villages. Consequently, around the world, in rural areas beyond the reach of the national grid, numerous individuals and communities took it upon themselves to construct their own rudimentary electricity distribution systems.

The traditional approach to serving the rural communities with electricity is to extend the central grid (Schnitzer et al., 2014). This approach is technically and financially inefficient owing to a combination of capital scarcity, insufficient energy service, reduced grid reliability, extended building times and construction challenges to connect remote areas. Adequately financed and operated micro-grids based on renewable and appropriate resources can overcome many of the challenges faced by traditional lighting or electrification strategies.

The availability of electricity to support proper rural health services was not adequate in many countries. The development of reasonably priced and reliable energy systems made it possible to provide vaccines and other basic health care services in remote areas. A number of international, national and local institutions, non-governmental organisations (NGOs) and private companies then deployed renewable energy systems to rural communities in the developing world where health care in rural areas is a national priority (Jimenez & Olson, 1998).

The global stakes in the sustainable deployment of clean and cost-effective electrification are high. Conventional electricity generation worldwide already currently accounts for 38% of worldwide carbon emissions, which threaten to irreversibly change the environment (Navroz K. Dubash;Rajan, 2002). However, a study conducted by Deichmann, Meisner, Murray and Wheeler (2011) showed that, unlike other scholars such as Lyndon and Tuckwell (2013) and Tenenbaum (2014), the decentralised renewable power expansion in sub-Saharan countries was not considered a universal solution to universal access, but an important part of the entire solution. This limitation was pegged to the challenge of not being dispatchable and thus posing a system stability challenge for consumers in the long run.

Despite Uganda's national grid electrification rate being only 15%, the concept of renewable energy Mini-grids is not widespread in the country. About 85% of the population relies on biomass and kerosene to meet their energy needs. These energy sources often pose hazards to domestic health through smoke-related illnesses and also to the environment through widespread deforestation and greenhouse gas emissions. Mini-grids powered by renewable energy sources can provide a cost-effective way to electrify remote sites while helping to mitigate the above challenges (Bakkabulindi, Sendegeya, and Lugujjo, 2012).

It is noted that grid electricity generation is cheaper than off-grid generation. However, it is expensive to extend it to some locations with isolated consumption. It becomes a question of whether or not to extend the grid or install off-grid solutions. The decision to use either off-grids or connect to the grid is different for all villages as their distance to the grid and consumption differ (Bjergegaard, 2015).

The Rural Electrification Strategy and Plan (RESP) (MEMD, 2013), covering the period 2013 to 2022, builds on the previous iteration of the RESP (2001-2010), which identified the promotion of renewable energy as one of the most important objectives of the strategy. The strategy listed investment in small distributed power generation facilities as one of its key objectives aimed at enhancing access to electricity by the poor households in rural communities.

Under circumstances where the central grid cannot sufficiently meet the power demand of the rural service providers, special rules and regulations will be provided concerning licensing power projects and wholesale power contracting to allow rural electric service providers to purchase directly from such facilities or to engage directly in small-scale power investment for their own consumption needs (MEMD, 2013).

3.5. Financial Analysis

Chukwunweike (2014) submits that financial analysis mainly assists in establishing the strengths and weaknesses of an enterprise, while monitoring cash flow of the enterprise. However, Chukwunweike (2014) defines financial analysis as the collection and refining of financial information to be presented in a summary format that can be used for decision-making.

Verryn (2014), citing Von Stauffenberg et al. (2014), reports that return on equity (ROE) and return on assets (ROA) are both profitability measures that summarise the performance of the company as a whole. Thus, if asset quality is poor or efficiency is low, it will be exposed in these measures.

Financial leverage could be used in a number of ways, including the following:

- To improve liquidity as well as profits from project development; and

- To ensure low equity risk and provide some level of support to marginally economic projects.

Bobinaite (2015) reports that companies having high leverage may indicate a likelihood to become bankrupt. In general, investors would prefer a higher ROE to a lower one and a stable ROE to a volatile one, but it is also important to pay attention to the way a company's business model, operations and financial decisions can impact ROE (Velázquez and Smith, 2013).

Brümmer and Hall (2016) observe that, generally, a strategy to reduce investment in inventory and trade receivables, at the same time increasing trade payables, improves the profitability of firms. Further, of all the variables that were looked at, management of inventory had the strongest statistically significant impact on a firm's profitability. Advanced inventory management systems were, therefore, recommended to optimise inventory levels and enhance profitability.

In a review of the relationship between working capital and profitability of firms, Deloof (2003) shows that there is a significant negative relationship between gross operating income and the number of days accounts receivable, inventories and accounts payable. It would, therefore, be important that the number of days accounts receivable and inventories are reduced to a reasonable minimum. This finding is in line with the view that less profitable firms wait longer to pay their bills.

Deloof's (2003) study indicates that an assessment of the working capital would be based on the firm's liquidity proficiency level. The efficiency of a firm can be measured by analyzing the cash flow of the business, particularly looking at the cash conversion cycle (CCC). In his study, Deloof defines CCC as a measure of the length of time that working capital is tied up in a firm's operations, which include components, namely trade receivables, inventories and trade payables.

Saluja and Kumar (2012:83) in their study concluded that "management of liquidity and profitability has become a crucial issue in today's cut-throat competition. If the firm decreases its liquidity the profitability would be high. The results showed that there is a negative relationship between profitability and liquidity. So it is essential for every firm to maintain equilibrium between profitability and liquidity".

Chukwunweike (2014) and Panwala (2009) observe that the main indicators that can be used to assess the performance of a business are liquidity and profitability. Particularly, the liquidity ratio determines the capacity of a business to meet its short-term obligations. On the other hand, the profitability ratio shows the efficiency of the company to utilise the resources of the company. Chukwunweike (2014) further recommends that a very high liquidity position of companies should not be pursued in the place of profitability but instead a balance should be struck between liquidity and the pursuit of profit.

3.6. Financial Sustainability

Sponsorship to charity organisations may provide additional funding. However, the impact on organisational flexibility and long-term sustainability remains important. This phenomenon is important for all charity organisations even though the study was focused on sports organisation (Bingham and Walters, 2017).

In a study of financial sustainability conducted in Australia by the Local Government Association (2012), financial performance mainly focused on analysis of the financial position of the company. This was done through the financial analysis mainly looking at the financial performance, the financial position and asset management of the businesses.

3.7. Financial Performance of Mini-grids

There is a low diffusion rate of Mini-grids in developing countries owing to several factors, such as low income levels which affect technology affordability, regulations that hamper entrepreneurship and low institutional stability that increases investment risks. Blum et al. (2015) add that system costs of Mini-grids are high owing to unfavourable national investment climates with high regulatory uncertainty and corruption. These are some of the reasons why international investors often avoid investing in Mini-grids.

According to Payen, Bordeleau and Young (2016), grant funding can lead to the financial sustainability of Mini-grids. The authors further note that, owing to lack of feedback on an appropriate and socially accepted tariff structure, the revenue streams of Mini-grids are usually quite low and insufficient to cover curative maintenance costs. They conclude that load factor optimisation is the key success factor in reaching financial sustainability. This requires matching supply with demand from the initial design to the day-to-day operations.

Mini-grid financial profitability can be increased by selling more of the electricity produced to strengthen their revenues, and through decreasing costs through clustering Mini-grids (Payen et al., 2016). In addition, private Mini-grid owners can raise funds to sustain the grids through obtaining development bank loans and mobilising finances from various donor agencies (Debajit Palit, 2014).

Mini-grids need a lot of financial support as the transaction cost of projects in remote areas is high and economies of scale are few. Governments should ensure Mini-grid the financial sustainability of Mini-grids through tariff and support systems (Bhattacharyya and Palit, 2016).

Deshmukh et al., (2013) as well as Colin and Rogers (2010) note that the challenges to the long-term sustainability of Mini-grids are, for example, high upfront capital costs, low capacity factors, often higher residential tariffs compared to central grid consumers, insufficient financing support and investment and technological failure. Well-designed policies alongside effective financing mechanisms will address the above challenges and enable the sustainable development of Mini-grids.

Mini-grids located in rural areas are vulnerable to energy losses due to theft of power and equipment. High electricity tariffs, coupled with people's unwillingness to pay, lead to low revenues, affecting the financial sustainability of the Mini-grids. Capital subsidies lower the cost of energy, thus enabling the systems to push to financial sustainability (Kimera, Okou and Sebitosi, 2014).

If capital subsidies and annual subsidies are awarded to off-grid projects, private investors will be quick to invest in these projects (Niraula, 2015). It was further contended that reducing operating expenses by aggregating projects can also boost the revenue of Mini-grids.

Access to a grid connection does not guarantee the use of electricity for all end users, in particular by poor households. Experience with increased access to electricity has shown that consumption levels in newly connected households remain lower than expected for some time. Affordability to enable greater use of electricity requires specific policy interventions (Winkler et al., 2011; Heinonen & Junnila, 2014).

Palit and Sarangi (2014) state that access to finance for scaling up Mini-grids is a major problem, as most of them operate in remote areas and so access to credit from formal financial institutions is limited. Financing of the capital costs in community-managed projects is also hard owing to the low power affordability of the communities. In addition, the small capacity of projects makes it hard for the developers to attract loans from commercial banks. In order to find an affordable solution to Mini-grids, it is critical to present the costs and benefits with all metrics, including capital cost, ongoing fuel costs, risk of future fuel price volatility, the internal rate of return, carbon mitigation benefits and savings relative to the current baseline (Casillas and Kammen, 2011).

Building sustainable financing structures for Mini-grids can be challenging. An example is establishing realistic tariffs for consumers despite the potential equity implications. Mini-grids in many countries are also publicly financed through grants or subsidies in order to cover upfront capital costs and sometimes ongoing costs but these can prevent the development of sustainable local electricity markets if they are not carefully designed. Peskett (2011) adds that investment barriers are created by complicated or outdated energy regulations. All these factors impact on the financial sustainability of Mini-grids.

