Paving the Path for Renewable Electrification

The role of government in supporting mini-grids firms to establish and grow in the energy sector of Kenya

Master's Thesis in Industrial Ecology

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Cover: Mini-grid facility operated by solar cells in the rural community of Kitonyoni, Kenya, March 2022, by Sanjidul Huda & Ludvig Söderbom.

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Abstract

Despite the importance of energy access, over a hundred million people lack access in rural Sub-Saharan Africa. Providing energy access to the people living in rural areas is the key to rural development. The Ministry of Energy in Kenya has developed Kenya Vision 2030, a national strategic plan to promote energy efficiency when previous targets were not successfully reached. Mini-grids powered by green energy have been identified as an essential technology to assist the sustainable energy transition. This thesis aims to understand what could be the role of the government in supporting mini-grid firms and enabling them to establish and grow in the energy sector of Kenya. Several strategy plans, articles, and literature has been assessed in this research. To obtain more in-depth knowledge, a field study was conducted in Kenya with relevant stakeholders, including the government, mini-grid firms and researchers. In the current state, the government does not forecast the policies of a particular type of firm. It instead applies to both public and private firms. The support fluctuates depending on the actor. The most significant identified challenges when giving support were internal conflicts within the board of decision-makers, standardised working process and grid extension. Critical factors for a successful mini-grid operation and development were also evaluated. The firms highlighted identified critical factors from the literature to explain what they believe is essential and how the government could, in particular, work with these factors. The government further stated how they could support the firms with these specific factors. Private firms will need to play a more prominent role in the future since they operate in isolated rural communities where neither the public sector nor the main grid has reached. The role of the government could be to develop a more detailed strategic plan that gives the private sector more space, include all stakeholders in the decision-making process, favours investors to participate in the sector and promote green technologies, and increase their use of renewable resources. The government of Kenya has been depicted as a showcase for regional countries regarding their energy development, thus the government's role in paving the path for renewable electrification in Sub-Saharan Africa.

Keywords: Mini-grids, Sustainable energy transition, Renewable energy sector, Rural electrification, Mini-grid operations, Ministry of Energy, Kenya.

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Thanks to our supervisor Annika Rickne for letting us be part of this research and providing valuable guidance throughout the thesis work. Thanks to our co-supervisor, Helene Ahlborg, for helping us with practical problems before entering Kenya and sharing experiences from similar studies. Besides guidance during the thesis, we have also gained knowledge for life. Lastly, we would like to express our gratitude to Adam Öjdahl from the Embassy of Sweden in Kenya. Thanks for the exciting discussions that exposed us to new aspects of the problem and the country.

Before the journey with the thesis began, we both had one goal: to conduct a thesis that would encourage sustainable development. With this hopefully accomplished, we would like to disclose our acknowledgement with a quote describing our motivation and to encourage ourselves in the new chapters to come,

"It is not the strongest or the most intelligent who will survive but those who can best manage change." - Leon C. Megginson, 1963.

Asante Sana

Ludvig Söderbom, Gothenburg, June 2022

Sanjidul Huda, Gothenburg, June 2022

List of Acronyms

Below is the list of acronyms that have been used throughout this thesis listed in alphabetical order:

CSR	Corporate Social Responsibility
DFI	Development Finance Institute
EPRA	Energy and Petroleum Regulation Authority
GHG	Green House Gases
K-OSAP	Kenya Off-Grid Solar Access Project
KNES	Kenya National Electrification Strategy
KPLC	Kenya Power and Lightning Company
MLP	Multi-Level Perspective
NDC	Nationally Determined Contribution
NEMA	National Environmental Management Authority
NPO	Non-Profit Organisations
NGO	Non-Governmental Organisation
O&M&M	Operation, Maintenance and Management Cost
PAYG	Pay-As-You-Go
PPA	Power Purchase Agreement
REA	Rural Electrification Authority
REREC	Rural Electrification and Renewable Energy Corporation
R&D	Research and Development
SDG	Sustainable Development Goal
SE4ALL	Sustainable Energy for All
SPD	Small Power Distributor
SPP	Small Power Plant
TIS	Technological Innovation Systems
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change

Contents

List of Figures

List of Tables

1
Introduction

In this chapter, a short introduction and background of the research theme will be presented, followed by the purpose, research question, delimitation and disposition of this master thesis.

1.1 Background

The United Nations (UN) released a sustainable development agenda in 2015 that consists of 17 universal goals for countries to achieve by 2030, with the overall focus to protect our planet, end poverty, and improve the lives of human beings [1]. The UN's sustainable development goals (SDG) are followed up annually to observe how they relate to the goals set for 2030. Each year, these targets are evaluated to evaluate their current status compared to their final measurements. The agenda's tracking report for goal number 7 is particularly of interest. The main focus of SDG7 is to ensure universal access to affordable, reliable, sustainable and modern energy [2]. According to 2020's follow-up report, there was a steady increase in universal access to electricity each year, reaching approximately 90 % in 2019. However, around 759 million people still lack access to electricity. 75 % of them live in areas located in Sub-Saharan Africa. 84 % of them live in rural areas [3]. Electrification in rural Sub-Saharan Africa has been delayed with the ongoing coronavirus pandemic. According to revised estimates, around 85 million people need access to electricity each year to reach the final target by 2030. Energy should be available to all residents, whether in cities or rural areas. It facilitates the possibility of clean cooking and increases the quality of life and availability of services. People in rural areas can support themselves and run small scale businesses, thereby generating a feasible income for the private household and the local community.

Kenya's government established the Kenya National Electrification Strategy (KNES) in 2018 [4]. KNES proposes a strategy for ensuring universal access to electricity for all Kenyans by 2022, with the help of funding and economic resources provided by the World Bank. The government realised that it would not be possible to reach the energy targets without a paradigm shift in the existing electrification strategy, i.e. a change in innovation and new technology is required for the sustainable energy transition to occur [5]. Off-grid solutions, mini-grids, and stand-alone solar systems are essential in this transition. Above all, it emphasises the critical role of the private sector in providing off-grid solutions for Kenyan households, companies, and community service centres in rural areas.

Universal access to electricity is a critical component of Kenya's Vision 2030 of becoming a newly industrialised, middle-income country [6]. The vision results from a highly participating, collaborative, and inclusive stakeholder process from foreign and local professionals, ordinary Kenyans, and stakeholders around the country. Unfortunately, Kenya did not achieve their previous goal of 100 % access to be reached by 2022 for both electricity and clean cooking solutions [7]. Nonetheless, the access rate in 2019 was 70 %, see figure 1.1. As a result, the government constructed a new strategic plan, the Energy Act 2019, to improve its working methods, increase energy firms' involvement in the energy sector, and promote renewable energy [8].

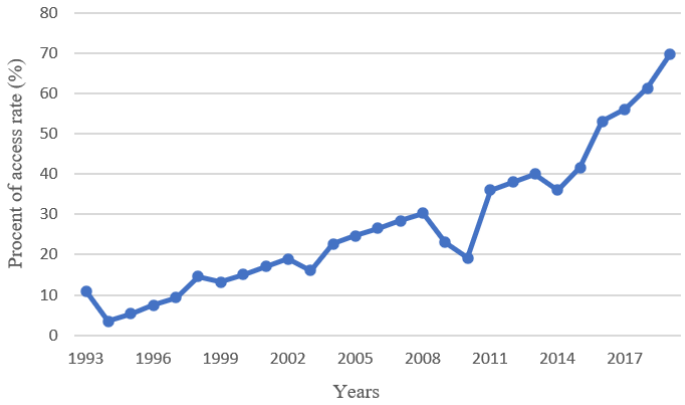

Figure 1.1: Access to electricity in percentage of the population in Kenya [9].

There are generally two different approaches to the problem of distributing electricity to rural inhabitants living in Sub-Saharan [10]. Grid extension is the first alternative, where new electrical lines are established from the main grid, which might not be cost-effective for remote areas. The second alternative is the use of off-grid solutions. At present, electricity networks are becoming more efficient with the help of green mini-grids, where most of these mini-grids are located in rural areas remote from the central power grid. Public and private actors, local citizens and institutions benefit from mini-grid instalments by ensuring their welfare, private economy, technological advancement, and business opportunities. When implementing mini-grids, they must be established with primarily renewable energy sources. Mini-grids enable the inhabitants of rural areas to access clean energy without affecting the global environment with higher emissions of greenhouse gases. Renewable energy sources are also widely available, and cost-efficient [11]. Hence, less investment is required for that specific grid.

As mentioned, Kenya has not been able to reach its previous goal of universal energy access for all inhabitants, and this action plan has been postponed. There is a challenge today for the government of Kenya to reach SDG7. Mini-grids are considered to be a tool for achieving this goal. The first installation of a mini-grid system in Kenya is dated back to 1980 [10]. Since then, technology has evolved, and in 2016, the capacity of mini-grids in Kenya was 25.3 MW.

For this action plan to succeed, the government needs to make it more favourable for energy firms to invest and participate in mini-grid projects. For the target to be reached, electrification must be innovated faster than it is at the moment for the target to be reached [3]. The government is responsible for energy firms since both these entities strive to reach the energy targets, and it cannot happen if they do not collaborate efficiently with each other [12].

The Ministry of Energy's role is to design and execute policies that support the energy sector [12]. It establishes strategic directions to help the industry expand while giving a long-term vision for all stakeholders. The Ministry will continue collaborating with partners to assist the country in meeting its National Determined Contributions (NDC) responsibilities. Raising energy awareness, developing skills, and mobilising financial resources will be essential in achieving this goal. Support should be given to existing industry energy firms and those interested in participating in green mini-grids projects. The government established the Rural Electrification and Renewable Energy Corporation (REREC) as part of the action plan to encourage green energy from renewable sources to combat climate change and other environmental concerns. By 2030, renewable energy should account for 80 % of total energy consumption, and clean energy access should be 100 %. Renewable energy is produced from sources that can naturally replenish themselves, such as the wind and sun, whereas clean energy refers to all zero-carbon energy sources.

The Kenya Off-Grid Solar Access Project (K-OSAP) attempts to enable development in the mini-grid sector [13]. The government plans to build and run roughly 158 mini-grids, developed and maintained by REREC or Kenya Power and Lighting Company (KPLC). These are the major public energy firms in Kenya. Furthermore, the private sector plans to build around 130 mini-grids, which are now in different construction phases. By 2022, the estimated number of operating mini-grids will be 391 sites in Kenya, see figure 1.2.

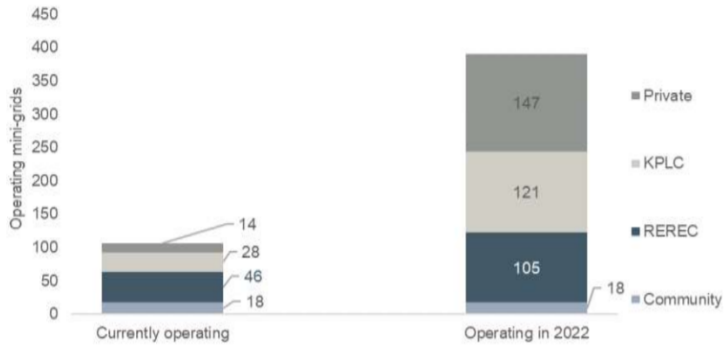

Figure 1.2: Overview of mini-grids facilities year 2018 in Kenya, compared with estimated mini-grids sites year 2022 [13].

1.2 Purpose

This research aims to understand the government's role in supporting mini-grid firms and, in turn, successfully providing energy access for the people of Kenya.

In this thesis, the government is defined as the Ministry of Energy in Kenya members who are the prior decision-makers regarding energy regulations and policy-making [14]. The Ministry's mandate is to design and enforce policies that enable Kenya's energy firms to operate efficiently. The literature fails to explain thoroughly how the government can support energy firms and enable them to grow within the sector of mini-grids. Hence, there exists a research gap. Although several sources provide information about the government's obligations towards businesses and the local communities, the previous energy target for 2022 was not reached. This thesis will focus on the government's role towards the firms. The following research question will be evaluated in this thesis,

What could be the role of government in supporting firms to establish activities and be able to grow within the mini-grids sector in Kenya successfully?

The following sub-questions will be evaluated to understand the research question comprehensively. These have been categorised considering both the government and firms, see figure 1.3. The unit of analysis for this study is the government's role toward the energy firms.

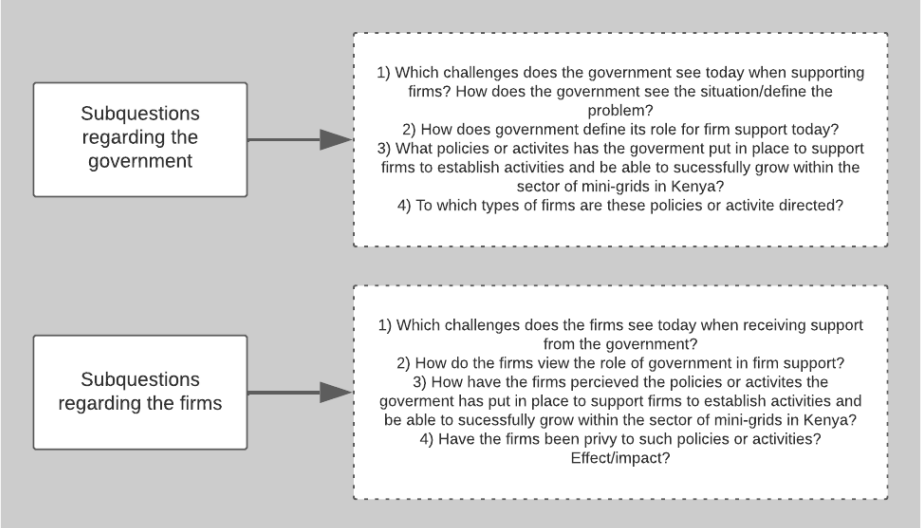

Figure 1.3: Sub-questions to be evaluated in this thesis.

1.3 Delimitation

To improve the chances of reaching reliable conclusions about the role of government in supporting mini-grid firms in the energy sector, the scope of this thesis has been reduced by the limitations described below. The conclusion is intended to be broad enough to apply to others while being detailed enough to bring actual benefit. Nonetheless, since the political environment in Kenya is dynamic, conclusions and findings today may not be the same tomorrow.

- The Ministry of Energy will be regarded as the government in this research since they have the prior responsibility when constructing and building new policies and regulations and establishing activities for the energy sector. Therefore, other governmental bodies will not be the initial focus. When external governmental bodies are mentioned, they will be specified.

- The energy sector is referred to as the renewable energy sector, focusing on mini-grid firms and operations. This thesis will not consider other firms working with renewable resources and technology as a base.

- When evaluating what type of support the mini-grid firms need and how the government can support them, this research will focus on general issues that have been found during the interviews and literature review. Minor or specific issues the firms see that are only directed to an individual firm will not be considered a critical issue for the government to support.

- When constructing the MLP framework, the focus will be on the niche, defined as mini-grid operations.

1.4 Disposition

Provided below is the disposition of this report:

Chapter 1: Introduction to the thesis and presentation of the research theme. The purpose and the research question that this thesis will investigate are described, together with the delimitation and disposition of the report.

Chapter 2: Presentation of the current situation for mini-grids in Kenya together with identified actors in the energy sector. Definition of mini-grid operations and the state of the renewable energy sector today. Further, alternatives with grid extension in Africa and the current national frameworks in Kenya have been presented.

Chapter 3: Problem description of previous energy targets in Kenya and Sub-Saharan Africa. Case studies on off-grid regulations in Sri Lanka and Nepal. Explanation of the MLP framework with the literature review of critical factors for a successful mini-grid operation and development.

Chapter 4: Presentation of the methodology, with motivation on the research approach and case study. Outline how data and data collection procedures have taken place, including a pre-study, literature review, and interviews. Further, an evaluation of the analysis and MLP framework and perspectives concerning ethics, reliability and validity are described.

Chapter 5: Presentation of the findings and results from the interviews categorised in the sub-questions to governments' response and firms' response.

Chapter 6: The findings from the interviews, together with the literature review, have been analysed and discussed. The focus of the analysis with regards to MLP has been on the niche.

Chapter 7: Conclusion of the thesis on how the government can support mini-grid firms to establish and grow in the energy sector. Recommendation for future research where there seems to exist a research gap has been provided.

Appendixes: Semi-structured interview guides for researchers, government and firms are outlined.

2

The situation for renewable mini-grids in Kenya

This chapter presents the essential actors in the mini-grid sector of Kenya, together with a definition of mini-grid operations and alternatives with grid extension in Africa. This section also describes the current situation for renewable mini-grids and the industry. A taxonomy of the current policies will also be presented.

2.1 Important actors in the mini-grid sector

Government

The government in this thesis focus on the Ministry of Energy in Kenya since the Ministry's mandate is to design and execute policies that enable Kenya's energy sector to operate efficiently and thrive [14]. Hence, it is directly connected to the country's mini-grid development. The Ministry establishes strategic directions to support mini-grid implementation and provides a long-term vision for all stakeholders. Kenya's Ministry of Energy's mission is to ensure the provision of affordable, reliable, and secure energy services that contribute to national development and environmental protection. The overall goal is to provide energy to all Kenyans. Despite the Ministry of Energy, other authorities that may not have the decision-making rights but still work within the energy sector will also be considered, e.g. Energy and Petroleum Regulation Authority (EPRA).

Public firms

Besides the Ministry of Energy, there are primarily two public firms directly interconnected with the government. Kenya Power and Lighting Company (KPLC) and Rural Electrification and Renewable Energy Corporation (REREC). These actors account for approximately 60 % of the mini-grid implementations in Kenya, see figure 1.2, and are considered essential actors. The majority of larger-scale mini-grids in Kenya are operated and installed by public firms [10]. The mini-grid facilities operated by public firms in Kenya vary in size. One of the most significant mini-grid operations has an installed capacity of 4.2 MW and is located in Wajir. Electricity provided by public firms considers the whole value chain from inbound logistics and production to distribution and services to the end-user.

Kenya Power and Lighting Company (KPLC)

Kenya Power and Lighting Company (KPLC) owns and runs most of the country's electrical transmission, and distribution infrastructure [15]. KPLC is dedicated to providing consumers with cost-effective, reliable, and high-quality power that enhances people's lives. For this goal to be achieved, appropriate technologies and innovations must improve the power network and customer service. KPLC's core responsibilities include planning for enough energy generation and transmission capacity to satisfy demand. They also include building and maintaining the power distribution and transmission network and selling electricity to clients. The government is a shareholder of this company and owns 50.1 % of the company, while private investors own 49.9 %.

Rural Electrification And Renewable Energy Corporation (REREC)

The Rural Electrification Authority (REA) was established by the Energy Act 2006 and began its operations in 2007 [16]. The REA's mission was to accelerate Kenya's rural electrification. The organisation's name has changed from Rural Electrification Authority to Rural Electrification and Renewable Energy Corporation (REREC). REREC's scope has been broadened to lead Kenya's renewable energy program for social-economic transformation and deliver rural electrification initiatives. The funding for REREC was obtained 82 % from governmental funding and 18 % from overseas development partners, including the World Bank, France, and China.

Private firms

Private firms are emerging globally to provide power to rural communities. Private firms often face a challenge to succeed since public firms receive more internal support and funding from the government than private firms do not receive [17]. Within the sector of private firms, both profit-driven businesses and non-profit organisations (NPOs) are participating actors in the market. Although electricity has generally been viewed as a fundamental state-provided service, the current situation in some policy areas lacks sufficient support from the government. Therefore, it is inevitable to succeed without the help of private firms to achieve electrification in rural Kenya. Currently, estimated numbers depict that the private sector has accounted for approximately 30 % of the mini-grid implementations in Kenya, see figure 1.2.

Today, around 30 private firms are providing off-grid electrification through mini-grids, and standalone systems in Kenya [18]. Many private firms in Sub-Saharan Africa are international and multi-national organisations and companies that operate in remote rural areas. An email (A. Öjdahl, private communication, June. 1, 2022) explains an abundance of smaller domestic mini-grid firms in Kenya. When observing historical trends, it can be identified that those who reach a slightly larger scale are usually backed by either international investors or major international energy companies.

These firms are usually responsible for most of the value chain, from installation to operation and distribution. However, these stages are beginning to disperse at the current state, and different actors specialise in one or other parts of the value chain. It can be depicted as a positive sign as the energy sector is beginning to mature moderately, even though it is still only at the beginning of that development. The government must still offer financial assistance and support with the legislation for the private firms to operate successfully. In contrast to public mini-grids, private mini-grids have much lower generation capacities, often below 10 kW, and cannot provide electricity to the same amount of people [10].

Community-based actors

There are small fractions of installed mini-grids in Kenya entirely operated by minor communities. The vast majority of these communities are responsible for the whole operation and management of the system without the support from the government [19]. The mini-grids have management committees that are accountable for the system functioning correctly. Members of the board are elected by the community and include a presiding officer, vice-chairman, treasurer, and operations manager responsible for running the system. Local communities usually start community-owned mini-grids because they want power for lighting and private household. Typically, the project's first funding is collected by contributions from community members interested in the idea. The communities' efforts are complemented by donors providing technical assistance and equipment in most mini-grid initiatives.

2.2 Mini-grid operation

A mini-grid is a self-sufficient and independent power network that generates and distributes electricity to serve a small number of residents in a rural area or thousands of people in a large city [20]. Mini-grids can either be connected to the main grid or entirely disconnected. There is a wide range of mini-grids globally, ranging from a few kW to several MW. In this study, the mini-grid operations examined will be of systems that serve several customers and are disconnected from the main grid.

The early ideas of development economics from the 1950s to 1970s considered rural electrification as a catalyst for pre-electrification for rural development [21]. Rural electrification can enable small scale businesses to use electric equipment and tools, increasing their productivity and income. They also improve access to energy and the delivery of social and commercial services through a variety of village-level facilities, e.g. schools, hospitals, and financial institutions, see figure 2.1. Increased productivity and revenue growth, combined with improved social and business support services delivery, contribute to more significant social and economic benefits for rural areas.

Once a mini-grid is connected to the main grid, it no longer operates as an isolated system. It becomes a small component of the national grid, regardless of whether it maintains its generation [22]. One existing problem with facilitating the connection between the main grid and mini-grid is the absence of regulatory certainty where the mini-grid developers and investors are unlikely to invest in small power plant (SPP) projects. In this situation, investors do not want to risk and participate in off-grid projects. Thus rural communities suffer because they are denied access to power and must wait years or decades for the national grid to arrive.

SPPs are small-scale, independently operated power plants located near their customers [22]. Since SPPs and mini-grids are small facilities that generate and sell power, the literature refers to both using the same name. The literature provides five options regarding connecting the SPP to the main grid, see table 2.1. However, there appear to be no clear and transparent regulations in the case of Kenya.

Table 2.1: Options when mini-grid, referred to SPP, connects to the main grid [22].

Options	**Descriptions**
1. The SPP stops generating and becomes a pure distributor.	When connected to the main grid, it stops producing electricity in favour of purchasing it from the utility and reselling it to its customers at retail.
2. The SPP stops distributing and sells the power it generates to the main grid.	The SPP will no longer sell electricity to retail customers and instead, sell electricity to the main grid.
3. The SPP Operates as a combined SPP-SPD (Small power distributor).	The SSP transforms into an SPD, which purchases electricity from a national utility and resells it to retail customers. It keeps a generator, either old or new, as a backup and possibly as a power source to sell to the main grid and retail customers.
4. The utility buys the SPP.	The utility company, referred to the public firms, will buy and operate the SPPs mini-grid distribution network.
5. Abandonment.	When it is not cost-effective to repair necessary components, the SPP will be abandoned.

The literature has identified Rwanda as a country with many on-grid mini-grids selling energy to the main grid [23]. Hence operations are viable. Most small-scale hydropower plants are connected to the national grid, providing additional generation capacity at a fixed price. Rwanda is notable for its very high level of grid integration and the prevalence of private sector involvement in the energy sector. According to a case study from the literature, 16 of the 17 surveyed plants are connected to the national grid and operate under a 25-year power purchase agreement (PPA) that determines the purchase price of the plant's power. The PPAs are 'all production' agreements, which means that the national grid will purchase all of the electricity generated by the facilities. While a grid connection ensures a consistent sales price for generated power, it could disadvantage the plant equipment to frequent shutdowns due to local blackouts.

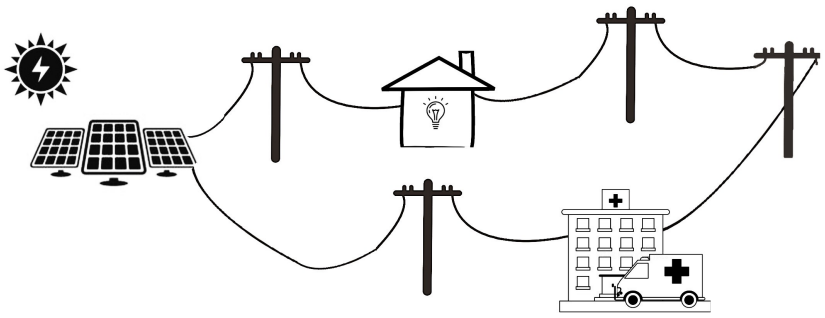

Figure 2.1: Schematic overview of simple mini-grid operation providing energy to the private household and a hospital.

2.3 State of the energy sector today

Increasing economic activities with a growing national population have resulted in an increased domestic energy demand for Kenya [24]. Currently, the demand has been primarily met by foreign imported energy. The high cost of imported energy severely stifles the country's economic progress. For instance, imported crude petroleum contributes to around 25 % of the national import expenditure. The unreliability of energy supply infrastructure deepens the problem of high energy costs. Due to power interruptions, Kenyan businesses lose roughly 10 % of their output [25]. Thus sustainable, affordable and domestic energy for the people of Kenya has been recognised as a critical factor in the national policy.

The national grid operates as an integrated network linked by 220 kV and 132 kV transmission systems, with a limited number of 66 kV transmission lines [24]. The main grid is one of the sector's primary issues, and shortcomings cause regular power outages and technical and non-technical losses. Due to this issue, the public operators have prioritised system resilience and the implementation of off-grid and smart grid technology.

At the current state, the authorities are actively extending transmission lines (4,000 kilometres) and distribution lines (3,200 kilometres), as well as constructing substations (4,200 MVA). The following statistics on Kenyans' energy access were gathered from the SDG7 tracking and progress report, see table 2.2.

Table 2.2: SDG7 tracking and progress report [3].

Electricity rate (2019)	**Percentage of the population (%)**
Electrification total	70
Electrification urban areas	91
Electrification rural areas	62

Several projects, financed by Development Finance Institute (DFI), are in place to increase distribution lines to reach rural communities and maximise existing transformers' usage [24]. These projects have affected the number of people who have access to electricity. Kenya's electrification rate increased from 38 % in 2012 to 70 % in 2019 [9]. Access to electricity refers to the proportion of the population who has access to electricity over a given time or geographic location. Energy access is defined as the end user's ability to consume electricity for desired services.

A mechanism for measuring energy access is the Multi-Tier Framework, where a survey is based on access to electricity service from Tier 1 to Tier 5 [3]. The different tiers reflect various degrees of usability [22]. Additional electrical services can be provided as one advance to higher tiers with more efficient attributes, e.g. more service hours. The Multi-Tier framework explains the level of electrification offered to a community's consumers. However, this does not imply that the people will utilise the available services. The demand for or use of these services will be determined by the private household's income and the relative pricing of alternative energy sources.

Despite difficulties surrounding geographic region clauses in distribution rates, mini-grid capacity rapidly expands in Kenya [9]. There is also substantial potential for renewable energy power generation in the country. Due to abundant solar, hydro, wind, biomass, and geothermal resources, the government sought to expand the renewable energy sector to central and rural areas. Using a least-cost strategy, the government has prioritised building geothermal and wind energy facilities and solar-fed mini-grids for rural electrification. The share of the electricity production at its current state has been illustrated below, see figure 2.2.

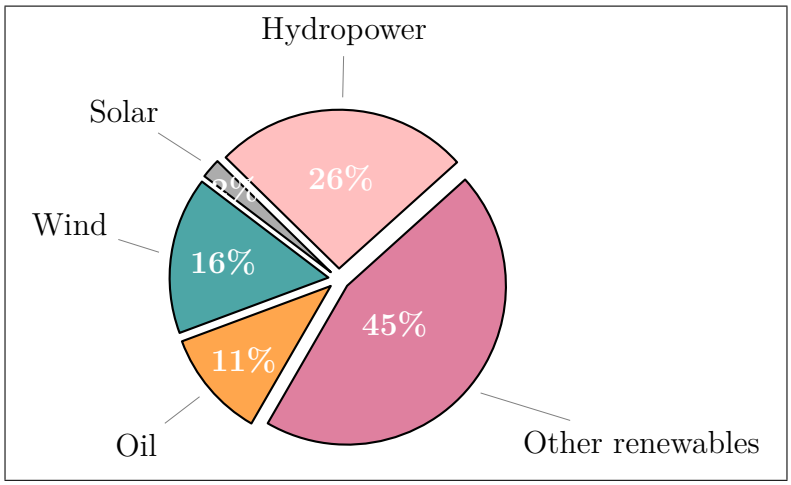

Figure 2.2: Share of electricity production by diverse sources in Kenya 2021 [26].