Rural electrification is expensive and many Mini-grids serving rural areas experience a gap between their costs and revenues. These gaps may arise from regulations that prohibit them from charging tariffs that cover the costs (Tenenbaum, 2014). According to Facility (2016), financial sustainability of off-grid Mini-grids is a challenge as the rural beneficiaries have low incomes. This key challenge includes finding the best operator model to overcome the barriers.

The failure of Mini-grids in the planning phase is usually caused by political conditions and financing problems (Gaudchau, Gerlach, Wasgindt and Breyer, 2013). The high electricity tariffs can increase the already high investment costs, hence exacerbating to the financing problems. The availability of credit is poor because of high transaction costs, excessive financial payback periods, political instability, currency risks and lack of confidence in project development among banks.

The ability of households to pay for improved energy services in rural areas is a major challenge. This is because the population is predominantly engaged in agriculture and allied activities and the income streams are often seasonal and not steady throughout the year. Most of the population depending on subsistence-level agriculture or other activities can barely meet the capital expenses of an electrification project, leave alone the cost of operation, maintenance and repair (Barnes, 2005; World Bank, 2008; Torero, 2014).

Lyndon (2013) argues that, in order for Mini-grids to achieve long-term financial viability, Mini-grid they should be able to bring together public and private finance to single points of activity. This should be on a scale that reduces transactional costs. Furthermore, the grids should have the ability to optimise supply chains, the capability to manage operation and maintenance costs and the capacity to aggregate consumers at a level that can significantly reduce supply administration costs.

In a study conducted by the Renewable Energy Cooperative Programme (2009) on the Kisizi Hospital grid, a small grid in western Uganda, it was observed that the sustainability of a privately owned and operated Mini-grid can be influenced by its role in the host community.

During earlier stages, when new customers were being connected, some people in the community were unwilling to pay full connection fees and chose instead to either go without power or to buy it on resale from their neighbours. In some cases, the company had to adjust to more lenient policies, such as the provision of free electricity to hospital staff. This was, however, found to be depleting the Kisizi system resources and a reversal of the policy had to be made.

As Uganda has urgent need to bring electricity to those who do not have it, it becomes important to choose the right way of electrification, both regarding technology and costs (Kimera, 2014).

Ezor (2009) reports that since the enactment of the Electricity Act of Uganda in 1999, problems with power theft, insufficient supply, geographical isolation and high infrastructure costs have inhibited rural communities from gaining access to electricity. However, according to a study by ERA (2011), energy losses were observed to be on a downward trend and were expected to reduce further if investments were made in the distribution network.

According to the Ministry of Energy and Mineral Development (MEMD, 2007), Uganda's Renewable Energy Policy of 2007 specifically mentions the following key issues:

i) Small renewable energy power investment;
ii) Accessibility of power to rural populations through Mini-grids and embedded supply;
iii) Minimising the risk of overdependence on one source of generation;
iv) Rising cost of emergency power; and

v) Inadequate legal and institutional frameworks.

3.8. Conclusions

The literature on Mini-grids that was reviewed focused on access to energy and implementation alongside Mini-grids, with limited highlights on the financing and efficiency of the Mini-grids. In the researcher's quest no literature was found that relates to the sustainability of Mini-grids in Uganda. This study, therefore, aims at assessing the financial sustainability of electricity Mini-grids in Uganda using the audited financial reports of selected Mini-grids. In order to support the study, literature on financial ratios was reviewed that highlighted the use of profitability, efficiency ratios, leverage and liquidity ratios as key to the analysis of the company's financial performance. This review, therefore, formed the basis for the development of the research methodology.

Chapter Four discusses the methodology of the research, the data selection for the study and the tools of analysis.

CHAPTER FOUR

METHODOLOGY

4. Introduction

This chapter outlines the methodology employed in this study. The financing and sustainability aspects of Mini-grids have been examined by a number of studies whose outcome is true in some of the developing countries. This chapter provides the analytical methods and variables used as well as their sources of data to examine the extent to which this effect holds for Uganda.

4.1. Data Collection

The data was obtained from financial reports of companies that are already in operation and are licensed by ERA to develop, own and operate electricity distribution facilities in Uganda. Particularly, the financial statements included two important components, i.e. balance sheet and income statements.

Whereas it was ideal to conduct an analysis of all the Mini-grids in Uganda, it was not possible to acquire the audited financial reports of all the eight Mini-grids. Out of the all the Mini-grids, only four were purposively selected to represent the sub-categories as shown in **Table 2**. The data was collected from the ERA resource centre covering the period 2010 to 2015.

Table 2: Characteristics of Mini-grids under analysis

Name of Mini-grid	Characteristics
WENRECO	• Generates its own power • Operated by a limited liability company
BECS	• Buys power from third party • Operated by community cooperative society
KIL	• Buys power from third party • Operated by a limited liability company
FESL	• Buys power from third party • Operates more than one concession area • Operated as a limited liability company

The financial data received was used as inputs in the computations of financial ratios, which disclosed the financial sustainability of companies. The time period covered by the research is 2010–2015. This is because it was the most recent information that was available.

4.2. Data Analysis

Ratio analysis of financial statements was used as the method for assessing financial sustainability of Mini-grids (Bobinaite, 2015; Bridleand Wooders, 2014). The approach of using ratio analysis allows for comparison of company performance and can be used to derive conclusions about the performance of a company. This study placed emphasis on financial leverage, liquidity, profitability and efficiency ratios, as described in **Table 3.**

4.2.1. Profitability ratios

Profitability is key to the survival and success of a company. It refers to the company's ability to generate earnings as compared to its expenses during a specific period of time and, thus, to earn profit. It shows the efficiency of a performed activity. Positive profitability is an indication of the sustainability of the firm. Negative profitability, on the other hand, is an indication of the challenges of the business and the possibility of failure.

4.2.2. Financial leverage

Financial leverage is the degree to which a business is using borrowed funds. It is the loss expectation resulting from inability to repay loans. The higher the leverage, the more the credit risk to the company.

4.2.3. Liquidity ratios

Liquidity ratios can be derived from the balance sheet to establish how much the company earned in a day. The current ratio can show the relationship of working capital for all the current assets in order to meet the current obligations of the company. The liquidity ratios generally reflect the short-term sustainability of the business.

4.2.4. Productivity ratios

The efficiency ratios are used to determine whether the management of a company has been efficient in its operations by making revenue and generating cash. The ratios reflect the relative efficiency of a company in utilising the asset.

Table 3: Key financial ratios for the analysis

No.	Ratio	Formula	Interpretation
		Profitability Ratios	
1	Profit Margin	Net Profit/Total Sales	This ratio computes the profitability of the business in relation to sales.
2	Return on Equity (ROE)	$\frac{Net\ Profit}{Average\ Total\ Investment}$	This can be used to show how the shareholders' funds have been utilised by the firm.
3	Return on Assets (ROA)	$\frac{Net\ Profit}{Average\ Total\ Assets}$	It shows how well the business utilises the assets of the firm to make profits. The higher the ratio, the more efficient the business is in utilising the assets to make profit.
4	Earnings per Share (EPS)	$\frac{Net\ Profit}{Average\ Outstanding\ Commo}$	This is used to compute the profit available for the equity per share.
		Efficiency Ratios	
5	Operating Self-Sufficiency	$\frac{Operating\ Revenue}{Operating\ Expenses}$	The operating ratio shows the operational efficiency of the business. A low operating ratio implies that the operating profit is high.
6	Defensive Interval Days	$\frac{Current\ Assets - Inve}{(Op.Exp - Other\ Op.exp - De}$	Number of days a company can operate without any cash returns while meeting its basic operational cost.
		Leverage	
7	Gearing Ratio and Debt Ratio	$\frac{Total\ Liability}{\text{Total Assets}}$	This ratio shows the Proportions of debt and equity in the assets of a firm.
8	Interest Cover	$\frac{Earnings\ Before\ Interest\ and}{\text{Interest Expenses}}$	It measures how easily a company can pay interest on outstanding debts.
		Liquidity	
9	Current Ratio	$\frac{Total\ Current\ Assets}{Total\ Current\ Liabilities}$	It measures the short-term liquidity of a firm. A firm with a higher ratio has better liquidity.
10	Receivable Turnover	$\frac{Sales}{Accounts\ Payables}$	This ratio measures how fast debts are collected. If the ratio is high, it implies that there is a short period between credit sales and the collection of cash.
11	Accounts Payable Payment Period	$\frac{Accounts\ Payables\ X\ No.of\ W}{Net\ Credit\ Purchas}$	A high ratio shows that accounts are settled fast.

Source: Bridle and Wooders (2014); Verryn (2014); Bobinaite, (2015)

4.3. Conclusion

This chapter highlighted the data source with particular focus on four Mini-grids, i.e. WENRECO, BECS, KIL and FESL. The analysis of the study is by ratio analysis using audited financial statements of the respective Mini-grids from 2010 to 2015.

Chapter Five presents the study findings to meet the objectives of the study.

CHAPTER FIVE

DATA ANALYSIS, FINDINGS AND DISCUSSION

5. Introduction

This section presents the results of the analysis undertaken and the discussion thereof. Both the background information and the statistics from the case studies were analysed in this section. The chapter provides the basis on which conclusions and recommendations of the study are formulated.