International agreements, sustainable development targets and external pressure on the government outside the nation's boundaries influence Kenya's decision to intervene in a sustainable energy transition [27]. Investors after high-profit margins will pressure mini-grid facilities to be as financially successful as possible. Investments from developing institutions and crowd fundraising will not be enough to pay mini-grid expenditures during the project's lifetime [28]. As a result, these investments will pressure the development of mini-grids to make them self-sustaining and generate income.

Kenya has already implemented several policies and regulations that are currently in function, and some policies are still being constructed to become more effective [29]. These policies aim to optimise the work for the government and the firms to reach the energy targets and Kenya Vision 2030 and promote energy efficiency and conservation. Enabling changes and modifications are being assessed continuously to target a sustainable national economy and lower GHG emissions. The policies are divided into three segments, including high-level policy strategies, see table 2.3, climate change-related, see table 2.4, and energy-related, see table 2.5.

Table 2.3: Policies and legislation on energy efficiency regards to high-level policy strategy. The definitions of the aim is derived from the strategy plan *"Kenya National Efficiency and Conservation Strategy"* [29].

National framework	**Aim**
The Constitution of Kenya	The Constitution is the supreme law of the Republic and binds all persons and all State organs at both levels of government. It states that Kenya shall ensure sustainable exploitation, utilisation, management and conservation of the environment and natural resources. Article 203 (2) requires that county governments be allocated a minimum of 15 % of the annual national fiscal revenue. However, the actual allocation often surpasses this minimum, which gives county governments considerable influence on investments in energy efficiency actions.
Kenya Vision 2030	Kenya Vision 2030 is the country's overarching development blueprint covering 2008 to 2030. It aims to transform Kenya into a newly industrialising "middle-income country providing a high-quality life to all its citizens by 2030." This target will be achieved through improving competitiveness in manufacturing and promoting efficiencies. These measures necessitate energy efficiency in manufacturing.
Big Four Agenda	The 'Big Four' Agenda aims to make Kenya a globally a competitive and prosperous country with a high-quality life for all Kenyans by 2030. The Agenda establishes four priority areas: Ensuring Food and Nutrition Security, Affordable Housing, Enhanced Manufacturing, and Universal Health Coverage. The Ministry of Energy has identified strategic initiatives for the Big Four Agenda. The initiatives focus on realising improved energy access, energy efficiency and conservation.

Table 2.4: Policies and legislation on energy efficiency regards to climate change related strategy. The definitions of the aim is derived from the strategy plan *"Kenya National Efficiency and Conservation Strategy"* [29].

National framework	**Aim**
Climate change	This document is the national legislation that sets a response framework to climate change and provides mechanisms and measures to achieve low-carbon and climate-resilient development. The Action Plan shall aim to enhance energy conservation and efficiency and renewable energy among end-users, industrial, commercial, transport and domestic users, and put measures for climate change mitigation.

Table 2.5: Policies and legislation on energy efficiency regards to energy related strategy. The definitions of the aim is derived from the strategy plan *"Kenya National Efficiency and Conservation Strategy"* [29].

National framework	**Aim**
Energy related	Coordinate the development and implementation of national energy efficiency and conservation programmes. Consolidate regulations and empower the Minister responsible for energy to promote energy policies and actions, such as adopting Minimum Energy Performance Standards and integrating energy efficiency requirements into the Building Codes. Prescribe the minimum qualification for energy auditors and energy managers.

3
Problem Description

This chapter presents the research problem that currently exists and why this study is essential. Energy targets in Kenya and Sub-Saharan Africa have been presented with case studies regarding off-grid regulations from Sri Lanka and Nepal. Further, an overview of technological innovation and the literature review regarding critical factors for successful mini-grid operations and development.

3.1 Energy targets

3.1.1 Kenya and Sub-Saharan countries

Kenya has previously failed to reach their energy target regarding transition to 100 % green energy by 2020, and universal access to energy by 2022 [30]. The move comes as Kenya seeks to triple the number of people connected to its power grid to reach 60 % of the population. The transition to 100 % renewable energy might improve the population's access to the national power system while simultaneously lowering industry output costs. By implementing the target, the government and firms are expected to improve their commitments to achieve the target by 2022. Nevertheless, this target was not met. The Ministry of Energy later adopted the Energy Act 2019 and developed a new national energy strategy plan to reach 100 % clean energy consumption by 2030 and 100 % access to clean cooking by 2028 [8]. Kenya's president has urged the international community to spend more on research, innovation, technology transfer, and public-private partnerships to fund renewable energy solutions.

The energy targets are often similarly built in Sub-Saharan Africa [31]. Rwanda, for instance, has developed an energy development agenda to achieve a 100 % electrification target by 2024 [23]. This rapid increase in electricity access results from government initiatives and new energy policies. The target will be achieved with a combination of on-grid and off-grid solutions. Other countries, such as Ethiopia, Senegal and Côte d'Ivoire, plan to achieve full access by 2025 with a fast-paced extension of the main grid and increase the number of public and private off-grid operations [31].

3.1.2 Regulations on off-grid systems and case for Nepal and Sri Lanka

The regulation imposes costs on mini-grid developers, which could hinder or even eliminate the mini-grid firms' commercial viability [22]. As a result, some research suggests that regulators should be concerted to develop a "light-handed" regulatory structure. In reality, light-handed regulation usually means minimising the amount of information necessary by the regulator and minimising the number of discrete regulatory processes and decisions. The documents have also been standardised in this regulatory structure.

However, there have been instances where light-handed regulations have failed [22]. Light-handed regulation had unintended repercussions in both Sri Lanka and Nepal, where it was employed for mini-grid developers that wanted to sell only wholesale to the national utility on its main grid. Both countries developed a "first-come, first-served" paradigm. In Nepal, the regulatory threshold was set low in several instructive ways, including low application costs, short deadlines, poor management, and no in-depth monitoring of projects. Thus, Nepal has received too many applications for projects that sell hydropower wholesale to the national utility. However, it was stated that many of these applicants had no real intention of developing their proposed project, causing delays in processing legitimate projects. Sri Lanka went through a similar scenario between 1996 and 2008 where the regulatory system in Sri Lanka, like Nepal, resulted in an overwhelming amount of paper projects that clogged the system but provided nothing in the way of new electricity [22]. The light-handed regulations, instead of providing successful mini-grid operations, hindered development. Based on these case studies, light-handed regulation does not seem to be appropriate for all types of mini-grid operations.

3.1.3 Global status of electrification

Regional disparities remain, with Sub-Saharan Africa accounting for three-quarters of the global access deficit [32]. Latin America, the Caribbean, Eastern Asia, and Southeastern Asia are on the verge of universal access, with more than 98% of their populations having access. However, less than half of the population in Sub-Saharan Africa has access. With annual electrification growth rates of over 3 %, Bangladesh, Kenya, and Uganda have made the most progress among the developing countries, since 2010, mainly due to a combination of the main grid, mini-grid, and on-grid solar energy transition. Significant progress has been achieved regarding electrification across the world [33]. Various factors determine the success of this transition, including the level of government commitment and the support of institutions and financial institutions. Clear policy frameworks and milestones, enforcement of appropriate technical standards, standardised operational metrics, support for finance, R&D, and stakeholder training have improved performance. However, universal electrification faces several challenges, including the existing network infrastructure in different countries. In addition, the cost of additional grid extensions and the possibility of electrification through the portfolio of off-grid solutions.

Multiple ministries with overlapping organisational frameworks for off-grid electrification result in poorly coordinated approaches [33]. Moreover, officials and ministries in the government tend to have biased opinions regarding what energy source should be prioritised, which creates internal conflicts and hinders the establishment of robust policy instruments. Strengthening the regulatory environment is one of the criteria for developing an enabling environment for attracting private investment in the off-grid industry and enabling firms to grow.

Several case studies have investigated and analysed how the government could improve their work towards the energy sector and thereby improve its sustainability targets [34]. There is evidence that policies and support have been given successfully and improved the work by the firms. For instance, China has new industries involving innovation-driven sources and environmental protection supported by the government [35]. The study concludes that government support can improve firms' innovation output and enhance innovation's intensive margin. In a situation with a bad economic environment and intense competition, the literature states that the firm's innovation rises as support increases. There is a need for subsidies and initiatives by the government in the areas of R&D and strict financial supervision to make policies effective.

In Kenya, energy targets and operating a functional off-grid system still fail due to ambitious targets and an abundance of strict regulations. There exists a research gap considering how the government could engage more efficiently and collaboratively with mini-grids firms in the energy sector to reach Kenya Vision 2030. The research problem that will be addressed in this study is what could be the role of the government in supporting mini-grid firms and enabling them to grow in the energy sector successfully. The research problem is significant for Kenya's Ministry of Energy to understand since the Ministry can implement appropriate policy instruments for mini-grid firms. A more precise understanding could be acknowledged by analysing the interplay between the government and the firms.

3.2 A technological transition

It is essential to use more sustainable energy sources to protect and conserve the planet's resources, reduce greenhouse gases and other ecological footprints, and utilise more renewable resources [36]. The energy transition intends to alter the global order regarding the growth and the environment, particularly energy in its many forms, with priority to electricity. Suppose sustainable energy sources are introduced in a way that makes it easy for firms to engage in the renewable energy industry. In that case, our society will become less reliant on fossil fuels in the long term. Sustainable energy conversions include increased use of renewable energy sources, particularly wind and solar, a transition from coal and petroleum to natural gas, hydrogen as a low-carbon fuel, and increased energy efficiency. Green mini-grids, powered by renewable energy, can be utilised to offer electricity access with backup diesel generators. Green mini-grid firms have the potential to successively replace fossil-fueled mini-grid operations if energy firms acquire the necessary support and investment from the government. The fact that the existing energy sector is moving toward sustainability, rather than the mini-grids themselves, is the technological transition for this research.

A transition is required for new technology and products to get a foundation. In the case of sustainability and renewable energy, one way to understand the technological transition is through the Multi-level perspective (MLP) [27]. The MLP framework identifies general patterns in socio-technical transformations. Transition is viewed as a non-linear process resulting from the interaction of development at three analytical levels, including niches, socio-technical regimes, and landscape. Sustainable transition involves interactions between actors and processes, including technology, policy and politics, economics, cultural expositions, and structural change dynamics. Therefore, a transition can only occur through collaboration among identified stakeholders with a practical facilitating policy framework, infrastructure, technology development, and adaptation [36]. Thus, it is aligned with the research question to understand the government's role in supporting energy firms in succeeding in this transition.

Implementing new technology into the system will depend on and affect the surrounding environment [37]. For instance, in the case of electric vehicles, the environment and limitations of the technology itself must be considered. The entire system must be modified to be compatible with introducing a new technical framework. That is one of the reasons why these changes take a long time, even though the necessary technology has been available for years. The essential notion behind the socio-technical transition concept is that the shift cannot be accomplished via planning and control. Instead, the system self-organises and evolves into another dynamic stable configuration based on innovations, technologies, and other factors.

A *niche* is a protected region, demonstration project, or market segment of specific interest to actors willing to support innovation [27]. Niche markets can destabilise markets and be a force toward a technical and innovative transition. Transitions require niches because they supply the seeds for systemic change. The *socio-technical regime* is the part of the framework that accounts for the current socio-technical system stability. It is a collection of principles that guide and organise social groups' activities to replicate the socio-technical system's many aspects. Institutional systems, national laws and regulations, and legally enforceable contracts are activities of such standards. The larger context that drives the niche and regime is the *landscape*. Demographic patterns, political views, cultural ideals, and microeconomics are types of landscapes. In this research, the landscape pressures Kenya to participate in mini-grid projects and move towards renewable electrification.

There is a transition in Kenya and mini-grids are one of the solutions for paving the path in this transition. In this research, mini-grid operations will be considered a niche since this technology has the potential to enable energy access to rural communities in Kenya. This technology can add electricity to an existing energy mix where it would be very costly with a grid extension. Mini-grids itself does not replace any form of energy provider. However, it complements rural electrification by decreasing the communities' reliance on fossil fuel-driven equipment and facilitates the growth of rural development [21]. Hence, renewable resources will be used as it successfully replaces the community's fossil fuel-based alternatives. Mini-grid operations, no matter the energy source, can be further seen as a complementary technology to provide energy in remote rural areas where the government has yet not been able to extend its main grid [38]. Thus a solution that will survive until the national utility can extend the main grid and reach the mini-grid facilities.

The MLP framework will be utilised as an entrance in this thesis to answer the research question. However, the derived sub-questions have not been designed to provide a comprehensive answer applicable to all dimensions of the MLP framework. Nevertheless, they can provide important information and valuable data regarding mini-grid firms that can grow within the renewable energy sector. Therefore, this framework's focus will be on the niche, i.e. mini-grid operations. A niche can be seen as a pilot project that is used to test new alternative technologies and solutions to investigate if they have the potential to grow in the future [37]. The most promising pilots and innovations from various start-up projects will eventually settle into dominant configurations. If they prove to be successful in the pilot phase, the project will have the potential to grow into society gradually. With the proper support, the current electricity infrastructure regime may be destabilised, and the dominant configuration can challenge and possibly replace the existing regime.

The literature has depicted three distinct electricity scenarios of off-grid, smart-grid, or super-grid systems to understand how the niche could be established in the future [39]. With the off-grid system, the mini-grid will be essential since this option creates a decentralised electricity system without connecting to the main grid.

With the smart-grid system, the mini-grid will be a part of the solution where a decentralised system configuration promotes small-scale mini-grids and numerous renewable energy technologies [39]. The last explained endpoint is a super-grid system characterised by highly centralised renewable electricity production and large-scale transmission over extensive distances. At this endpoint, the niche of the mini-grid will be abandoned and only enable space for one centralised grid. The literature states that it is too early to predict which direction the transition is moving and which scenario is more favourable.

A framework that could be applied to the research is Technological Innovation Systems (TIS). This framework is used to study the emergence and growth of new technological fields and industries [40]. TIS is regarded as a critical framework in transition studies for identifying flaws and making recommendations for policy design in support of a particular technology. It is impossible to incorporate all elements of socio-technical transitions because it does not consider the decline of socio-technical systems and lacks a solid theoretical basis to consider the interaction of numerous technologies adequately. Thus, TIS will not be assessed in this research.

3.3 Critical factors for success

For a niche to grow and prosper in this technological transition, the firms must receive a foothold [27]. In a new technological environment and a country with a rather insufficient market mechanism, the government must support firms in various ways necessary to operate sufficiently. Thus, it is crucial to understand how firms can grow and how the government may support the firms to answer the research question. For this study, a previous master thesis in particular were read thoroughly to grasp an understanding of different important factors for success [41]. Their thesis examines critical factors for a successful mini-grid operation in Tanzania. Further academic journals were read to obtain a more in-depth knowledge on this topic. Critical success factors are the components of an organisation or firm that are crucial for its success [42]. These are areas of activity that require management's continual and cautious attention. The identified critical factors for success have been sorted in the PESTEL framework of political, economic, socio-cultural, technological, environmental and legal dimensions [43]. The PESTEL framework is utilised in strategic management to analyse the external business environment to identify strengths, weaknesses, and risks in each dimension. In this regard, the PESTEL framework will sort the critical factors depending on the area of focus.

In particular, this research will utilise the identified critical factors for a successful mini-grid operation and development from the literature to examine what the firms in Kenya consider important. The government will also be incorporated to suggest how they could support the firms with the specific factors. Since our research question aims to understand the role of government in supporting the firms to establish and grow, the identified critical factors will acknowledge the firm's specific needs. The working environment of the firms is considered to be similar throughout Sub-Saharan Africa. Thus, the factors arrive from areas in this geographical region.

Political dimension

There is a need for tailored policies and regulations adaptable to the dynamic political environment in Sub-Saharan Africa to succeed with rural electrification [22]. According to stakeholders within the energy sector, the main drivers for rural electrification in Tanzania are political priorities since they have the power to establish policies and legislation in the sector [44]. It has also been mentioned that regulatory frameworks and strategic plans are essential tools to encourage the energy sector's growth, especially for the private firms to establish and grow [45]. Hence, policymakers must consider the shape of legislative and regulatory frameworks to adapt these to one or more business models. Therefore, there is a need to design a dynamic business model adjustable for a changing political environment [22].

The literature further highlights the importance of having a multi-stakeholder collaboration [46]. It has been considered critical to involve all stakeholders in a collaborative decision-making process. However, this could also backfire since challenges exist today regarding an aligned understanding of the critical issue between stakeholders. Even if multi-stakeholder collaborations are highly valued, decreased public sector involvement should be pursued in the long run until the private sector has achieved self-sustaining market conditions and matured. The public sector must initially provide multi-level financial support to entice the private sector to achieve a matured market condition [47]. In addition to multi-stakeholder participation, stakeholders should exchange and facilitate access to data on rural mini-grid development to assist critical actors in project success [22]. Promoting a collaborative database and gathering information between multi-stakeholders concerning mini-grid development is a critical factor.

Economical dimension

There are revenue and payment methods that have proven to have a significant impact on the business of mini-grid operations [48]. The literature identifies three critical areas for company sustainability, cost-reflective pricing, revenue collection, and efficient metering [45]. To be profitable, mini-grid firms must establish balanced tariffs covering operating, maintenance, and management costs (O&M&M). When cross-subsidised tariffs are utilised, the result is poor financial performance and an inability to cover these expenditures. However, regardless of how much tariff mini-grid operators are permitted to charge, it is not guaranteed that rural consumers will be able to afford cost-reflective prices.

Furthermore, the capacity to collect revenues is critical [45]. The pay-as-you-go (PAYG) payment system is a commonly discussed and highly respected payment system with unique revenue collection options [49]. The customer continuously purchases a limited amount of prepaid energy through PAYG, and the system can be turned on and off as needed. The ease with which consumers can make payments is a significant feature of PAYG.

However, the potential rural mini-grid operator should analyse the customers' payment behaviour and willingness to pay before entering the market to determine an appropriate payment mechanism and tariff level [50]. Therefore, utilising a payment model that imposes upfront payment has been considered a critical factor. In addition, an effective metering system has been acknowledged as a critical tool for successfully functioning rural mini-grids to reduce energy bypassing [51]. Thus it is vital to recognise and use an efficient metering system, e.g. smart metering.

Socio-cultural dimension

Engaging and involving the local community has been identified as an essential aspect of success by the literature [50]. The involvement of the local community, various stakeholders, and potential consumers in the energy sector from the earliest design phase are crucial. Hence, the mini-grid is suited to local needs and conditions to increase acceptability and satisfaction. Before firms build mini-grid operations in rural communities, it is critical to study consumer behaviour, learn about, and account for consumers' willingness and ability to pay [52]. There is a risk that introducing a service that the local population cannot afford may fail. Furthermore, improving the locals' ability and desire to pay could be assessed by providing extra services that help to stimulate the development of income-generating activities [53]. Firms must understand how consumers prefer to pay to create a payment plan appropriate for local consumers.

The literature mentions technological assistance as an essential driver for stimulating the in-come generating activities since it emphasises the relevance of knowledge among mini-grid developers about the local community and awareness among members of the local community about mini-grid technology [54]. According to reports, community-based ownership is a significant driver of mini-grid project success. Suppose the community is in a more mature renewable energy sector. In that case, the chances of finding educated locals are better than if there is no such market [55]. Technological assistance is significant since a lack of local maintenance capability, or a complete lack thereof, decreases the odds of success and may lead to the failure of mini-grid operations [54]. If local capacity is low, local users and operators must be educated to ensure proper consumption and operation, which increases project lifetime [46].

Technological dimension

It is essential to use green and renewable mini-grids to increase energy access without affecting the environment [46]. It is concluded that a hybrid mini-grid powered by hydro and solar PV is the most viable solution for most locations. Hydropower is implemented since this is the most cost-effective resource, and solar PV is used to accommodate seasonal resource fluctuations. The use of diesel can further operate mini-grids. However, a case study from Mozambique and Tanzania concluded that all the stakeholders did not encourage using diesel generators to improve rural electrification [44]. Hence, diesel generators are seen as costly and unreliable.

Furthermore, it is vital to consider quality control at an early stage as a critical factor. Quality significantly impacts system lifetime, and no sacrifices should be made to achieve the lowest generation costs [46]. Early implementation of quality control is crucial to achieving a long-lasting mini-grid while simultaneously identifying potential risks and making electricity affordable to consumers.

Environmental dimension

The literature explains that one critical factor is related to the surrounding environment of hydropower mini-grid facilities. The use of hydropower can harm the environment. For instance, in Rwanda, during the rainy season, high sediment levels and soil erosion are present, which harm the environment [23]. Renewable technologies should be utilised in a way that minimises the environmental impact. Therefore, the protection of the local environment in areas of hydropower mini-grid is considered a critical factor.

Legal dimension

In Kenya, there is an uneven electrical grid distribution and resource allocation [56]. Within an unjustifiable energy sector, there appears to be a need for more controls and a push for legal recognition to reduce corrupt officials. Mini-grid developers frequently hold opposing viewpoints on regulation [22]. Developers who have been attempting to sell electricity to the national utility are overjoyed when the regulator directs the national utility to buy the produced electricity at a price that covers their costs and allows them to profit. In this case, the mini-grids see the regulator as partners. In contrast, a mini-grid developer, particularly one privately owned and who wishes to sell at retail, occasionally remarks that dealings with the regulator are aggravating. The typical complaint is that regulators impose significant fees, and the decision-making process can be slow.

The last complaint is common in underdeveloped countries [22]. According to the literature, the higher the transparency of regulatory processes, the slower the regulation. Furthermore, there is a privately expressed concern in many nations that the more necessary governmental permissions, the more probable it is that the developer will be solicited for a bribe in exchange for the required piece of paper.

The developer further requires a licence or other comparable paperwork to operate legally [22]. The licence offers them credibility, which is required to acquire a bank loan or other funding source to make the project a reality. Most developers would prefer to obtain this initial regulatory permission without further substantive regulation. Regulators view this from another perspective. In their opinion, providing a legal monopoly by granting an exclusive right to serve one or more communities obligates them to defend those clients. These entities must be balanced without the presence of corruption or bribery. Therefore, striving for a better legal acknowledgement is considered a critical factor.

Table 3.1: List of critical factors for a successful green mini-grid operation and development from the literature.

Dimensions	**Critical factors from the literature**
Political	Design a dynamic business model adjustable for a changing political environment.
	Promote a collaborative database gathering information between multi-stakeholders concerning mini-grid development.
Economical	Utilising a payment model that imposes upfront payment.
	Utilise an efficient metering system such as smart metering.
Socio-cultural	Engage and involve the local community.
	Stimulate the development of income generating activities.
Technological	Hybrid mini-grid powered by hydropower and solar PV.
	Establish procedures for quality control.
Environmental	Protection of the local environment.
Legal	Strive for legal acknowledgement.

4
Research design

This chapter presents the methodology and working processes for this thesis. A description of the case study has been presented and outlined together with the data collection method. Lastly, evaluation of the analysis, reliability, validity and method.

4.1 Methodology

In the initial phase of this research, a descriptive research method was used during the pre-study and the literature review when describing Kenya's current situation and the renewable energy sector. Further, during the interview phase, the respondents enable a qualitative understanding of the current energy situation in Kenya and state how the government can support the firms and what type of support the firms need. Thus, an explanatory approach was used during the interviews to let the respondents explain what is essential for the renewable energy sector to grow successfully. A flowchart of the working processes is presented, see figure 4.1.

The key independent variable used in this study is the government's understanding of the critical issues and the firm's understanding of the critical issues. The dependent variable is the type of support the government can give the firms.

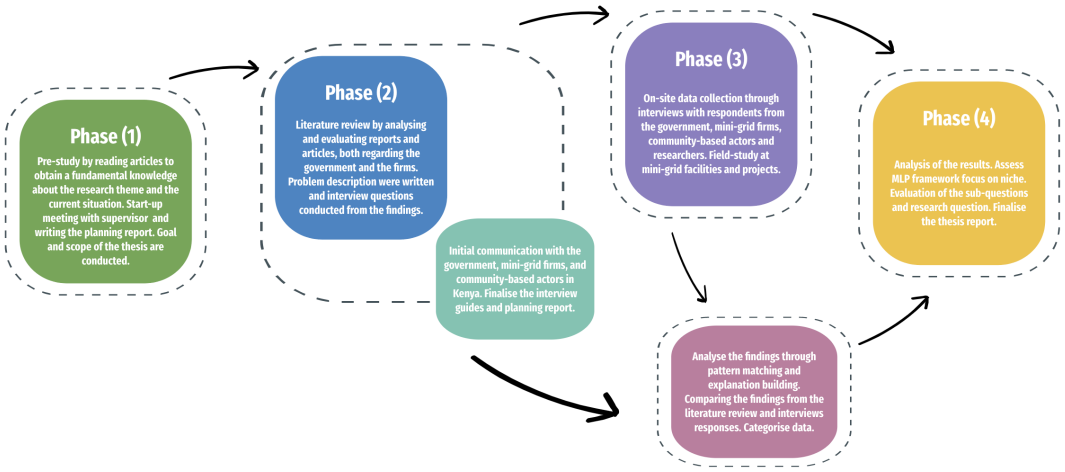

Figure 4.1: The outline of the working process for this thesis.

4.2 Research model of the Case Study

This research will apply a qualitative case study in Kenya to establish how the government and the firms view the research questions. In particular, the role of the government in handling challenges and how they could support the firms to establish and grow in the energy sector. The firms will also be addressed to understand what they believe the challenges are and, in particular, what support they need to grow. The critical factors for success will be utilised in the interviews since they will provide in-depth information regarding what specific factors are considered to be necessary, if there are more to add and how the government may assist in this matter, see figure 4.2.

Three different populations have been identified for this research during the literature review to conduct the case study. These populations consist of the government, mini-grid firms and researchers in the energy sector of Kenya. For the government, a sample size of 2 respondents from the Ministry of Energy was used. For the mini-grid firms, the total population size was determined to be 50 different actors, 30 private firms [18], 2 public firms and 18 community-based actors [13]. Out of the 50 mini-grids, a sample size of 6 mini-grid was used. For the researcher, the sample size was 4.

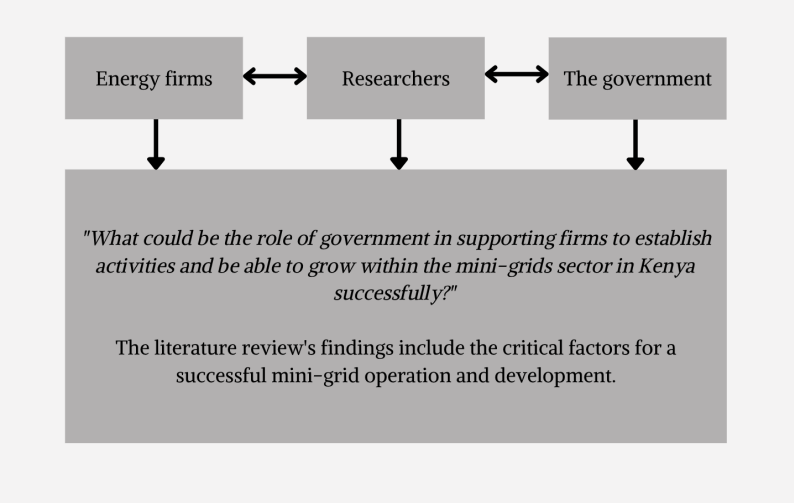

Figure 4.2: The different populations and their interactions with the research question.

In the case of technological innovations, the MLP framework covers the politics of social innovation processes, emphasising the regime changes required, the hurdles encountered, the power dynamics at work, and the effect and mobilisation of external landscape events and dynamics. Since this research focuses on mini-grid operations, this framework depicts how the niche can promote the renewable energy transition. The disadvantage of the MLP framework is that the sustainability transition can be challenging to define since socio-technical transitions are a particular type of research that considers relatively unusual, long-term macro-changes [57]. It is difficult to build large data sets that can be statistically analysed for connections between variables. As a result, transitions are a complicated and multifaceted research issue, and researchers often disagree on the methodology to perform MLP. By building a concrete understanding from the literature review, interview questions will be able to be developed.

4.3 Data and data collection

Both primary and secondary data have been gathered and evaluated for this research. In the pre-study and literature review, secondary data was collected from articles and strategy reports to understand Kenya's current energy situation. The policies and activities and how mini-grid firms operate in various locations were also identified. The initial focus when finding data for the MLP is to understand the niche. The primary data were collected through interviews with relevant actors in Kenya, i.e. ministries from the government, researchers and personnel from the mini-grid firms. The purpose of primary data is to provide recent information regarding how the government can support firms, what kind of support they need, has previous support helped, and what can be improved for the future. Since the literature has mentioned that the political environment in Sub-Saharan Africa is highly dynamic and frequently changes [22], primary data provides this research with updated trends.