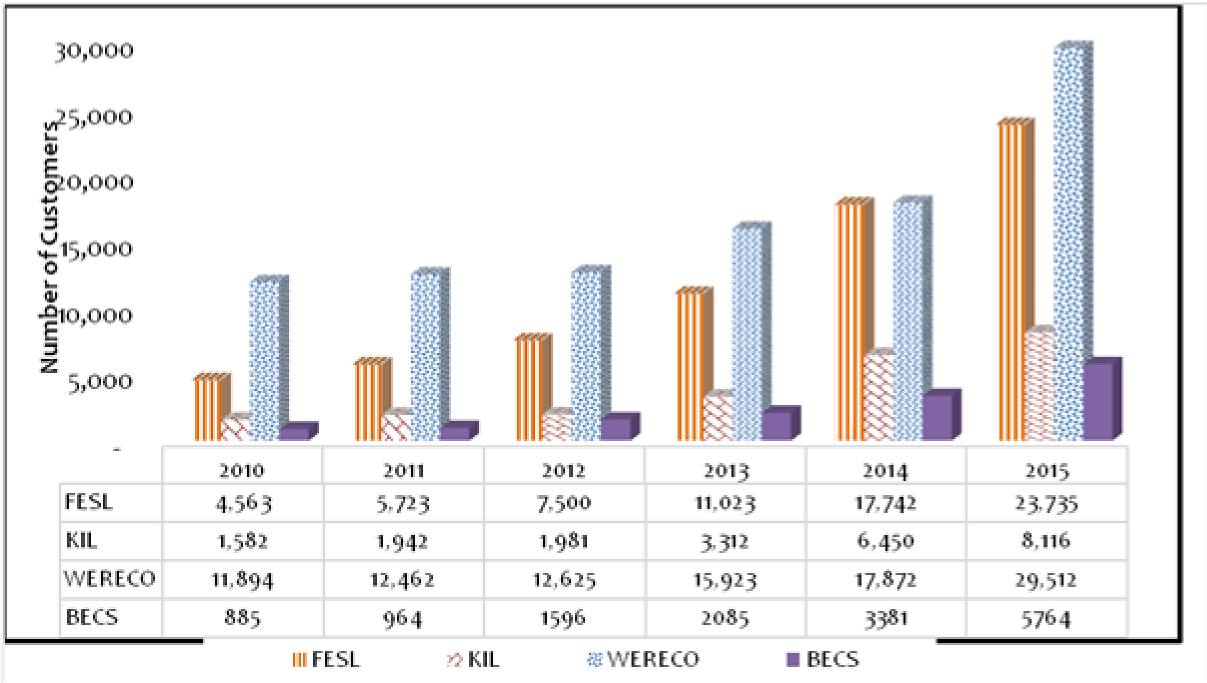
5.1. Descriptive Statistics of Mini-grids

The general characteristics of the Mini-grids under review are presented in the following sub-sections. The sub-sections discuss the number of customers, the trend of energy sales and the energy losses (revenue linkage) by the respective companies as a precursor to the analysis of statements.

5.2. Customer Numbers

The trend of customers is shown in **Figure 5.** On average, the number of customers in the Mini-grids more than tripled from 2010 to 2015. BECS registered the highest rate of growth in customers, who increased from 885 to 5,764 over the five-year period. This translates into a compound average growth rate of 37% per year. On the other hand, WENRECO had the lowest increase in customers, from 11,894 in 2010 to 29,512 by 2015. This represents a compound annual growth rate of 16% over the five-year period. Generally, all Mini-grids at least doubled their customer numbers. This indicates the level of demand for electricity in the rural areas that previously did not have access to electricity, which indicates growth in the business.

Figure 5: Number of customers per Mini-grid 2010-2015



Source: ERA

5.3. Energy Sales by the Respective Mini-grids

Year	Energy Sales (MWh)				Electricity Consumption (kWh) per Customer			
	FESL	**KIL**	**WENRECO**	**BECS**	**FESL**	**KIL**	**WENRECO**	**BECS**
2010	2,596	1,649	4,662	-	569	1,042	392	-
2011	3,580	1,785	3,266	749	626	919	262	777
2012	5,716	2,433	3,263	1,160	762	1,228	258	727
2013	8,131	2,886	6,750	1,405	738	871	424	674
2014	10,754	3,280	6,972	1,565	606	509	390	463
2015	17,646	4,581	8,576	1,712	743	564	291	297
Compound Annual Growth Rate (CAGR)	**38%**	**19%**	**11%**	**18%**				

shows the energy sales by the respective Mini-grids from 2010 to 2015. The total energy sale is observed to increase in all the Mini-grids in the entire period of study. FESL registered the highest compound average growth rate in sales of 38%. This means that the Mini-grid was increasing in sales of energy by up to 38% per year. Part of this growth rate may be attributed to the additional distribution that the company took over in 2011.

WENRECO reported the lowest compound annual growth rate (CAGR) in energy sales of 11% per year. It can be noted, however, that the company before 2013 was only distributing electricity using a diesel generation plant alone. This was observed to have constrained the increase in energy sales until WENRECO acquired a 3.5 MW hydro plant in 2013. A spike in sales by WENRECO is, therefore, noted in 2013 following the commissioning of the Nyagak III hydro plant. This may be a response from some constrained demand that was existing in the system.

The average consumption of electricity is observed to generally be reducing for all the Mini-grids from 2010 to 2015. This can be explained by the additional connection of the much poorer customers in the rural areas. As such, the demand from the marginal consumption per additional customer brings down the overall average.

Table 4: Energy sales and average consumption per customer per Mini-grid

Year	**Energy Sales (MWh)**				**Electricity Consumption (kWh) per Customer**			
	FESL	**KIL**	**WENRECO**	**BECS**	**FESL**	**KIL**	**WENRECO**	**BECS**
2010	2,596	1,649	4,662	-	569	1,042	392	-
2011	3,580	1,785	3,266	749	626	919	262	777
2012	5,716	2,433	3,263	1,160	762	1,228	258	727
2013	8,131	2,886	6,750	1,405	738	871	424	674
2014	10,754	3,280	6,972	1,565	606	509	390	463
2015	17,646	4,581	8,576	1,712	743	564	291	297
Compound Annual Growth Rate (CAGR)	**38%**	**19%**	**11%**	**18%**				

Source: ERA, 2016

5.4. Trend of Energy Losses in the Mini-grids

Loss of energy has a significant impact on the financial sustainability of Mini-grids. This is because the Mini-grid will incur costs of production as well as operation and maintenance yet will not realise the corresponding sales revenue.

It should be noted that WENRECO did not report their energy losses since they are responsible for generating the energy and supplying it to the final consumer. This is different from the rest of the Mini-grids under review which purchase power from a third party. As such, the energy losses are internalised through generation.

In the period under review, FESL had the highest energy losses that range between 23% and 40%, as reported during the period 2010 to 2015. KIL also registered very high losses in energy in 2011 and 2012, with losses as high as 60%. However, this was significantly improved from 2013 to 2015, as shown in **Table 5**. It should be noted that WENRCO did not report their energy losses because they operate the entire value chain from generation to the final supply, so the energy losses were internalised.

BECS and FESL are noted to have registered a steady increase in energy losses from 2013 to 2015. This may be as a result of poor network maintenance, power theft or other inefficiencies that need to be addressed. It is, therefore, expected that this effect filters through the financial statements of these companies.

Table 5: Energy losses by Mini-grids

Mini-grid	2010	2011	2012	2013	2014	2015
Kilembe Investments	19%	43%	61%	10%	11%	9%
FESL	25%	23%	26%	21%	43%	29%
BECS		14%	17%	19%	19%	20%

Source: ERA

** Energy losses for WENRECO were not reported because the company undertakes generation and supply on its own without involving a third party.

5.5. Analysis of Financial Performance

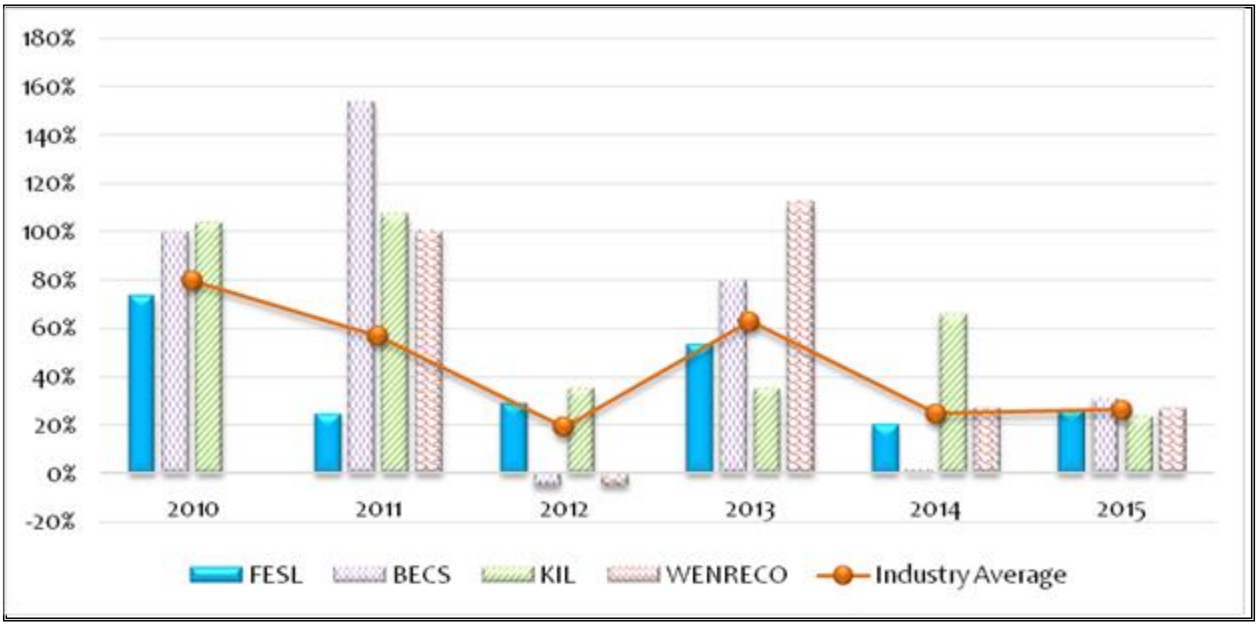
This section presents the analysis of financial performance of the respective Mini-grids using the tools discussed in Chapter Four of this report.

5.5.1. Revenue growth

The trend of growth in sales revenue is shown in **Figure 6**, with BECS recording growth of 61% in 2012. This performance was above the industrial compounded average growth rate of 37.7% over the five-year period. The growth in revenue was partly attributed to the growth in customer numbers and in energy sales. However, during the same period, the growth in energy sales was not reflected in the companies' profitability attributed to increased DOMC and high reported energy losses.