The data collection methods have been divided into three phases that depend on each other. The aim of the first phase, pre-study, was to obtain an overall knowledge of our research theme, i.e. how the energy sector currently functions in Kenya and the current situation for renewable energy, what are the challenges in the sector, and what is the role of the government in this sector. With an understanding of the current phenomena, research questions and sub-questions were formulated. The second phase, literature review and problem description, focus on relevant articles and strategy reports that have been collected through keyword analysis from the pre-study. The third phase, interviews, provides primary data through interactions with relevant stakeholders in Kenya's energy sector. The primary data collection has been conducted in Kenya with field visits and on-site interviews.

4.3.1 Pre-study

This study began with investigating material and data to understand the research theme and choose relevant subjects for this thesis. Approximately twelve publications from the research field were read. Most came from the supervisors, while others came from applicable energy policies, reports and national energy strategy plans. The later publications were discovered using scientific sites, e.g. Google Scholar and ScienceDirect. Both supervisors were contacted while these actions were carried out.

The supervisors have prior expertise in renewable electrification in Sub-Saharan Africa. These consultations provided a broader understanding. Simultaneously, a project plan was created to understand better the project scope and how the research design should be carried out. Interesting existing issues were highlighted when reading the articles and literature, and relevant keywords from the literature were selected. These keywords were frequently mentioned in several articles and therefore believed essential for this research theme. The keywords were listed and further utilised during the literature review phase, see table 4.1. The pre-study phase resulted in a more in-depth knowledge of the research topic, a defined goal and project scope, and a draft of the introduction and methodology chapters.

Table 4.1: Selected keywords from the pre-study for the literature review. Filtration is defined as between what year the sources are published.

Keywords	Filtration	References used/considered
Current energy situation Kenya	2018-2022	(1/3)
Kenya rural electrification	No filtration	(2/3)
Mini-grids Kenya	No filtration	(2/5)
Kenya energy sector	2019-2022	(2/5)
Kenya energy policy	2018-2022	(2/4)
SDG7	No filtration	(2/2)
Challenges mini-grid Kenya	No filtration	(3/6)
Role government energy Kenya	2018-2022	(3/6)
MLP electrification Kenya	No filtration	(3/4)

The research question, together with several sub-questions, was conducted with the help of the supervisor. The research question aims to provide an understanding of what could be the role of the government in supporting mini-grid firms, while the sub-questions were constructed to support this theme. These sub-questions have been divided into two categories, the government and the firms, see figure 1.3. The sub-questions aim to provide more factual information regarding the current state while providing a more profound knowledge and dimension to our research. The research intends to use the sub-question to examine the niche within the MLP framework, i.e. how mini-grid operations can enhance the sustainable energy transition and how the government could support this transition by assisting the firms.

4.3.2 Literature review

Once the pre-study was successful, the literature review was carried out. The literature review aimed to examine how the current literature provides information and data regarding the research question, sub-questions, and the purpose of this thesis. For this research, the articles and literature were explored and evaluated from the selected keywords, see table 4.1. The investigation and evaluation of the literature review have followed an iterative research approach. This type of research approach is considered a critical process for qualitative research strategy since the literature was adjusted throughout the evaluation depending on new data and observations [58]. Several relevant articles and reports were evaluated from the keyword analysis, which gave us the base for our research theme. These articles were further applied to construct the chapter in this thesis regarding the current situation in Kenya for the renewable energy sector and to identify the research gap that was concluded to be missing from existing literature. A few more keywords were added to the list during the evaluation of the articles since the literature review process has been iterative. These keywords were found in existing articles and are believed to be critical for evaluating our research question.

Table 4.2: Additional keywords for the literature review.

Keywords	**Filtration**	**References used/considered**
Ministry of Energy Kenya	No filtration	(1/1)
Public and Private energy firms	2018-2022	(2/3)
Energy firms Kenya	2018-2022	(2/5)
Energy policy	No filtration	(1/3)
Drivers barriers energy firms	2009-2022	(6/7)
Electrification Africa	No filtration	(3/4)
Global electrification	No filtration	(3/4)
Critical factors rural electrification	No filtration	(8/10)

4.3.3 Interviews

A semi-structured approach has been formatted in this research. Hence, it allows the respondents to develop their responses while asking specific, open-ended questions. As previously mentioned, this thesis identified three populations, the government, mini-grid firms, and researchers. Different sampling methods were used for the different populations except for the government, where no sampling was present. Instead, all relevant employees at the Ministry of Energy were contacted. The respondent was found using their official website and LinkedIn, where a message was sent out to the personnel. A total of 15 respondents were found working at the government with relevant titles, where four respondents messaged back. Out of the four respondents, two agreed to an interview. The response rate from the government was 13.3 %. It would have been desirable to have more respondents from this sample. Hence, additional data and information would presumably be obtained to increase the validity of this research.

The population of firms was divided into three sample groups, private firms, public firms and community-based actors. The sampling was selected according to information obtained from figure 1.2. The figure illustrates an estimation of operating mini-grids in Kenya by 2022, where roughly around 1/3 of each category is operated by private firms, KPLC, and REREC, and a minor fraction is community-based. A total of two interviews from each group were conducted. The contact and communication with the firms and community-based actors were assisted by the supervisor from Kenya, who presented a list of relevant firms working with mini-grid operations and renewable energy projects. These respondents were contacted through telephone or email. The number of respondents from the firms is sufficient to obtain a satisfactory result.

When interviewing the researchers within the energy sector, snowball sampling was used. The first communication from a respondent from this sample was connected with the help of a supervisor from Kenya. When the interview was finished, the respondent was asked to supply contact information of relevant researchers that could be useful for this study. A total of four respondents from this population were interviewed who gave supplemental information and clarified uncertainties that had arisen from previous interviews. This amount was assumed to be sufficient enough to present valid data.

All the interviews conducted were based on three types of interview guides. Each guide had specific questions related to the presented sub-questions and research questions, see appendixes A.1, A.2, and A.3. The interview questions were constructed from the literature review, and the question was tailored depending on the population and specific respondents, recognising their unique perspectives and internal experience. A list of the identified critical factors was given to the respondents from the government and firms. However, the respondents could add or remove some of the factors during the discussion. The interview guide was emailed to each responder a few days before the interview, giving them time to prepare.

The respondents were asked to provide permission for recording after being introduced during the interview. As all respondents agreed, all interviews were recorded for further evaluation and transcription. The transcription was then given to the respondent for feedback and clarification, allowing the respondents to assess the material acquired from the interviews. The interviews took approximately one hour to complete, and the respondent determined the designated place for the interview. The location and identity of the respondents will not be specified for security reasons.

Table 4.3: Respondents interviewed for this research.

Respondents	Categories	Role	Date	Duration
1	Government	Ministry	10/3 - 22	1 h
2	Government	Ministry	21/3 - 22	1 h
3	Public Firm	Engineer/Manager	11/3 - 22	1 h
4	Public Firm	Engineer	29/3 - 22	1 h
5	Private Firm	CEO	29/3 - 22	1 h
6	Private Firm	Manager	16/3 - 22	1 h
7	Community-based	Chairman	7/3 - 22	1.5 h
8	Community-based	Chairman	1/4 - 22	1.5 h
9	Researcher	Consultant	29/3 - 22	1 h
10	Researcher	PhD Student	7/3 - 22	0.5 h
11	Researcher	Director Research	5/4 - 22	1 h
12	Researcher	Research Assistant	5/4 - 22	1.5 h

4.4 Evaluation of analysis

The analysis procedure was assessed by performing pattern matching and explanation building of the responses obtained from the interviews. Pattern matching is applied to compare patterns identified from the empirical data among the respondents and findings from the literature [59]. The latter assessment was explanation building that addresses the questions *"How?"* and *"Why?"* by further investigating in-depth the patterns discovered [60]. In this master's thesis, pattern matching and explanation building are critical since the established patterns must be qualitatively described before any relevant inferences can be drawn. Since the interview model was based on semi-structured interviews, various respondents have different experiences and expertise within this research field, resulting in opposing perspectives and viewpoints.

After the interviews were transcribed from notes and recordings, the transcriptions were thoroughly examined, and responses from separate interviews were grouped based on the theme. The content of the responses was frequently based on the questions in the interview guide, although other information was produced through unique follow-up questions and extensive answers. There are five specific questions derived from the responses in the results chapter.

Since the sub-questions are categorised into a group of questions explicitly targeting the government and one group targeting the firms, the five specific questions used in the result chapter are aligned from these categories. The five specific questions used in the result chapter provide information and data regarding the niche of the MLP framework, see table 4.4.

Table 4.4: Specific questions used in the results chapter.

1	What is the role of the government in supporting green mini-grid firms in Kenya?
2	Which are the main challenges when the government supports mini-grid firms?
3	What policies and activities have the government implemented today in the energy sector, and has it fulfilled its function?
4	How does the government work with critical factors, and what are important factors to the firms?
5	What combinations of policies, activities and support would benefit the energy firms in the future?

The next phase of the analysis procedure investigates the connections between a respondent's responses and arguments for those responses. The interviews aimed to obtain more in-depth knowledge about how the government can support mini-grid firms and how the firms have perceived this support from actors within the energy sector of Kenya on-site. Hence, comparing and finding similarities and differences between the interviews and the literature review findings was essential. After that, it became possible to draw qualitative conclusions about what support exists today in the energy sector and how the firms have perceived this support. More in-depth, how mini-grid operations can be a helpful tool in the sustainable energy transition where this technology can shift the current energy sector to be more renewable. Mini-grid operations are under focus because the niche incorporates a system of new technologies where innovative ideas occur.

4.5 Ethical discussion

It is critical to proceed with caution and openness regarding the cultural divide. When the interview questions were conducted, they were assessed with cultural sensitivity. The supervisor in Kenya approved the interview guide for cultural reasons. Thus, no inappropriate questions were asked. When established, the interview guide was sent to respondents a few days before the interview to allow time for preparation to ensure permission from the respondent to conduct the interview. In addition, respondents were asked if they consent to be recorded and then emailed transcripts for comment afterwards. After the interviews, the respondents were given a chance to clarify any misconceptions, giving them their last thoughts on the exact facts utilised as empirical data in this research. Before arriving in Kenya, it was necessary to research and acquire basic knowledge about the culture and behaviour to obtain a valuable interface with the respondents during the interview.

4.6 Reliability, validity and method evaluation

Reliability and validity are used as criteria to evaluate measurement quality [61]. Reliability refers to the consistency of a measure. High reliability means that the measurement system produces consistent results under the same circumstances. However, minor fluctuations in findings are accepted. If measurements are performed under the same circumstances several times, the results will be of a similar state, therefore, be replicated. The purpose of reliability is to decrease errors and prejudices. The methodology of this study has been well developed, ensuring that it can be replicated under similar conditions. When collecting the empirical data from the interviews, the respondents from the same population were ensured to be given the same open-ended questions. However, as the interview process was semi-structured, it is unrealistic to expect to receive comparable data from each respondent. The literature does not clearly define how many interviews should be included to receive high reliability. However, literature and articles suggest that 5 to 50 participants should be seen as a sufficient amount [62].

For this research, our supervisor in Kenya provided a list of contact information for public and private firms in the energy sector. Two public firms are working with renewable mini-grids and rural electrification in Kenya, and both successfully agreed to conduct interviews. Two more private firms were also reached, and the response was successful. The respondents from private firms could have been randomly selected to improve the reliability of this study. Regardless, since there was no direct contact information on private actors in Kenya, the supervisor supported the schedule of these meetings. There was a challenge in receiving responses when reaching out to the government. One assumption can be that the Ministry of Energy is difficult to reach, and scheduling an interview would require booking an appointment several months in advance.

For all the respondents, their diverse experience and expertise must be highlighted, as it is relevant to the quality of the empirical data. The government Ministries have worked in the renewable energy sector of Kenya for a long time and were involved in policy and decision-making assignments. Further, there are two public firms in Kenya, one that works with universal energy distribution, and the other has a significant focus on rural electrification. Several respondents from private firms and community-based actors have experience in mini-grid facilities construction and maintenance, have worked with small enterprises and local communities, and are knowledgeable about tariff negotiations with authorities. An essential factor must be considered is that there will soon be an election in Kenya in August 2022, where new or adjusted legislation is expected to be implemented. Therefore, the reliability of this research focuses on the current energy situation in Kenya. However, the respondents were asked how they view the sustainability transition and what combinations of policies, regulations, and activities can be applied in the future for sustainable growth of the energy sector.

The term validity refers to whether or not the measurements accurately reflect what they are supposed to measure [61]. Validity relates to whether the approach and framework used to investigate the research issue are adequate. As a result, the quality of the results is strongly tied to the study's validity. Before doing the literature research and conducting the interviews, a pre-study containing a brief literature review was conducted to ensure high validity for this study. This procedure enabled identifying and selecting keywords of interest and a more excellent grasp of the problem description. The iterative strategy used throughout the literature review was another measure to ensure greater validity. The findings of a prior thesis were utilised as the foundation for the literature analysis, in which essential elements for effective mini-grid operations were carefully studied and evaluated. The thesis has been under the supervision of our examiner and supervisor from Chalmers and Kenya, whom all have experience within this research field. To further increase the validity of this thesis, a presentation consisting of the gathered information and data from the interviews was held in Kenya to our supervisor, and private discussions were made with ambassadors from the Swedish Embassy of Kenya to enlighten self-awareness about this research theme.

When evaluating the methodological weaknesses of this research, more attention could be given to the initial phases regarding the working processes, see figure 4.1. The cause for this was time constraints before leaving for field studies in Kenya. If more time had been given, the pre-study and the literature review could have been more thoroughly revised, and a better understanding of this research theme acknowledged. Primarily since the interview questions were derived from the literature review, they could have been more specific. Nonetheless, the interviews were well executed, and sufficient data were obtained for the research to evaluate and finalise conclusions. This study explains the role of the government and what types of support could be given to the energy sector more in-depth and has addressed responses from both the government, firms and researchers.

5
Results

5.1 What is the role of the government in supporting green mini-grid-firms in Kenya?

5.1.1 Governments responses

When asked what the current role of the government is in supporting green mini-grid firms in Kenya, respondents 1 and 2 explained that the government plays a critical role in improving electrification in Kenya. Respondent 1 states that the government's role is to create an enabling environment where independent developers can grow their mini-grid firms. Respondent 2 shares respondent 1 opinion that the private sector is critical to the electrification of Kenya.

According to respondent 2, the primary function of the government is to facilitate. The government functions as a middleman between consumers and the different mini-grid firms, and its responsibility is to develop policies and regulations that enable investments in mini-grids. The government's role is to establish policies and frameworks to help electrification. Respondent 1 mentions energy mapping, a tool that identifies where mini-grids projects could take place. Respondent 2 says the importance of Kenya's national electrification strategy, which describes how the government intends to increase energy access. In addition, respondent 1 states that the government helps newly entering firms enter the market to overcome barriers. The government needs a stable market since sudden changes can hinder companies' success and economy.

Respondent 9 addresses that the government in Kenya invests in numerous resources to develop rural electrification. The respondent states that connecting remote areas with the main grid is difficult and expensive, and it will take a long time before they can reach these areas. Therefore the government is developing mini-grids in these areas. Respondent 10 describes that the role of government is at multiple levels, in numerous categories, in conducting policies that support firms in the right direction and creating a safe environment where energy firms can grow and protect themselves from corruption.

5.1.2 Firms responses

Considering how the firms perceive the role of the government in supporting green mini-grid firms in Kenya, all respondents agree that the governments must guide and facilitate regulations and policies to help firms and the energy sector to transit toward the use of more renewable energy sources. For the public firms, respondent 3 and 4 mentions that the public firms are constructed from governmental policies. Therefore the government has a significant influence on the energy sector in Kenya. They influence decision-making policies and enable the direction of the firms. Respondent 3 mentions,

"The government finances and even supports taxation policies, e.g. equipment or machines for mini-grid facilities such as solar PV and inverters. This financial support cuts down the cost, therefore, we can grow within the energy sector."

Respondent 4 explains the role of the government as to when the main grid has reached the mini-grid facility in remote areas. The government can decide on two options, the mini-grid could be installed into the main grid or shifted to another place. The respondents mention that the optimal path for energy access to all Kenyans by 2030 is through grid extensions that branch out and reach mini-grids. Thus rural electrification has been successfully made. The mini-grids are not the key to successful energy access but rather a tool to enhance the sustainable energy transition.

Respondents 5 and 6 from the private firms agreed that a solid and stable policy is fundamental for successfully growing within the energy sector. Both respondents mention that the government is currently changing the laws therefore, the current political situation in Kenya is dynamic, and the government needs to provide the support that keeps the firms within the sector sustainable. However, respondent 5 further mentions that the regulations and policies that exist today perhaps seem perfect on paper, but in the application and real life, they are not working. The legislation does not cause a problem within the energy sector. Instead, it is the authorities' contempt towards them that is condemned. Respondent 5 states,

"Frameworks, in reality, are poor, and authorities are not doing enough to make policy and regulations more active. The government must attempt to decrease the corruption."

While respondent 6 gave a contradictory answer to the previous statement, explaining that the authorities are doing sufficient work.

"The government and different authorities have been supportive from the beginning in how to encourage private sectors and mini-grid firms to grow within the market."

From the community-based actors, respondent 7 mentions that when the donors first brought the facility, they went to the government for land ownership. The donors did the project management and instalment of the mini-grids. Today, the government's only role within the community is that whenever the batteries need to be changed, the government will help with the purchase. All communities interviewed in this research agreed that they feel that the proper support has been given for the community to grow sustainably, develop small scale businesses, and increase the quality of life.

Respondent 8 mentions that the grid extension by the government has reached their community and has successively taken over significant parts and components of the community. Hospitals, schools and learning centres are now supplied with electricity from the main grid. Respondent 8 agrees with respondent 4 that grid extension is critical for Kenya to acquire their energy target.

5.2 What policies and activities have the government implemented today in the energy sector, and has it fulfilled its function?

5.2.1 Governments responses

Respondent 1 highlights that the government uses various regulations to promote the mini-grid sector. For instance, K-OSAP is currently under development and focuses on renewable mini-grid projects to promote the development of green electrification. Respondent 2 explains that the government is improving existing regulations and updating them, referring to Energy Act 2019. The respondent says that any firm that wants to invest in green mini-grids should be able to do so, and support must exist from the government for the firms to establish themselves. When asked if these regulations have been directed to any specific firm, respondent 2 replied,

"When developing strategies, policies, and regulations, we do not forecast on a specific type of firm, whether private or public. We only want to see how we can grow the industry. Hence we look at the full spectrum. Both private and public firms are addressed in these regulations. Nevertheless, of course, they apply differently between the actors."

Respondent 1 agrees with this statement and describes that tariffs significantly differ between public and private firms in the mini-grid market. Public firms have uniform tariffs, cross-subsidised between the main grid and mini-grids, while private firms have cost-effective tariffs. However, the respondent mentions significant differences between public and private firms. Both firms' policies and regulations are the same, but the public firms receive more financial aid and internal support than the private firms. The reason is that the government is a shareholder of the public firms and, therefore, can control the management more in-depth. Private firms need more assistance to succeed since they are not government-managed.

If the implemented regulation has fulfilled its function, respondents 1 and 2 answered that current regulations helped rural electrification. They describe several indicators used to evaluate and measure success. Respondents 1 and 2 say that one key indicator to determine success is to analyse how many households have gained access to electricity since the regulations have taken place. Respondent 2 adds that other important indicators are the number of mini-grids driven by renewable energy and investors' willingness to invest in mini-grid projects.

When asked the same questions to researchers, respondent 9 mentioned three necessary regulations that the government has implemented to support mini-grid firms. These are the feed-in tariff, take and pay model and national integrated energy development plan. When asked whether the same regulations apply to both private and public firms, respondent 9 stated the following,

"It is not the same for public and private firms. The public firms are charging lower than the rate that private firms charge. The government now protects investors by allowing them to dictate the rate they want to charge. The public firms have no option on how much they can charge since policies implemented by the government protect them."

The most significant milestone regarding policies that the government has passed is the Energy Act 2019, according to respondent 11. The responder explains that the act governs the importation of solar equipment. When the cost of energy equipment was reduced, it increased investment in mini-grids and solar home systems. The respondent further explains that the Energy Act 2019 dictates that firms must employ a certain percentage of locals.

Respondent 12 clarifies that one must consider that policies and regulations are viewed differently by public and private firms since they have different responsibilities, missions and assignments. Public firms have institutional policies specific to the government on how the firm should operate. The government gives each institution a set of policies and regulations depending on the work they are supposed to do. When observing, e.g. KPLC, their institutional policy is to supply energy to the national grid and distribute it. This type of policy is specific, and therefore the private firms cannot be given the same funding or support as KPLC. Thus, the government gives different policies to different firms.

Respondent 12 adds that public firms have a safety to remain in the market. If they do not reach a certain electricity distribution level, it does not matter for them as much as private firms. According to the respondent, private firms risk being pushed out of the market if they cannot provide the energy they are supposed to and lose customers. The struggle of the private firms can also be viewed as a good thing since they have to fight and work efficiently. The private firms must ensure they are at the front of technology innovation, operational costs and development. Respondent 12 states,

"I think for me, the motivations for both are different. Private firms are more, what you call, business-oriented, while public firms are just service delivery. The latter mentioned that public firms have another form of motivation, they are more pressured to work with these mini-grid projects, and maybe they do not even want to work with them, whereas private firms want to work with this."

Regarding if the policy and regulation have fulfilled their function, respondent 12 replies both yes and no, and states,

"Success depends on what area or location you are observing. Some areas have successful projects where policy and regulations have worked, whereas others do not. However, we have come a long way, and rural electrification has improved."

5.2.2 Firms responses

Respondents 3 and 4 agree that the government has regulated them to be at the forefront when implementing strategies. Respondent 3 adds that the government helps public firms to interact with each other and invites new partnerships and collaborations to enter the market. Thus, creating a communication platform between public firms where different stakeholders can interact within the energy sector to support each other. Respondent 4 states that although the government provides the public firms with more funding and internal support, it also creates expectations and obligations that the firms will have towards the government to succeed and generate revenue. The government pressures the government to generate a certain amount of electricity.

Respondents 3 and 4 mention an up-rising effect of renewable energy sources and a functional movement to realise clean and green energy. Since more people are aware of the vital benefit of clean and green energy, the policies and activities that have been put in place indicate successively progress. Respondent 4 states,

"In the last 10 years, the government has done more electricity connections than they have done in 50 years. The rate of electrification has gone up. Thus, policies have helped electrify most of the country by extending the grid and using mini-grids. We are a good way of achieving a sustainable energy transition."

While the public firms seem satisfied with the policies and activities that the government has deployed, the private firms, on the other hand, were not equally satisfied. Respondent 5 claimed that the current market is not mature enough for mini-grid operations to benefit private firms due to the high tariffs. An ideal scenario would include participation from more equity providers and regulation or standardisation to design a mature market. Respondent 5 explains why the policies have not fulfilled their function in the renewable energy sector and are still immature and not receiving the required attention. Respondent 5 mentions,

"Let us go to the poorest region in the whole world and charge a tariff so high that it would not even be acceptable in Europe while the investors, by the way, come from our taxes, and expect a 20 % return. How is this supposed to work?"

Respondent 5 criticises the policy regarding licence to sell electricity from regulators and authorities. This policy is assumed to be accessible since the firm owner will receive everything they need and all the necessities for operating the mini-grids. However, the problem with the licence will come afterwards. According to the respondent, since the political environment in Kenya is dynamic and highly fluid, the legislation with the license can change suddenly. Hence, creating uncertainty. Even though there are agreements before the mini-grid operations begin, they seem to change with the new political environment.

Respondent 6 agrees with respondents 3 and 4 that rural electrification has improved rapidly since the energy strategy plan. Respondent 6 agrees with respondent 5 that the market is not mature enough. There is still a lack of standardisation for mini-grid operators and developers, hindering many market firms from growing and succeeding in the long run.

The community-based actors primarily depend on donors and investors since they are responsible for the mini-grid facilities. From the interviews, respondents 7 and 8 shared that they are satisfied with the support and different activities and projects the donors have given. Respondent 8 continued to explain that they have received fundamental technological assistance and education from their donor regarding how mini-grids operate and function. Respondent clarifies that, by receiving knowledge about these specialised compartments, they have managed to fix minor errors when they have occurred and shared this technical competence with the other inhabitants of the community. However, significant errors still require technical assistance from the government or experts. Furthermore, the donor has supported this community by installing cooling machines and equipment, which has made it possible for this community to store milk and other necessities. This cooling apparatus has opened up the market for small scale businesses since they can now store the milk in the cooler and last longer.

5.3 Which are the main challenges when the government supports mini-grid firms?

5.3.1 Governments responses

Respondents 1 and 2 identified several challenges associated with government support for mini-grid firms. Respondent 1 stated the following regarding challenges with fair pricing,

"Provision of electricity has become a social service. Electricity is for all, not only the rich but everyone. Electricity is becoming more of a basic need. Therefore, tariffs should be cost-reflective and not high. There is a risk for backlash if the cost is too high and customers cannot afford it."

Furthermore, respondent 1 considers land ownership a significant challenge. To avoid misconceptions concerning land ownership, mini-grid developers argue for clear regulations from the government regarding who owns the land. Respondent 2 believes that one significant challenge for today's government is what they should do when the main grid is extended to an operating mini-grid? Respondent 2 clarifies,

"Do we tell them to move, do we return their investments, or do we convert them to be generators? That is a challenge we have today, that we must be specific in our regulations."

Respondent 9 believes that insecurity is one of the significant challenges the government faces. According to the respondent, electrification in rural areas is interconnected to an increased threat from terrorist organisations. It is necessary to increase the cost of security to keep electrification safe. As a previous incident, the respondent mentions the attack on Garissa University College, where the university became a target due to electrification. According to the respondent, since electrification enhances the development within the area, terrorist organisations tend to target these areas.

Respondent 10 describes several critical challenges for the government. The first one is current funding. The government lacks financial support to make projects sustainable in the long term and make them profitable. Further challenges are the lack of standardisation on how an effective mini-grid operation should work and the transition from diesel-based mini-grids to renewable resources, which requires new personnel and technical assistance. Respondent 10 also addresses that the government needs to be able to satisfy both users and producers.

"Cost reflective tariffs will always be higher than the centralised grid, government challenges to create fair and affordable pricing concerning universal access of energy to the people."

Respondent 11 considers corruption a challenge when the government supports energy firms. According to the respondent, the government does not allocate resources equally. Once the funds have been allocated, there is a problem with corruption. Respondent further mentions the dominant energy sources and prefers the fossil fuel-based firms and their significant contribution to the energy sector as a primary challenge. According to the respondent, the fossil fuel-based firms and oil prices are considered external pressures on the government for a sustainable transition.

A challenge for the whole sector for renewable energy is described by respondent 12. The renewable sector in Kenya is not very well established. If compared with the fossil-fuel sector, renewable energy is just developing. Energy Act 2019, which the government has developed as an energy policy, is entirely new. The renewable sector has only been a minor part of that strategic plan. That particular strategy itself cannot develop the sector. It needs to be broadened and supplemented, i.e. more detailed guidelines on specific activities that the government needs to implement. Respondent 12 believes that since the renewable energy sector of Kenya has not been given a significant role, energy targets tend to fail.

5.3.2 Firms responses

The firms are aligned with most of the current challenges, particularly the limited funding for the sustainable energy transition. Respondent 3 focuses on political challenges, i.e. internal conflicts within the board of stakeholders, and mentions that decision-makers are often not united when discussing what energy source should be prioritised. There is a risk that the applied policies have been brought up by narrow political interests, which may hinder investments and funding from being allocated to the renewable energy sector.

Respondent 4 mentions that due to no existing standardisation, it had been a significant challenge for investors and newly entered firms within the energy sector to pursue their operations successfully. Furthermore, respondent 4 states that the absence of a regulated standardisation has long waiting to receive licences and permits for the firms to operate. The firms are put on hold during the waiting period, and losing revenue is inevitable. Respondent 6 agrees and states that the challenge is to get a fundamental framework that is flexible enough to allow the private sector to operate and grow. Thus, it is crucial to have a formalised standardisation.

For the private firms, respondent 5 states that the agreement between investors, government and the firm itself is insufficient. The respondent explains that laws, regulations, and policies can change suddenly since the political environment in Kenya is highly dynamic. Some of these changes can put heavy pressure on the firms from an economic point of view, and the net cost for operation and maintenance can become higher than expected. In these situations, the respondent expresses that neither the government nor the investors rarely give external support or subsidies, leaving the private firms trapped in the market.

Another challenge highlighted by respondent 5 is the level of insecurities regarding the elasticity of the demand. Hence, at times, the firms could lower the tariff if the elasticity is high, and the customers will consume the same amount of money proportionally. Even though understanding this demand is critical, private firms usually do not take this risk. Respondent 5 states,

"There is so much money in this market, but at the same time, there are many uncertainties for me as a business developer, and I do not want to take that risk."