Whereas the growth in sales revenue was registered as high, the earlier operation and maintenance analysis showed a much higher growth rate among Mini-grids. This indicates that the expenditure outstripped sales revenue, thus negatively affecting the profitability of the Mini-grids. This, therefore, requires Mini-grids to either increase the unit prices of electricity or find alternative financing, such as grant financing, to keep pace with the operational expenditures.

Figure 6: Trend of growth in sales revenue



Source: ERA

5.6. Profitability Ratios

These ratios show a company's ability to generate profits from its operations, and show the overall efficiency of the company's performance. As noted in the above review of the operation and maintenance costs, the Mini-grids incur more costs than the revenue that they generate and thus end up making losses, as discussed in the succeeding sections.

5.6.1. Profit margin

The net profit margin presents the ability of a company to generate earning after tax to the equity holders. As such, a review of this ratio looks at the ability of the Mini-grid operating companies to report profit to the shareholders. From the review, it was noted that the industrial net profit margin of the Mini-grids was a -8%, which was brought about by higher operating expenses compared to the incomes generated, with the exception of 2015 from the negative net profit margin positions. This implies the inability of the Mini-grid operating companies to raise returns to the shareholders and, as such, limit additional capital inclusion in the sector owing to negative returns on equity, as explained below.

5.6.2. Return on equity (ROE)

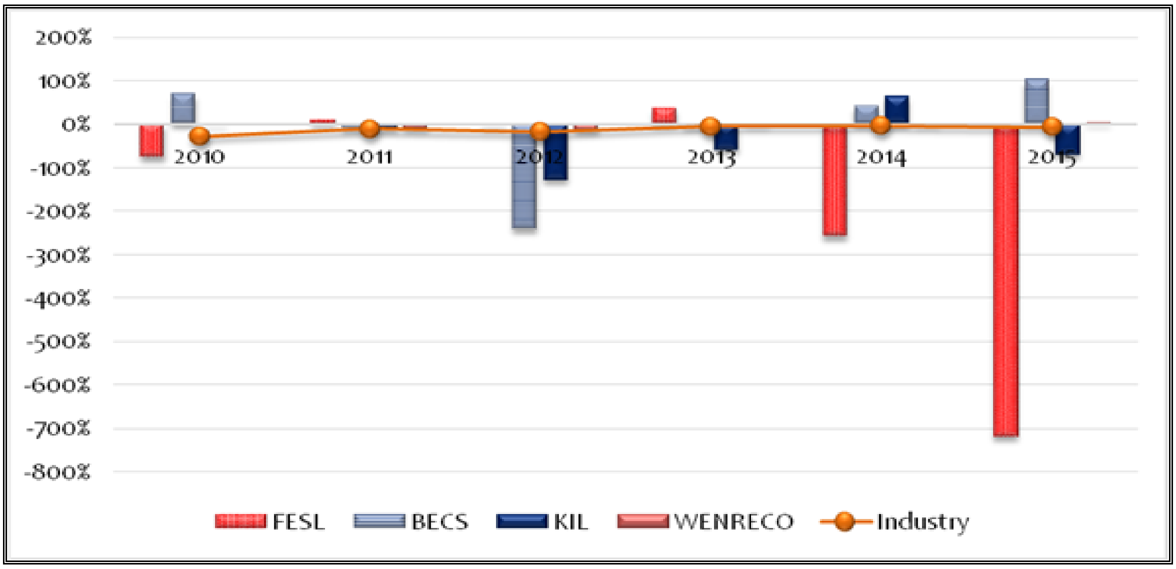
The return on equity (ROE) is often used to estimate the profitability of a corporation by revealing the amount of profit generated by a company with the capital that has been injected by the shareholders. It is one of the most important ratios to investors, and is computed as shown below:

Net Profit divided by Average Equity = ROE

As shown in the figure below, the Mini-grids have been posting negative return on equity since 2010, with returns on equity of some Mini-grids, such as FESL, deteriorating from -78% in 2010 to -700% in 2015, compared to an improving industrial average of -7% in 2015 in contrast to -26% in 2010. This performance points to an underlying trend of the companies' inefficient operation and, as such, continued inability of the companies to attract external funding from investors owing to negative returns.

Further analysis was undertaken that looked at the financial statements of FESL for the years 2014 and 2015 when the ROE was -200% and -700% respectively. FESL increased its expenses on other operating activities from UGX 92.2 million in 2013 to UGX 369.7 million in 2014. This represents an increase of these costs by over threefold in just one year. An additional breakdown of this item could not be accessed to appreciate its rationale. In a similar way, the company in 2015, increased staff administrative costs by 130% compared to 2014. This was in addition to the company drawing down their equity by about 75%. As a result of this transaction, the company's financial position worsened to extremely unsustainable levels in 2014 and 2015. This cast doubt on the going concern of the Mini-grid.

Figure 7: The return on equity of different Mini-grid operators 2010 to 2015



Source: ERA Report, 2016

A less fragile status of the ROE is portrayed by both KIL and BECS. Although the ROE is in some cases negative, there is a glimpse of positive returns in some years when both KIL and BECS posted positive ROE. The most promising company measured by ROE is BECS, which posted positive ROE, especially in 2014 and 2015. From the review, therefore, it is worth noting that the Mini-grid companies cannot raise additional capital in the form of equity owing to their loss-making positions, as discussed above. The same trend is reflected on the return on assets (ROA), as discussed in the next section.

5.6.3. Return on assets (ROA)

This ratio measures the efficiency with which the company is managing its investment in assets and using them to generate profit. It measures the amount of profit earned relative to the firm's level of investment in total assets. According to the review (**Error! Reference source not found.**), most of the Mini-grids posted negative return on assets (ROA), especially between 2011 and 2013. This low return may be due to the fact that the Mini-grids had just started their operations. There is, however, some improvement in the return, though still negative, on assets for most of the companies in 2014 and 2015.

The negative ROE by most Mini-grids points to inefficient utilisation of the companies' assets. There is, however, a notable sign of recovery by the Mini-grids in 2015 as shown in **Table 10,** with only FESL continuing to show poor performance over time. The negative ROA is attributed to the negative net profit margins reported by the company due to higher operating costs compared to the incomes generated. For the trend to improve, there is need for the companies to invest the assets effectively to ensure increased sales and maintain costs so as to have a positive return on the assets.

Table 6: Return on assets for Mini-grids 2010-2015

YEAR	FESL	BECS	KIL	WENRECO	Industry Average
2010	-23%	16%	0%	**	-2%
2011	2%	-3%	0%	-5%	-4%
2012	-2%	-66%	-4%	-7%	-7%
2013	3%	-19%	-1%	-2%	-2%
2014	-18%	3%	1%	0%	-1%
2015	-40%	5%	-2%	1%	-2%

Source: ERA, 2016

** Not reported

5.6.4. Earnings per share (EPS)

Earnings per share are the amount of net profit for the period that is attributable to each ordinary share which is outstanding during all or part of the period.

None of the four mini-grids in the period from 2010 to 2015 declared any dividend to be shared among the shareholders. On the contrary UMEME, a company in the same industry, declared dividends in 2014, which increased its price per share. For that matter, the EPS of the Mini-grids stands at nil. This does not give the shareholders or any prospective investors the confidence to invest more in the Mini-grids which, in the long run, will scramble the capital structure of the Mini-grids.

The non-declaration of dividends by the Mini-grids is also due to nil dividend cover available to the Mini-grids owing to their loss-making nature, as discussed above.

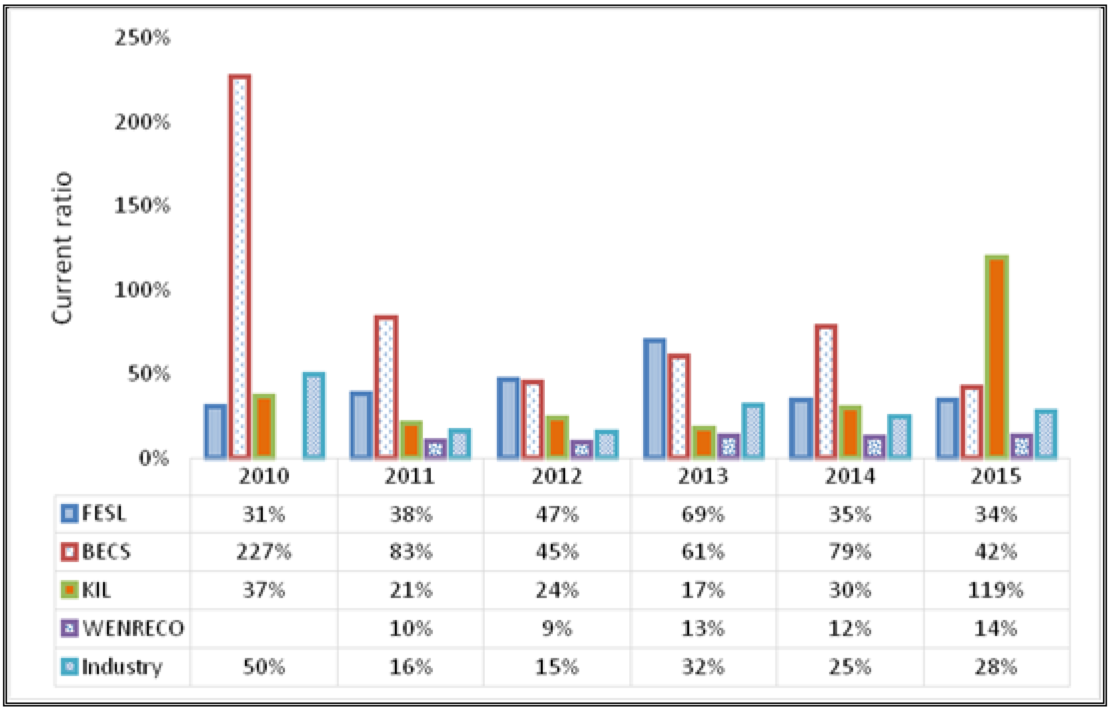
5.7. Liquidity Ratio

Liquidity is the amount of cash a company can use to settle its debts (and possibly to meet other unforeseen demands for cash payments, too). The idea behind this is that a company should have enough current assets that give a promise of 'cash to come' to meet its future commitments to pay off its current liabilities. The most commonly used ratio is the current ratio because of it applicability.