The community-based respondents 7 and 8 agree with mentioned challenges and explain that the support from the government can take a long time to be implemented. Suppose the chairman from the community has, e.g. reached out for help regarding maintenance or technical support. It can take several days for the errand to be under consideration and months before help arrives. For respondent 8, due to the lack of support and technology competence, some components of the mini-grid facilities have not been in operation for several years, hence a decrease in energy efficiency within that community. It is primarily the donors' fault since they are responsible for providing technical support for the facilities.

5.4 How does the government work with critical factors, and what are important factors to the firms?

5.4.1 Governments responses

Political dimension

A dynamic business model adaptable to the political environment is an essential critical factor, according to respondent 1. Kenyan policies can change instantly without any input from the private sector. Thus, when a new policy is assigned, it affects businesses and compels them to change or adjust their business models. Respondent 2 uses similar reasoning when describing why designing a dynamic business model is beneficial. The respondent explains that this is not a critical factor for mini-grid firms but relevant to all businesses. The respondent mentions the elections in August 2022, which will force the firms to adapt to new regulations. The changes might not be massive, but they will be noticeable.

Collaboration between multi-stakeholders at different levels is an essential critical factor that respondent 2 agrees to be necessary. The respondent explains that Kenya has two levels of government, the national and county government. The county commonly does construction and licence, and the review of tariffs is done at a national level. Therefore, firms must collaborate with these stakeholders to obtain an efficient working environment.

Economical dimension

Respondent 2 agrees that using an effective metering system is crucial. The government allows private firms to charge a cost-effective tariff, enabling them to return their initial investments. The applied tariff is reviewed and accepted by EPRA. The respondent explains that the government assists the firms with some financial aspects of the transition by giving them time to adapt to the new business model.

Socio-cultural dimension

Respondents 1 and 2 agree that engaging the local community to gain acceptance and work more efficiently is critical. Respondent 2 states,

"You have to sit down with the people to understand their needs. Furthermore, to understand how much people can afford and understand their culture. This helps with not only mini-grids but with all kinds of problems."

Technological dimension

Respondent 1 agrees with the critical factors presented regards to the technological dimension. Respondent 2 disagrees and mentions that quality control should not be considered a critical factor. The respondent explains there should not be a difference if the customers are connected to the main grid or mini-grid. The respondent mentions that IT support is vital to consider. However, the respondent mentions that the firms should work more efficiently with IT programs to achieve better results since this is not the case today. The respondent also acknowledges the critical factor of a hybrid mini-grid. According to the respondent, private firms use solar and batteries for smaller systems, and diesel is preferred as a backup for more powerful systems.

Environmental dimension

According to respondents 1 and 2, the critical factors presented are essential. Respondent 2 adds that the government must ensure that renewable resources run newly developed mini-grid operations. All private firms run their mini-grid operations with renewable energy as the primary energy source, while public firms still have mini-grids that operate with diesel or fossil fuel.

Legal dimension

The critical factors are agreed upon by respondents 1 and 2, whereas respondent 2 adds that it is beneficial for firms to involve the government at both levels in the early stages. The respondent mentions that there is always a risk of corruption and conflicts between stakeholders and authorities. They need to increase the security to minimise, preferably, eliminate the corruption happening behind doors.

5.4.2 Firms responses

Political dimension

When investigating how the firms view the critical factors for a successful mini-grid operation and development and how the government works with them, there were a few agreements on how they should cooperate when receiving support. Respondent 3 agrees that the political surroundings are dynamic in the nation. As a result of this dynamic situation, small firms find it challenging to stay in the market or even enter the market in the first place. The respondent believes that the government needs to support new firms entering the market with incentives or subsidies, thus growing the sector of green mini-grids. Respondent 4 agrees with this statement and adds that the government can either support your firm or refuse it.

Respondents 5 and 6 discuss the importance of collaboration between stakeholders and highlight this as one of the most vital factors for a successful mini-grid operation. Respondent 6 views the collaboration as something positive that the government works with by creating and constructing platforms or forums for mini-grid stakeholders to engage in innovation centres.

Respondent 5, however, is critical to this ideal image and states that the current collaborations are not efficient and must be improved and strictly regulated by the government. Respondent 5 clarifies that,

"The perfect image of functioning collaboration between stakeholders does not work in reality. You hire a consultant, pay 700 € per day, and receive no help. Most of the time, they do nothing. They are supposed to be technical assistants, but in this country, it is corrupt. They are robbing you. Collaboration is important, but it is tough in this nation's system where corruption and administration fail."

Economical dimension

All of the respondents from the firms agreed that economic factors are essential for their business to function. Respondents 3 and 6 mentions that the funding for infrastructure development, good health and green transition is limited in Kenya, and the government should focus more on the renewable energy sector. Respondent 6 adds that the investors must find a reason to invest in the renewable energy transition. Perhaps the lack of standardisation makes it more difficult for the investors to engage since most of the current project plans are poorly described.

Considering an efficient metering system, respondents 4 and 5 agreed this is critical. Instalments of efficient metres that can accurately measure energy usage are essential to bypass the metering system. Respondent 4 states,

"On the government side, they do have a standardised technology, ensuring that all commercial energy metres that are sold in the country can meet the minimum standards. Thereby, no cheating can occur using the metres."

For setting the price of electricity, the standard tariff scheme used is either a cost-reflective or cross-reflective tariff. Respondent 3 explains these concepts by defining that a cost-reflective tariff is where the consumers pay tariffs that match the efficient operation and maintenance cost of a mini-grid. Cross-reflective tariff is the ratio of the difference in actual compared to the tariff costs, divided by the absolute value of the actual cost of electricity supply. Respondent 3 further mentions that mini-grid consumers demand a cross-reflective tariff if it concerns a public firm since the costs will be less. In contrast, private firms want to supply the electricity in a cost-reflective due to profitability.

Respondent 5 disagreed with the cost-reflective tariff and believed it was a narrow point of view. The respondent argues that the cost-reflective tariff might function in the short term, perhaps three to five years, but private firms need to consider an investment plan for 25 years or more to be sustainable.

Ideally, the respondent mentions that the tariff should be homogeneous for all off-grid systems and builds up the argument by providing similar events from the past. Respondent 5 states,

"Look at Senegal and Tanzania, it does not work, and their mini-grid projects are becoming less to not successful. If mini-grid has different tariffs, then you will have problems. Therefore, it does not matter if you have 10 or 1000 mini-grids. It will be a failure. It will help if you need a homogeneous tariff for off-grid. Ideally, this tariff must be recognised and proportional for each country."

Socio-cultural dimension

All of the firms agreed that engagement of communities and people living in these areas is critical for the mini-grid project to function correctly and for small scale businesses and the quality of life to develop. Respondent 4 and 6 mentions that the firms cannot work without the people on the ground. One of the optimal ways of doing this is to include and discuss with politicians and inhabitants living and working in that area. Respondent 5 builds the argument further by stating that understanding the local demand and willingness to pay is essential. There are reasonable solutions for people living in rural areas, but firms and the decision-makers from the management team frequently do not consider their opinion.

Respondent 5 explains that all firms, public or private, should let the people living in the area become official stakeholders when operating in these areas. Respondent argues that it does not make sense not to consider the people living in these areas and their necessitates before decision-making. Respondent 6 states,

"We need to understand before we can act. When we go and build the mini-grid facilities, we need to understand the people living there. Even if these facilities enhance the quality of living in these areas, factors such as willingness to pay and accept are important."

For the firms to work better with the community, respondent 3 mentions that the government can demand Corporate Social Responsibility (CSR) reports and engage them in sustainability-related works. Respondent 3 states,

"With support from the government, CSR reports can be used to engage the local community even better. It creates a responsibility from the government side towards the community and people, but this is expensive to do".

Technological dimension

Respondent 3 explains that technical competence and knowledge are crucial for a sustainable energy transition. According to the respondent, this transition also means new knowledge about renewable energy and training operators and personnel with new technical assignments. The government can support this by giving the personnel updated and regular education.

Respondent 4 mentions that hybrid mini-grids with solar PV as backup are the most efficient mini-grid type. Since diesel price fluctuates, the firm wants to reduce its dependence on diesel and increase renewable energy sources. Further, respondent 4 briefly explains that most private firms depend entirely on green technologies while public firms have more technical equipment based on fossil fuels. The respondent addresses that the government must give the renewable energy sector more space and promote the use of green technologies.

The respondents agree that the firms' control and operational management quality are critical. The government can support the firms through regular check-ups and controls. Respondents 5 and 6 mentions that the government must also review the technical and operational reports to improve work. Only respondents 4 and 6 mention the use of IT and other software to improve the technical systems within the facilities, e.g. communication and detection of error for advanced operation. However, according to them, IT is not considered a critical factor.

Environmental dimension

Considering the environmental factors, the public firms' respondents did not answer. However, they mentioned a body within the government of Kenya called the National Environmental Management Authority (NEMA). Respondents 3 and 4 mentions that NEMA's mandate is to supervise, monitor and coordinate all environmental matters within the country. The scope of this authority is broad but environmental aspects regarding mini-grid facilities and protection of the local environment are included within the scope of NEMA's work. Respondent 4 states that the government is already working on this critical factor.

Respondent 5 mentions that the government is not efficiently working with recycling and waste management of used batteries, where the respondent states,

"Batteries are, however, a concern. There are no clear descriptions of how the government deals with batteries when they need to be disposed of. There is no recycling station or waste management system for the batteries. The policies are poorly described, and you can get away with cheating the recycling."

Legal dimension

All of the respondents from the firms agree that authorities must be involved and act appropriately. One issue respondents 3, 4 and 6 mentioned concerns that the licence to operate takes a long time to get approved. The long waiting time can hinder small firms from operating. The respondent agreed that the government must work more effectively to manage the decision-making process for the licence. Respondent (5) mentioned that the authorities are frequently built on corruption, and in reality, they do not function as properly as they might say in the documents. This type of corruption makes it more difficult for firms, especially private firms, to stay within the mini-grid sector. All of the firms agreed that the government must establish a more secure environment where legal corruption must be eliminated.

5.5 What combinations of policies, activities and support would benefit the energy firms in the future?

5.5.1 Governments responses

Respondent 1 explains that the government should support private firms by lowering their current tariffs. As a result, the mini-grids deployed by private firms will be more affordable for rural areas. When asked if the government works with standardisation, respondent 1 stated,

"Government does not prescribe the equipment but prescribes the service. Achieving it is not our concern, as long as it has the engineering and technology to meet the final result."

The respondent further explains that standardisation for firms can hinder technological development and decrease the rate of sustainable transition. The government cannot decide if the mini-grid requires a transformer or inverter as long as it can meet the power and voltage requirements of the customers.

Respondent 2 explains that the government is currently deploying new policies. Since the policies have not yet been evaluated, it is too early to recommend which policies can be beneficial. However, respondent 2 agrees with respondent 1 that the government of Kenya should facilitate the private sector development. The government might not have the resources to do everything therefore, to reach the last mile of the energy targets, the private sector is believed to play a critical role. Hence, private firms are influential in reaching Kenya's energy targets. That is why the government has done tax returns regarding solar power and renewable energy, according to the respondent. The respondent adds that in the future, the government must decide what locations in Kenya are most suitable for grid extension and what locations are best with a mini-grid.

Respondent 9 believes the government must support mini-grid developers with technology and finances. These are things that firms will always require. The responder explains,

"Funding is the key thing, and it is happening. That is why regulations and policies keep changing to favour investors and combat climate change."

Respondent 11 agrees with the respondents from the government that they need to work with the private sector more. According to the respondent, one way of achieving this is to implement favourable regulations on mini-grid equipment. Respondent 12 believes that the most critical thing the government can do is give more space and enable private firms to develop, innovate, and grow within the renewable energy sector.

Respondent 12 explains that if private firms can be given a space in the decision-making processes within the sector, that would be helpful. In that case, all stakeholders would be involved in the decision-making process and know the regulations and policies planned for implementation, including plans for the grid extension. At the current state, the private firms are not participating in the decision-making process when discussing what policies would be implemented or how to adjust them to make them more beneficial for the firms to grow.

Respondent 12 further explains the importance of building capacity and how the government can support mini-grid firms. Capacity can be looked at in terms of human capacity, e.g. educational curriculum. Are the firms getting the right employee for their company, and are the students at university getting the proper education and training needed to fulfil the job? According to the respondent, the answer is no. The training at the university is generalised, and there are missing practical activities within the education in Kenya. Therefore, in terms of human capacity, it is lacking. A more practical training curriculum is needed, focusing on renewable energy, and a practical education plan could help young professionals to gain a deeper understanding of technology and practical knowledge. Thus, they are familiar with the technological system when they enter the firm and on-site facilities. Respondent 12 explains that there is currently funding for young professionals to develop practical skills and training and start to work.

Regulator capacity is another issue brought up by respondent 12. They are needed to control the firms' needs and help them with the proper support. The regulators today do not understand precisely what renewable energy firms need since a formal way of regulating them is missing. When regulators fundamentally understand the mini-grid system, they better understand how to become more efficient. Setting the correct policies and regulations to improve and grow will be easier.

Respondent 12 continues with resource capacity as another issue. Minor mini-grid firms are struggling to upgrade to the same level as the major firms. The government needs to assist them in improving their work and development through incentives, subsidies, or other monetary support. Respondent 12 states,

"That for me would support the energy firms by the government in the future; Human capacity, regulator capacity and resource capacity. Of course, there are other aspects, e.g. emerging green technologies and diverse stakeholders and collaborations. Nevertheless, these, I believe, are co-synergies from the capacity building."

The respondent further argues that policies should focus more on future renewable and green technical innovation systems. The respondent mentions that generating profitable revenue with a green business model can be challenging. Nevertheless, suppose the government helps mini-grid firms establish themselves in the market with the proper support. In that case, they will generate revenue and remain viable while operating with a green business model.

5.5.2 Firms responses

For the public firms, respondents 3 and 4 mentioned advocacy for sustainable policy and funding to grow within the green mini-grid sector and focus on rural electrification. The government also needs incentives and subsidies for green technologies, mini-grids, and other renewable energy sources. Respondent 3 further explains the importance of public and social sensitisation. Respondent states,

"The purpose of public sensitisation activities is to listen to people across the country and engage more stakeholders in discussions to understand their unique needs so that the government's policies remain relevant and understandable. Through social sensitisation, we hope to increase information and promotion of research."