5.7.1. Current ratio

The current ratio or the liquidity ratio is used to assess the ability of a company to meet short-term obligations. It is sometimes referred to as the cash ratio. A higher current ratio indicates the higher capability of a company to pay back its debts. A current ratio that is less than one shows that the available short-term assets cannot meet the short-term obligations and, as such, a clear indication of insolvency of the company. The movement of the current ratio for the respective Mini-grids is shown in

Figure 8: Current ratio of Mini-grids



Source: ERA Report, 2016

BECS registered a better current ratio that was more than 50% over the period under review. This implies that all the Mini-grids under study do not have the capacity to meet their short-term liabilities. As such, the short-term financial sustainability of all the Mini-grids is under doubt. For the survival of these Mini-grids, alternative funding should be acquired or revision of the short-term liabilities made to align them with the assets.

5.7.2. Receivable turnover

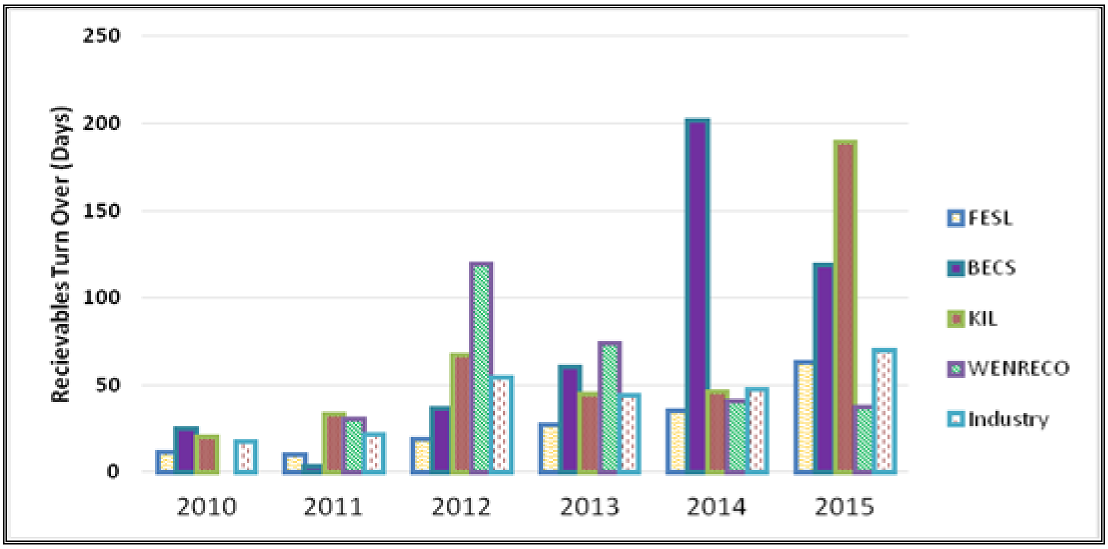
The receivable turnover ratio indicates how many times, on average, account receivables are collected during a year (sales divided by the average of accounts receivables). A popular variant of the receivables turnover ratio is to convert it into an average collection period in terms of days. The average collection period (also called days sales outstanding (DSO)) is the number of days, on average, that it takes a company to collect its accounts receivables, i.e. the average number of days required to convert receivables into cash. Receivable turnover is an accounting measure used to quantify a firm's effectiveness in extending credit as well as collecting debts as computed.

There is no general norm for the receivables turnover ratio because it strongly depends on the industry and other factors. The lower the receivable outstanding days the more efficient is the management of debtors or more liquid the debtors are and the better the company is in terms of collecting their accounts receivables. Similarly, higher debtor outstanding days imply inefficient management of debtors or less liquid debtors. However, in some cases too few debtor outstanding days can indicate that the company's credit lending policies are too stringent, preventing prime borrowing candidates from becoming customers.

There is a general increase in receivable turnover, as shown in the average industry days. On average, the number of days were observed to have increased from 18 in 2010 to 70 in 2015. This was an indication of deteriorating collection by the credit sections of the companies, with receivable collections increasing from 18 days to 70 days. This has an impact on the availability of cash for the companies to make payments on other commitments as shown in **Figure 9**. BECS, WENRECO and KIL registered the highest receivable outstanding days among the four mini-grids, reporting over 100 days compared to the industry 70 days. There is, therefore, need to improve on the receivable outstanding days if the Mini-grids are to meet their current obligations. The delayed payments by the receivables may be due to the customers connected to post-paid services where they would take long to effect payment. The many receivables outstanding days partly explains the poor current ratio discussed earlier in **Figure 8**.

On the other hand, FESL had less than a month of receivables turnover, an indication of good receivables management. There is, therefore, urgent need for the management of the Mini-grids to review their receivables policy in order to align payment obligations.

Figure 10: Receivable turnover



Source: ERA, 2016

5.7.3. Accounts payable payment period

During the period under review, WENRECO registered the highest trade payable days among the Mini-grids, rising from 281 days in 2010 to 1,109 in 2015, as shown in **Error! Reference source not found.**. This is in comparison to the industrial average number of days of 390 from 210 days in 2010. The high payable outstanding days is one of the factors in the low current ratio observed. This makes it difficult for them to meet their short-term obligation of paying suppliers. This can be an indication of failure by the Mini-grids. The high number of payable days makes the companies' money available for utilisation on other operating costs. This, however, can lead to risk of loss of credit confidence by the companies involved.

However, it was observed that the Mini-grids would not be able to pay off the outstanding obligation with their outstanding resources, thus the need for external support. This further casts doubt on the going concern of the Mini-grids.

Table 7: Trade payable days

Mini-grid	2010	2011	2012	2013	2014	2015	Percentage Change
WENRECO	281	209	252	942	765	1,109	295%
FESL	224	198	187	437	188	412	84%
BECS	112	8	236	192	318	393	251%
KIL	449	301	406	709	878	356	-21%

Source: **ERA**

5.8. Leverage Ratios

Leverage ratios refer to parameters that measure the ability of the business to meet its long-term debt obligations, such as interest payments on debt, the final principal payment on debt and any other fixed obligations. Long-term debt is defined as obligations to repay with a maturity of more than one year. These ratios have been assessed to ascertain the ability of the companies to raise debt or equity funding when required.

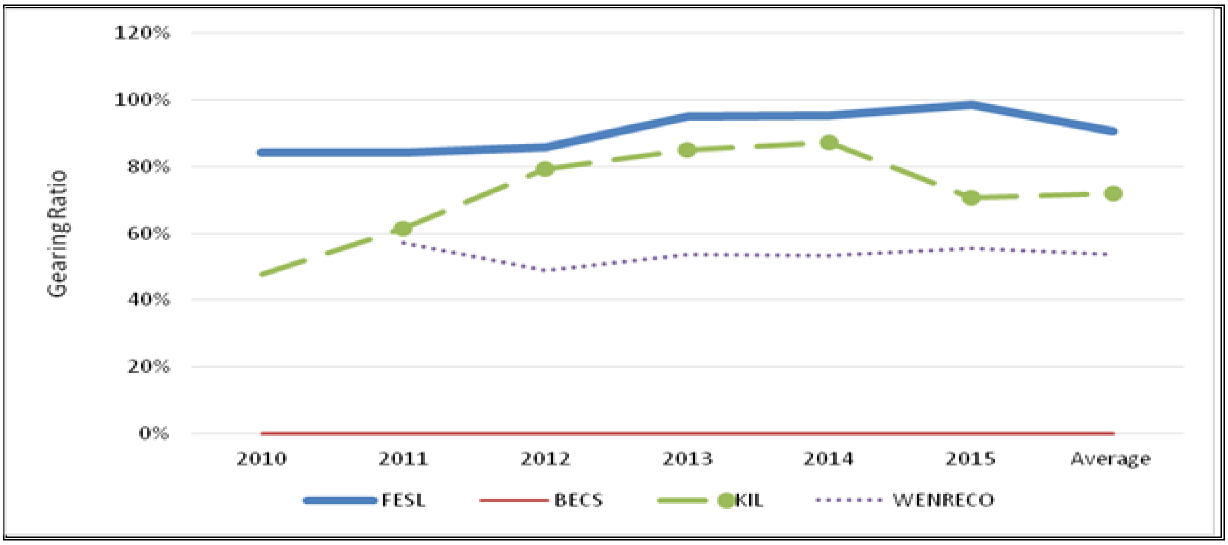
5.8.1. Gearing ratio and debt ratio

Gearing or leverage is concerned with a company's long-term capital structure. There is no absolute guide to the maximum safe debt ratio, but as a very general guide, 50% can be regarded as a safe limit to debt. The more highly geared the company, the greater the risk that little (if anything) will be available to distribute by way of dividend to the ordinary shareholders.

From the review of the operations of the Mini-grid operators, it was noted that BECS is absolutely not employing any debt in its financing structure. On the other hand, KIL, FESL and WENRECO have registered high gearing positions of above 50%, which, in effect, has had adverse negative impacts on the sustainability of the Mini-grids.

Error! Reference source not found. below shows the gearing ratios of the four Mini-grids under analysis. Out of the four, only BECS did not have debt used to finance the company. A significantly high level of debt was reported for KIL, FESL and WENRECO from 2010 to 2015. The highest level of gearing is reported by FESL in 2015, with debt financing being close to 100%. This implies that the shareholders have very little stake in the business. Therefore, the incentive to operate efficiently may be minimal since they have very little to lose in case of failure of the business. This also affects the sustainability of the business as a going concern, given the limited interest of the operators of the Mini-grid.

Figure 11: Gearing ratios for Mini-grids



Source: ERA

5.8.2. Interest cover

The interest cover ratio shows whether a company is earning enough profits before interest and tax to pay its interest costs comfortably, or whether its interest costs are high in relation to the size of its profits, so that a fall in PBIT would then have a significant effect on the profits available for ordinary shareholders.

The review showed that the indebted Mini-grids by 2015 were FESL and WENRECO. BECS did not report any debt over the review period while KIL had debt only until 2013. WENRECO had positive interest cover of 2.4 by 2015, as shown in Error! Reference source not found.. This implies that the company can afford to pay the interest obligation. On the other hand, FESL had -15.35 as interest cover by 2015. This implies that they are not in a position to even pay the obligation relating to interest only, let alone the principal. This would limit their ability to raise additional debt financing for the operations of the business.

Table 8: Interest cover for the Mini-grids

Mini-grid	2010	2011	2012	2013	2014	2015
FESL	-1.93	1.23	0.85	1.90	-6.05	-15.35
BECS	0	0	0	0	0	0
KIL	-1.49	-3.80	-59.25	-33.25	0	0
WENRECO	0	-7.09	-8.81	-0.52	0.75	2.41

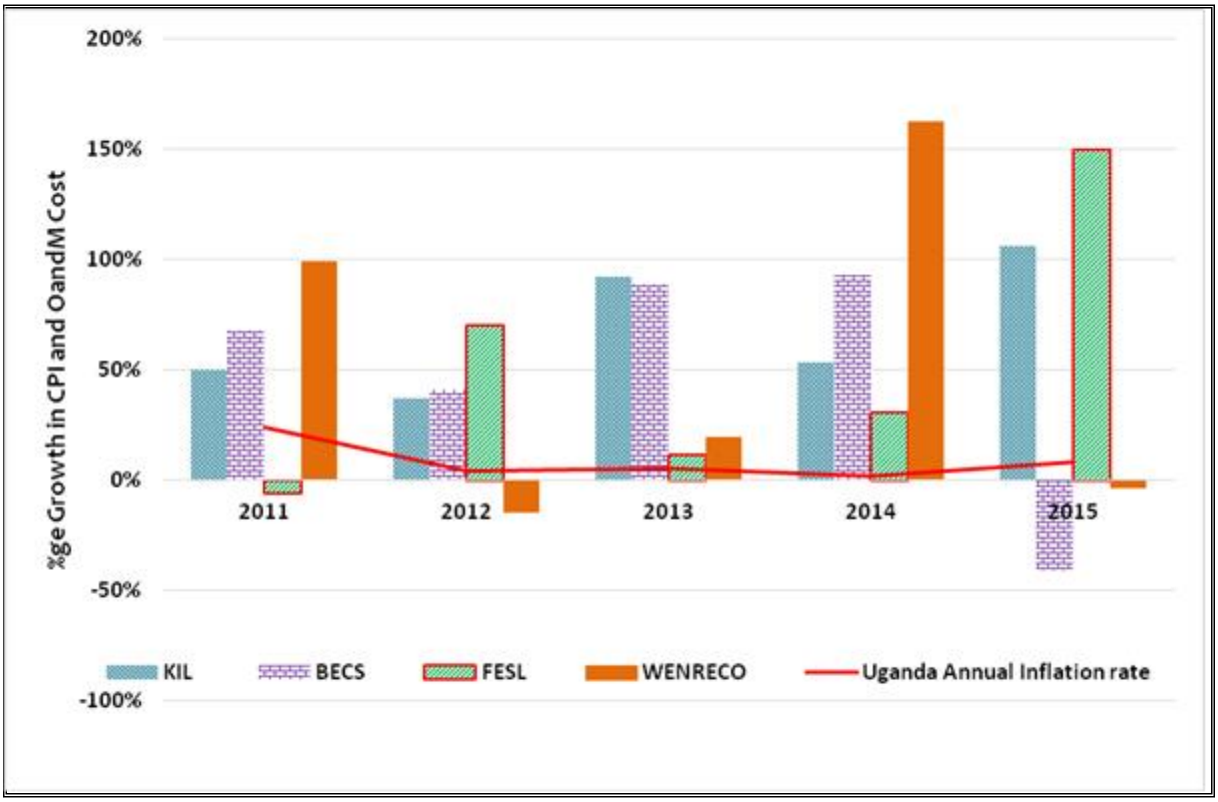
Source: ERA

5.8.3. Operation and maintenance costs (4)

The operation and maintenance costs of the Mini-grids were reviewed from 2010 to 2015 and their trend is shown in **Figure 12**. There was a significant increase in operation and maintenance costs in all the Mini-grids from 2010 to 2015, with considerable increments in operation and maintenance costs being noted in WENRECO and FESL.

The major driver of the operation and maintenance costs are costs related to repairs and maintenance of the networks across the reviewed Mini-grid operators and growth in staff costs attributed to growth in staff numbers. It is, however, noted that the growth in staff numbers led to growth in staff-related costs without corresponding growth in energy sales revenue. This explains the continued loss-making nature of the cooperatives. The growth in operation and maintenance costs is, however, above the reported inflation rates during the same period and an indication of operational inefficiencies, as highlighted in **Figure 12**.

Figure 12: Annual growth in operation and maintenance costs compared to inflation



Source: ERA and UBOS, 2015

5.8.4. Operating self-sufficiency (4)

Given the high operating costs of the Mini-grid, an operating self-sufficiency ratio (a measurement that indicates whether enough revenue has been collected to cover the operational expenses of the company) that falls below 100% implies the inability of the institution to raise enough funds for its own operations.

According to Arunachalam et al. (2016), the ratio measures the sustainability of the company. It also allows the determination of the extent to which operations are becoming self-sustaining. If operational self-sufficiency is not attained, then the equity will keep decreasing by the losses.

As seen in **Table 9**, the operational self-sufficiency ratios for the four Mini-grids were less than 100%, with the exception of WENRECO, between 2014 and 2015. This indicates the inability of the Mini-grids to be operationally sustainable without external reliance on either donated funds or further subsidies. Hence the need for the Mini-grids to explore additional revenue generating streams and/or management their operating costs if they are to be sustainable.

Table 9: Operational self-sufficiency

YEAR	FESL	BECS	KIL	WENRECO
2010	94%	51%	98%	
2011	101%	87%	97%	239%
2012	100%	66%	71%	76%
2013	94%	79%	82%	82%
2014	87%	60%	113%	98%
2015	79%	59%	79%	125%

Source: ERA, 2016

5.8.5. Defensive interval days (3)

Review of the energy revenue growth and operating costs of the company showed that the Mini-grids were all unable to operate on their own without external support. As such, they had to review the number of days the Mini-grids would operate while using their current assets without attracting any external funding. This has been computed through the defensive cover ratio, which gauges the threat of insolvency for investors by calculating the number of days a company can operate without any cash returns while meeting its basic operational costs. Generally, this number should be between 30 and 90 days.

$$Defensive\ Interval\ Days = \frac{Current\ Assets - Inventory}{(Op.Exp - Other\ Op.exp - Dep - Int - Tax)}$$

According to the financial statements reviewed of all the Mini-grids under study, their defensive interval improved from 72 days in 2010 to 109 days in 2015, an indication of improved revenue-generating ability over time to withstand cash needs without selling off the fixed assets. Only BECS whose cash burnout ratio reduced from 118 in 2010 to 82.9 in 2015 indicated the company’s worsening state of operations and signs of possible failure.

CHAPTER SIX

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

6. Introduction

This chapter presents the summary of the findings and the conclusions, and gives recommendations regarding the assessment of the financial sustainability of Mini-grids in Uganda.

6.1. Summary of Findings

This study set out to assess the financial sustainability of Mini-grids in Uganda. It focused on four Mini-grids as case studies: FESL, which operates in more than one concession area; BECS, which is operated by the community as a cooperative; KIL, as a limited liability company; and WENRECO, which operates its own generation unit on an isolated grid. The specific objectives of the study included: assessment of the growth in sales revenue of the respective Mini-grids; examination of the level of profitability of Mini-grids in Uganda; assessment of adequacy of liquidity of the Mini-grids; and examination of efficiency and operational sustainability for each of the companies.

The research objectives were addressed using secondary data. This was conducted by analysing the 2010 to 2015 audited financial statements for the respective Mini-grids and other operational information submitted by the Mini-grids to the regulator, ERA, as discussed in the following section.

6.1.1. Growth in the Mini-grids

A review of the descriptive data was conducted that looked at the total number of customers per Mini-grid. It was noted that all the Mini-grids realised growth in the number of customers of at least 15% per year. The highest growth rate was realised by BECS at 37% and the lowest was by WENRECO at 16% per year. The increase in customer numbers translated into an increase in energy sales. Energy sales, therefore, registered an 11% growth per year as the minimum across all the Mini-grids during the review period.

This growth was noted to be in line with the business growth, given the increase in the number of customers per Mini-grid. There was, however, a notable reduction in the average energy sales per customer in the later years of the study period. This reduction was attributed to the increase in connection of much poorer customers whose average consumption was actually lower than that of the existing consumers on the Mini-grid.

The sales revenue growth was observed to be high, with a compound average growth rate in sales revenue of not less than 15% per year. This increase in sales revenue showed the prospects of growth in the business.

Considering the above overall observations on the business growth of the Mini-grids, it can be concluded that all the Mini-grids exhibited growth in the business operation over the period 2010 to 2015.

6.1.2. Adequacy of liquidity

An analysis of the liquidity indicator showed that FESL and KIL had a poor liquidity position and they were not in a position to finance their short-term financial obligations. The current ratio for both FESL and KIL was observed to generally be less than 50% for the five years rolling. This implies that the companies may collapse any time since they cannot even meet their short-term obligations. Further assessment of the receivables turnover showed that apart from FESL, the rest of the companies could on average collect their sales in around 60 days, which may have contributed to the stifling of the capacity of the Mini-grids to meet short-term obligations. This cast doubt on the short-term financial sustainability of the Mini-grids as observed over the review period.

The gearing ratio of the companies was observed to be significantly high, with FESL operating 90% of the assets financed by debt whereas KIL and WENRECO had debts of 74 % and 54% respectively. The high gearing implies that the shareholders have very little at stake and, therefore, may not have the incentive to operate the businesses. In other words, the risk to them is minimised. This also exposes business to all credit-related risks as well a possible exhaustion of the capacity to acquire more debt financing.

6.1.3. Profitability of the Mini-grids

The analysis established that the industrial net profit margin of the Mini-grids was a -8% brought about by higher operating expenses compared to the incomes generated, with the exception of 2015, from the negative net profit margin positions. This implies the inability of the Mini-grid operating companies to raise returns to the shareholder and, as such, limit additional capital inclusion in the sector owing to negative ROE, as explained below.

A detailed analysis of the financial reports showed that the ROE and ROA were generally negative for the four Mini-grids over the six years. This was mainly due to increasing losses and operation and maintenance costs, which negatively affected the profitability of the business. These parameters, therefore, implied the constrained financial sustainability of the Mini-grid.

6.1.4. Efficiency and operational sustainability of the Mini-grids

The operational self-sufficiency ratio was also computed and by 2014 all the Mini-grids, apart from WENRECO, did not have the capacity to sustain their operations. This was observed with ratios that were less than 100% for BECS, KIL and FESL in 2014 and 2015. The auditors of FESL noted, with concern, in their report that the company had material liabilities that affected the sustainability of the business owing to the very high losses.

In the same vein, it was noted that the growth rate in operation and maintenance costs was increased at a minimum of 39% per annum for all Mini-grids. This implies that the sales revenue could be outstripped by expenses and thus constrain the business. A comparison of the increase in operation and maintenance costs with inflation indicated that the costs were increasing at a far higher rate than the general price level with annual inflation of less than 10%. The high operation and maintenance costs, therefore, had a significant negative impact on the profitability and sustainability of the Mini-grids.

A review of energy losses by the respective Mini-grids showed that high energy losses were experienced and that this negatively affected the sustainability of the Mini-grids because they incurred costs to generate electricity and as well lost sales revenue. KIL experienced the highest energy losses of 61 % in 2012, followed by FESL at 43%. Furthermore, this cast doubt on the financial sustainability of the Mini-grids in the country.

6.2. Conclusions and Recommendations

This study established that although there was growth in the Mini-grids in terms of customers connected and energy sales, the energy losses and operation and maintenance costs were increasing at a much higher rate, thus affecting the profitability of the Mini-grids. Considering the poor liquidity, profitability and operation sufficiency, it can be concluded that the Mini-gridgrids in Uganda are not financially sustainable. It did not matter whether the Mini-grids acquired electricity from a third party or it generated its own power. It also did not matter, either, whether the Mini-grid was owned by the community as a cooperative or a private limited liability company.

It was noted that despite growth in energy sales, customer numbers and revenues of all Mini-grids, the main factors that adversely affected the financial sustainability of Mini-grids were:

- High operation and maintenance costs.
- Poor financial management evidenced by poor working capital management.
- High leverage levels reported above 50% from 2010 to 2015.
- Operational efficiency challenges, including energy losses and imprudent financial management practices, such as poor management of receivables.

Bhattacharyya and Palit (2016) report that Mini-grids need a lot of financial support to ensure their sustainability as there is a high transaction cost of projects in remote areas and only a few economies of scale. This finding was re-echoed by the Mini-grid operators in the interviews.

Despite the fact that Mini-grids are not financially sustainable in Uganda, as established in this study, it is important that these Mini-grids are maintained in order to harness the other benefits that come from them, including socio-economic transformation among the poor. Peskett (2011) and Inversin (2000) observe that the benefits of Mini-grids go beyond lighting. The other benefits are socio-economic in nature, and include support for health services, as well as enhancement of economic activities and the livelihood of the poor in the rural areas. The socio-economic benefits from access to electricity in these rural areas may far outweigh the financial limitations observed. It is, therefore, important that Mini-grids continue to get the necessary support until such a time as they are sustainable.

The GoU should ensure Mini-grid financial sustainability through the maintained support framework in place for the near future until they become self-sustaining. In addition, more efforts should be made to increase industrial and commercial development in the Mini-grid areas to reduce the overall operation and maintenance costs.

6.3. Limitations of the Study

Whereas the auditor’s role with regard to the financial statements is to express an opinion as to whether the financial statements have been prepared in all material respects to give a true and fair view of the company's financial performance and financial position, it is management's responsibility to prepare financial statements that are true and fair. The analysis and conclusion made regarding the financial reports made for the Mini-grids are only as accurate as the presentation made by the management of the respective companies

The other limitation of the study was the small sample of four Mini-grids that were assessed over a relatively short period of only five years. This limitation was, however, mitigated through the use of the survey of the managers and parastatals, which enhanced the information acquired from the financial reports.

6.4. Areas for Further Research

Given the limitations of the current study, future research may focus on the analysis of the internal operation of the Mini-grids to gain further insights into the operation and sustainability of Mini-grids. Further analysis may focus on the operation of the micro-grids that serve not more than 100 customers.

A study should be conducted to establish the optimal size and internal operational parameters that will ensure the sustainability of the Mini-grids. In addition, more studies need to be conducted to establish the amount of government subsidy or external support required per Mini-grid and the time it would prudently take to attain self-sustainability.

REFERENCES

Africa Renewable Energy Cooperation Programme. (2009). *Mini-Grid Policy Toolkit- Case Study Country : UGANDA Project : Kisiizi Hydroelectric Mini-grid Hybrid Operator Model*. Kampala,Uganda.

Arunachalam, M., Chen, C., & Davey, H. (2016). Financial Sustainability of Local Authorities in New Zealand : Performance Analysis and Coping Strategies. *New Zealand Journal Of Applied Business Research*, *14*(1), 19–37.

Bakkabulindi, G., Sendegeya, A., & Lugujjo, E. (2012). *Technical, Economic And Sustainability Considerations of a Solar PV Mini Grid as a Tool for Rural Electrification in Uganda*. *Makerere University*. Kampala,Uganda.

Barnes, D. F. (2011). Effective solutions for rural electrification in developing countries: Lessons from successful programs. *Current Opinion in Environmental Sustainability*, *3*(4), 260–264. https://doi.org/10.1016/j.cosust.2011.06.001

Bazilian, M. E. al. (2010). Measuring Energy Access. *The Earth Institute, Colombia*.

Bhattacharyya, S. C., & Palit, D. (2016). Mini-grid based off-grid electrification to enhance electricity access in developing countries : What policies may be required ? *Energy Policy*, *94*, 166–178. https://doi.org/10.1016/j.enpol.2016.04.010

Bingham, T., & Walters, G. (2017). Social Responsibility Partnerships Linked references are available on JSTOR for this article : DHDE9 Financial Sustainability Within UK Charities : *International Journal of Voluntary and Non-Proft Organisations*, *24*(3), 606–629.

Bjergegaard, R. (2015). *Rural Electrification of Uganda: A Technological and Least Cost Feasibility Study*. Aalborg University.

Blum, N. U., Bening, C. R., & Schmidt, T. S. (2015). An analysis of remote electric mini-grids in Laos using the Technological Innovation Systems approach. *Technological Forecasting & Social Change*, *95*, 218–233. https://doi.org/10.1016/j.techfore.2015.02.002

Bobinaite, V. (2015). Financial sustainability of wind electricity sectors in the Baltic States. *Renewable and Sustainable Energy Reviews*, *47*, 794–815. https://doi.org/10.1016/j.rser.2015.03.088

Bridle, T. C., & Wooders, R. (2014). A Financially Sustainable Power Sector: Developing assessment methodologies. *Internation Institute for Sustainable Development*, (March 2014).

Brümmer, L., & Hall, J. (2016). Working Capital Managment of South African Retail Firms. *Journal of Economic and Financial Sciences*, *9*(July), 545–560.

Casillas, C. E., & Kammen, D. M. (2011). The delivery of low-cost, low-carbon rural energy services. *Energy Policy*, *39*(8), 4520–4528. https://doi.org/10.1016/j.enpol.2011.04.018

Chukwunweike, V. (2014). The Impact of Liquidity on Profitability of Some Selected Companies : The Financial Statement Analysis (FSA) Approach. *Research Journal of Finance and Accounting*, *5*(5), 81–90.

Colin, A., & Rogers, D. E. (2010). Renewable rural electrification : Sustainability assessment of mini-hybrid off-grid technological systems in the African context. *Renewable Energy, 35*(1), 257–265. https://doi.org/10.1016/j.renene.2009.03.028

Crousillat, E., Hamilton, R., & Antmann, P. (2010). Addressing the Electricity Access Gap. *Report From Http://Siteresources.Worldbank.Org/*, (June), 98.

Debajit Palit, G. K. S. (2014). *Renewable energy-based rural electrification:The mini-grid experience from India*. Retrieved from file:///C:/Users/hp/Desktop/Financial suatainability of mini grids/GNESD publication_Mini grids India_web.pdf

Deichmann, U., Meisner, C., Murray, S., & Wheeler, D. (2011). The economics of renewable energy expansion in rural Sub-Saharan Africa. *Energy Policy*, *39*(1), 215–227. https://doi.org/10.1016/j.enpol.2010.09.034

Deloof, M. (2003). Does working capital management affects profitability of Belgian firms? *Journal of Business Finance and Accounting*, *30*(3), 573–587. https://doi.org/10.1111/1468-5957.00008

Deshmukh, R., Carvalho, J. P., & Gambhir, A. (2013). *Sustainable Development of Renewable Energy Mini- - grids for Energy Access : A Framework for Policy Design National Laboratory*.

E.Gaudchau. A.-K Gerlach Ch.Breyer, V. W. (2013). Business Models For Renewable Energy Based Mini-Grids In Non-Electrified Regions. *European Photovoltaic Solar Energy Confrence*. Retrieved from file:///C:/Users/hp/Desktop/Financial suatainability of mini grids/Paper_BusinessModelsForNonElectrifiedRegions28thEUPVSEC.pdf

Electricity Regulatory Authority (ERA). (2011). *Study on Distribution System Losses and Collection Rates By Umeme Ltd*. Kampala,Uganda.

ERA. (2015). *Sector Perfomance Report*. Retrieved from era.or.ug

Ezor, Z. (2009). *Power to the People: Rural Electrification in Uganda*. *School of International Training of uganda*. Retrieved from http://digitalcollections.sit.edu/cgi/viewcontent.cgi?article=1675&context=isp_collection

Facility, T. A. (2016). Off-grid Rural Electrification- Mini-grid Systems. *Sustainable Energy Handbook*, (February), 1–15. Retrieved from file:///C:/Users/hp/Desktop/Financial suatainability of mini grids/fiche_5_3_rural_electrification_off_grid_mini_grid.pdf

Gaudchau, E., Gerlach, A. ., Wasgindt, V., & Breyer, C. (2013). Business Models for Renewable Energy Based Mini Grids in Non-Electrified Regions. In *28th European Photovoltaic Solar Energy Conference, September 30 - October 4, 2013, Paris, France*. Paris,France.

Gollwitzer, L., Ockwell, D., & Ely, A. (2015). *Institutional Innovation in the Management of Pro-Poor Energy Access in East Africa* (SWPS 2015-29 (November) No. ISSN 2057-6668) (Vol. 29). Sussex,United Kingdom.

Greacen, C. S., & Greacen, C. (2004). Thailand's electricity reforms: Privatization of benefits and socialization of costs and risks. *Pacific Affairs*, *77*(3), 517–541. https://doi.org/10.2307/40022913

Heinonen, J., & Junnila, S. (2014). Residential energy consumption patterns and the overall housing energy requirements of urban and rural households in Finland. *Energy and Buildings*, *76*, 295–303. https://doi.org/10.1016/j.enbuild.2014.02.079

International Energy Agency. (2011). *Energy for All: Financing access for the poor (Special early excerpt of the World Energy Outlook 2011)*. *World Energy Outlook 2011*. Retrieved from http://www.iea.org/media/weowebsite/energydevelopment/weo2011_energy_for_all-1.pdf

Inversin, A. R. (2000). *Mini-grid design manual*. *National Rural Elective Cooperative Association*. Retrieved from http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Mini-Grid+Design+Manual#0

Jimenez, C. A., & Olson, K. (1998). *Renewable Energy for Rural Health Clinics*. Colorado, United States of America.

Kempener, R., Lavagne, O., Saygin, D., Skeer, J., Vinci, S., & Gielen, D. (2015). *Off-Grid Renewable Energy Systems: Status and Methodological Issues*. Retrieved from https://www.irena.org/DocumentDownloads/Publications/IRENA_Off-grid_Renewable_Systems_WP_2015.pdf

Kimera, R. (2014). Considerations for a sustainable hybrid mini-grid system : A case for Wanale village , Uganda. *Energy in Southern Africa*, *25*(1), 33–43. Retrieved from file:///C:/Users/hp/Desktop/Financial suatainability of mini grids/25-1jesa-kimera-etal.pdf

Kimera, R., Okou, R., & Sebitosi, A. Ben. (2014). Considerations for a sustainable hybrid mini-grid system : A case for Wanale village , Uganda. *Journal of Energy in Southern Africa*, *25*(1), 33–43.

Local Government Association. (2012). *Financial Sustainability*. Retrieved from http://www.lga.sa.gov.au/goto/fsp

Lyndon, F., & Tuckwell, M. (2013). *The future of mini-grids : from low cost to high value . Using demand driven design to maximise revenue and impact* .

Mawejje, J., Munyambonera, E., & Bategeka, L. (2013). Powering Ahead: The Reform of the Electricity Sector in Uganda. *Energy and Environment Research*, *3*(2), 126–138. https://doi.org/10.5539/eer.v3n2p126

MEMD. (2013). *The Rural Electrification Strategy and Plan For Uganda 2013-2022*. Kampala,Uganda: The Government of Uganda.

Ministry of Energy and Mineral Development Uganda. (2007). *The Renewable Energy Policy for*

Uganda 2007 for Uganda. Kampala,Uganda.
Möller, B., & Al, E. (2014). *Mini-grid and Hybrid Systems*. (B. MÖLLER, M. GOLBA, & W. BOIE, Eds.). University of Flensburg.
Mutambi, B. (2011). Uganda's Experience with Promotion of Rural Electrification - Connection subsidies. In *African Rural Electrification* (pp. 1–15). Dakar Senegal: Africa Rural Electrification.
Nagpal, K. (2012). Smart Mini-Grids_ Innovative solutions to combat energy. *Thomson Reuters Foundation.*, p. 1. New Delhi.
Navroz K. Dubash;Rajan, S. C. (2002). *India: Electricity Reform Under Political Constraints*. *Power Politics: Equity and Environment in Electricity Reform*. Retrieved from http://orton.catie.ac.cr/cgi-bin/wxis.exe/?IsisScript=FARN.xis&method=post&formato=2&cantidad=1&expresion=mfn=007643
Niraula, A. (2015). Scaling up of off-grid Solar Micro grids. *University of Edinburgh*. Retrieved from file:///C:/Users/hp/Desktop/Financial suatainability of mini grids/Dissertation_Msc_Anjal.pdf
OECD/EIA. (2010). Energy Poverty: How to make modern energy access universal? *Special Early Excerpt of the World Energy Outlook*, (September), 52. Retrieved from http://www.iea.org/IEAnews/4710/Poverty_jones.pdf
Off-Grid Energy Australia. (n.d.). Off Grid Systems.
Orlandi, I., Tyabji, N., Chase, J., Wilshire, M., & Vickers, B. (2016). *Off-grid solar market trends report 2016*. https://doi.org/10.1017/CBO9781107415324.004
Palit, D., & Sarangi, G. K. (2014). Renewable Energy based Mini-grids for Enhancing Electricity Access : Experiences and Lessons from India, (March), 19–21. Retrieved from file:///C:/Users/hp/Desktop/Financial suatainability of mini grids/cp25-palit-and-sarangi-s-104-icue2014-211-o.pdf
Panwala, M. (2009). Dimensions of liquidity management – a case study of the Surattextile's traders co-operative bank limited, *2*(1), 117–126.
Parliament of Uganda. Electrity Act 1999 of Uganda (1999). Uganda: Parliament of Uganda.
Payen, L. (ENEA), Bordeleau, M. (ENEA), & Young, T. (Practical A. (2016). *Developing Mini-grids in Zambia: How to build sustainable and scalable business models?*
Peskett, L. (2011). Policy briefing. *GVEP I Nternational*, *44*(1119168). Retrieved from file:///C:/Users/hp/Desktop/Financial suatainability of mini grids/policy_briefing_-_mini-grid_final.pdf
Rural Electrification Agency Uganda. (2013). Rural Electrification Strategy and Plan 2013-2022. Kampala,Uganda: Ministry of Energy and Mineral Development Uganda.
Saluja, P., & Kumar, D. P. (2012). LIQUIDITY AND PROFITABILITY TRADE OFF (A Study on Airtel Bharti Limited). *International Journal of Advanced Research in Management and Social Sciences*, *1*(3), 77–84.
Schillebeeckx, S. J. D., Parikh, P., Bansal, R., & George, G. (2012). An integrated framework for rural electrification: Adopting a user-centric approach to business model development. *Energy Policy*, *48*, 687–697. https://doi.org/10.1016/j.enpol.2012.05.078
Schnitzer, et al. (2014). Microgrids for Rural Electrification : A critical review of best practices based on seven case studies Microgrids for Rural Electrification : A critical review of best practices. *United Nations Foundation*.
Tamir, K., Urmee, T., & Pryor, T. (2015). Issues of small scale renewable energy systems installed in rural Soum centres in Mongolia. *Energy for Sustainable Development*, *27*(May), 1–9. https://doi.org/10.1016/j.esd.2015.04.002
Tenenbaum, B. (2014). *From the Bottom Up*. Retrieved from file:///C:/Users/hp/Desktop/Financial suatainability of mini grids/9781464800931.pdf
Tenenbaum Bernard, Greacen Chris , Siyambalapitiya Tilak, and K. J. (2014). *From the Bottom Up: How small Power Producers and Mini-Grids can Deliver Electrification and Renewable Energy in Africa*. WorldBank.
Torero, M. (2014). The Impact of Rural Electrification. In *11th Conference AFD*

PROPARCO/EUDN: Energy for Development (pp. 0–21).
UBOS. (2016). *The National Population and Housing Census 2014 – Main Report*. Kampala,Uganda. Retrieved from http://documents.worldbank.org/curated/en/2014/01/18914308/below-glass-floor-analytical-review-expenditure-provincial-administrations-front-line-rural-health-vol-2-2-main-report
UNDP. (2009). *The energy access situation in developing countries: A Review focusing on the least developed countries and Sub-Saharan Africa*. Retrieved from http://content.undp.org/go/cms-service/stream/asset/?asset_id=2205620
Velázquez, A. M., & Smith, P. N. (2013). Equity returns and the business cycle: The role of supply and demand shocks. *Manchester School*, *81*(SUPPL.1), 100–124. https://doi.org/10.1111/manc.12022
Verryn, A. (2014). *Towards sustainable microfinance : The case of Capitec Bank and Grameen Bank by*. University of Cape Town.
Winkler, H. (2011). Access and Affordability of Electricity in Developing Countries. *World Development*, *39*(6), 1037–1050. https://doi.org/10.1016/j.worlddev.2010.02.021

APPENDICES

Appendix 1: Structure of the Electricity Supply Industry in Uganda