One regulation believed to be critical for mini-grid firms to operate successfully is a standardisation of the working process for mini-grids. The issue has been brought up by all of the respondents from the firms. Respondent 4 explains that there is no finalised standardisation today, which becomes a barrier for the firms to operate optimally. There is much communication back and forth even to get a licence. Respondent 4 believes there will be a more straightforward path to what needs to be done with standardisation. Respondent 6 adds that most challenges originate from initial operations due to no standardisation.

Since grid extension from the main grid is branching out to rural areas, all of the respondents from the firms agreed that it is crucial for a more in-depth strategy plan and policy regarding how the mini-grid operators should respond when the extension reaches their facilities. Respondent 4 clarifies that action plans exist on how both public and private firms should operate, but this documentation is not available to the public and must be updated. Respondent 4 further states,

"The optimal solution for green electrification and providing all people access to energy is by extending the main grid and letting it branch out to mini-grid facilities in the rural areas. Mini-grid can be considered pre-electrification. They play a critical role in the sustainable energy transition in Sub-Saharan Africa. With the help of mini-grid operations, we will reach Kenya's energy target 2030".

Further, respondent 5 explains why the current system with licensing is not sustainable and advises the government to use concessions instead. Respondent 5 mentions that in the French-speaking countries of Africa, the system and legislation function differently from English-speaking countries. In French-speaking countries, concessions give companies the right to operate a particular business on another firm's property or within a government's jurisdiction. These documents define your rights. In English-speaking countries, it is the other way around and called licence.

In Kenya, a licence is mandatory from regulators and authorities to sell electricity to the public. Respondent 5 states,

"I prefer the concession approach since the licencing approach seems easy at the beginning, you get everything you need quickly, but the problem comes afterwards. The political environment and surroundings will change. You buy mini-grid operations for 25 years. Of course, you will need to adapt to what comes around during these years. Especially if the license is corrupt."

Respondent 5 further argues that in the licencing approach, most rules of changing legislation depend on the law. The concession depends on the project and not on the politics surrounding it. It will perhaps take a few years to establish functioning concessions between stakeholders. However, the firms are theoretically saved for the next 25 years once settled. According to respondent 5, the government should change the policy and regulations to concessions over the licence. However, respondent 5 mentions that the licence system should function if the policy and regulations were more stable and not as dynamic and dependent on the political surroundings.

Considering the cost and pricing of the electricity, respondent 5 argues for a more homogenised tariff for mini-grid developers. In contrast, respondent 6 argues the importance of finding methods to access cross-subsidies tariffs for mini-grid operations. Cross subsidisation is the practice of charging higher prices to one type of consumer to simultaneously lower prices for another group.

For the community-based, both respondents 7 and 8 agree that in the future, more activities and support in the form of technological competence and knowledge are essential and could be provided by the government. It takes a long time for technicians to arrive in the rural community to provide maintenance in the current state. In addition, some technical problems cannot be solved, not even by the technicians. Respondent 8 states,

"The wind power facility and some parts of the solar mini-grids do not function and have not functioned for several years, so we had to take them down. The government should support and send experts that can fix them".

Respondent 7 believes that the community can develop further with more support. From the current mini-grid facility and the electricity, it has offered to the inhabitants. Many small scale businesses have grown, generating income and revenue. Thus, improving the quality of life for the people, and with more support, they can grow even further. As a reflection, the respondent 7 states,

"Before, we looked for a place to charge our phones and batteries, but for right now, we are free, everyone can charge their phones at home."

6
Analysis

6.1 The current situation of mini-grid operations and the need for a sustainable transition

With an increasing population rate in Kenya, there is also an increase in demand for electricity, and the government needs to provide energy access for all the inhabitants. The demand could be provided with the help of renewable energy sources to combat environmental challenges and achieve a sustainable transition [36]. From the interviews, it was clear that the government plays a critical role in creating an enabling environment for the mini-grid firms to establish and grow in the energy sector, as all the respondents stated. They are seen as those who should facilitate expanding the energy sector and assist firms to reach the new energy targets. However, previous targets regarding clean and renewable energy by 2020 and energy access by 2022 have not been reached [7]. The literature mentions that the government realised this sustainable energy transition is impossible without a paradigm shift in the current sector [5]. The targets have been ambitious to be reached within the time frame [30]. As population and economic growth occur rapidly in Kenya, when constructing targets, the Ministry of Energy should take into consideration the current state of the energy sector and thereby implement strategies that are reasonable to be reached. It seems impossible to set energy access to all the population in such a short time. However, not reaching previous may have strengthened the motivation for future policies and governance to be more solid and cooperative.

The respondents from the mini-grid firms believed that the government could facilitate the energy sector to transit towards using more renewable energy sources. The literature states the importance of establishing activities that enhance the growth of the renewable energy sector and that energy access should be facilitated by the use of green energy [36]. In Kenya, foreign energy sources, e.g. crude and petroleum, are imported to cover the high domestic demand for energy [24]. Importation of crude oil stifles domestic economic progress and hinders a sustainable economy. Despite the importance of environmental aspects of the sustainable energy transition, the national economy is another pressure for the government to give the renewable sector more space. Respondents mention financial support and taxation policies to be considered vital for this particular matter. For instance, when reducing the cost of mini-grid appliances, e.g. solar PV and other green technical equipment, these become affordable for the firms, especially the private firms, to purchase and utilise in their operations.

Mini-grid operations were mentioned to play a significant part in the socio-technical transition by the respondents. As the literature confirms, it is considered a niche since they provide seeds for systematic change [27]. It is essential to consider that the mini-grids are not the only tool for this sustainable transition. There exist other types of technologies and off-grid solutions operated by green energy. Mini-grid's cost-effectiveness and easy operating system stand out, and there is already a developing market for this technology in rural communities. Therefore, mini-grids play an essential tool in enhancing rural electrification. The literature mentions that the mini-grids can be seen as a pre-electrification, a catalyst for the sustainable energy transition to occur [21]. The respondents from the government agreed. There is a need for a clear policy framework and enforcement of technical standards for this niche to grow within the energy sector. Analysing the improvement of China, for instance, the government has strengthened their support regarding innovation-driven sources where renewable energy sources have been given attention [35].

6.2 Support and policies by the government

Energy Act 2019 and K-OSAP were considered essential strategy plans by the government to encourage the energy sector's growth by the respondents. As the literature confirms, they play an influential role when implementing energy policies. However, Energy Act 2019 were criticised since the renewable energy sector has not been given enough space or attention compared to the fossil-fuel-based resources sector. Even if the literature claims that this strategic plan will optimise the nation's work towards reaching Kenya Vision 2030 [8], it is difficult to believe the energy targets will succeed when there exist no strict frameworks for the growth of the renewable energy sector. Hence, there is a need for a paradigm shift to become less reliant on fossil fuels.

When formatting policy instruments, the support is constructed to apply to both public and private firms since the long-term vision is the same, to increase energy access, which is confirmed by the literature [15], [16]. The respondents mention that one distinction between these firms is that the support fluctuates depending on the actor. The fact that the support is given differently does not necessarily mean anything negative since it depends on the purpose and motivation of the firms. A public firm receives more financial aid support since the government is a shareholder in these firms. Thus internal support is necessary for them to succeed. The private firms have higher operation and maintenance costs, but if appropriately facilitated, they generate more revenue. What is essential to recognise is that the private firms must be given more space in the energy sector since they operate in remote communities where the government cannot operate. The government should favour the cost-reflective tariff for private firms that supports them to return a profit on their initial investment. It can be seen as a government policy to attract more investors and private firms into the current energy sector.

The support deployed by the government seems to have positive feedback from most of the respondents since they are fulfilling their function. The rate of electricity connection has increased. There is, however, a need for more strategic development policies since the existing market is not developed enough for mini-grid operations to be profitable due to high tariffs, which has been confirmed by the literature [46]. One respondent was not satisfied with the current support by the government and criticised the lack of attention they were given and policies regarding licence to sell electricity from regulators. There could be various reasons why this particular respondent was not satisfied. One explanation confirmed by the literature states that a mini-grid developer who wishes to sell at retail will frequently complain about its marketing with regulators, for instance, licence to sell situations [22]. There is a need for regulatory balance between the energy producers, customers and the government to reduce these types of conflicts.

Measuring the success of energy access can be challenging to estimate. Respondents highlight a few indicators analysing the number of households connected to a power generator. The literature has partly confirmed this. However, the use of the Multi-tier framework was not brought up by the respondents [3]. Since this tool aims to measure access to energy, it is believed to be strange that respondents from the government did not mention this.

6.3 Challenges when the government support mini-grid firms

A common challenge for technology innovation to be part of a sustainable transition is that the environment must adapt to the innovation. From the interviews, it was stated that there is limited funding for, among other things, infrastructure development. The government did not give more attention to the respondents on this topic, even though it was considered a critical concern. The literature has confirmed this issue to be essential and mentions that there must be other changes and adaptations for how the government works and supports the entire energy sector and its infrastructure for mini-grid operations [22]. The surrounding infrastructure should be considered and adjusted with decision-makers in the energy sector. Technological innovation cannot succeed without a supportive regime [37]. Developing infrastructure regarding mini-grids could increase the pace of rural development.

There will always be a challenge to satisfy consumers and producers regarding fair electricity pricing, mainly what tariff structure should be utilised. From the interviews, it was clear that mini-grid consumers prefer to have a cross-reflective tariff since it has a lower price. However, this disadvantages the firms from becoming profitable. In contrast, mini-grid developers prefer a cost-reflective tariff since it generates more revenue while increasing the selling price. The literature confirms that with a cross-subsidised tariff, the results are poor financial and firms struggle to cover external costs [45].

Since there will likely always be a problem finding a balance in fair pricing, the government must facilitate both energy producers and consumers. Moreover, there is a need for all types of firms to assess consumers' behaviour in the areas they will operate before entering the market. A benefit in the long run of cost-reflective tariffs is that it encourages investors and private firms to participate in the energy sector and could potentially lower the price in the future.

The respondents brought up grid extensions as one of Kenya's more significant challenges today. The private firms in their current state are uncertain about when the main grid might reach their facilities. The government does not seem to acknowledge what could be the most suitable alternative when this occurs. It was mentioned that today in Kenya, no strict regulation or framework seems to recognise this issue. Hence hinders investors and private firms from participating in mini-grid projects. The literature, however, has mentioned several options and guidelines on how the government could facilitate grid extension [22]. Further, the literature highlighted three potential endpoints of the energy system where mini-grids could play an influential role in two of them [39]. The mini-grid could either be a part of the current regime with the smart grid endpoint or work as an independent actor in the regime in the off-grid endpoint. The off-grid system was initially only a temporary energy provider since it operated in remote rural areas until the main grid reached them [21]. However, many off-grid systems have successively become profitable, and mini-grid consumer sometimes chooses to stay connected with the off-grid system. Within the framework of the MLP, it is impossible to predict how the niche will be innovated since the regime's future is uncertain.

6.4 Governmental support for the critical factors for successful mini-grid operations

Political dimension

The first identified critical factor in the political dimensions is designing a dynamic business model adjustable for a changing political environment. The respondents agree on the importance of this factor, particularly regarding the upcoming election this year in August 2022, where there is potential for new strategies to be developed. The literature mentions that the government must consider the shape of legislative and regulatory frameworks so that these can be adapted to one or more business models [22]. The political system throughout Sub-Saharan Africa has been interpreted to have an extreme environment where decisions are made spontaneously, especially when the private firms are not considered official stakeholders in the decision-making process. Hence all firms must be prepared for changes in the legislation. The government could support the firms with financial aid and transition-related regulation.

Promoting a collaborative database gathering information between multi-stakeholders concerning mini-grid development has also been considered a critical factor. A respondent from the private firm stated that collaboration works only if the system is not built on corruption. In that case, collaboration tends to fail. The literature has clarified that, although operating with multiple stakeholders should generate an effective result, there is also a high risk of failure if operated poorly under a corrupt environment [46]. Collaborative databases are interpreted to be essential for new emerging technologies since different partnerships can share knowledge, expertise and experience. Even if private firms are in a competitive market, a collaborative method of working is believed to be essential for this sector to grow in the future. Therefore, the government could support the firms by providing a safe environment and establishing communication platforms for all firms.

Economical dimension

Utilising a payment model that imposes upfront payment has been considered a critical factor. As the respondent mentions, before entering the operating area, the government and the firms must assess consumers' behaviour and ability to pay for not risking a backlash in the form of having consumers who cannot afford the electricity. The literature mentions that the capacity to collect revenue is essential [45]. One method is the application of PAYG. However, this was not mentioned by the respondents. Instead, the Take-and-Pay model was mentioned. In the latter method, the grid must pay for all the electricity whether it is used. The government could support the firms by devising an efficient payment model that allows firms to profit while making the tariffs affordable for those living in rural areas.

Most Kenyans are impoverished, and this number is growing in rural areas. As a result, if a cost-reflective tariff is applied, it can be hard for them to afford the electricity at its actual cost. Kenya's fixed electrical grid has a surplus. It is insufficient with many off-takers who can cover most of the costs. Further, when it comes to private households, electricity use is minimal. Considering the overall scope, it will not be a sustainable business case for investors if the electricity produced cannot generate good revenue.

Utilising an efficient metering system such as smart metering has been considered to be a critical factor. Respondents from private firms underlined the importance of using an effective metering system to monitor energy usage adequately. The literature has confirmed that smart metering is essential to reduce energy bypassing [51]. The governmental body EPRA manages the metering systems.

Socio-cultural dimension

Engaging and involving the local community has been considered a critical factor. Respondents state that when operating in a rural community, all types of firms should make an effort to understand the people's behaviour and even consider them as official stakeholders of the project. The literature clarifies that it is critical for mini-grid developers to study the consumers' behaviour, to learn about them and their abilities to pay [52]. Building a mini-grid facility in an area does not make sense without talking to the people there. For optimising the work, mini-grid operations could be tailored to local demands and surroundings. The government could support the local community by making them official stakeholders in decision-making.

Conducting CSR reports were mentioned in the interviews that the literature did not mention. The respondent emphasises incorporating CSR reports into firm business models because it encourages the firms to increase their responsibility towards the people living in the community from an economic, environmental, and social standpoint. It has to be clarified that CSR reports are expensive to assess, particularly for private firms. However, if the firm has the capital, it is beneficial to implement CSR reports into its business model.

From the interviews, the respondents did not explicitly bring up stimulating the development of income-generating activities. However, it has still been considered a critical factor. The literature mentions a need to improve the locals' ability and desire to pay by providing external services that assist the development of income-generating activities [53]. The literature has further highlighted that with the help of mini-grid operations, rural electrification increases the productivity and income of small scale businesses and improves the delivery of social and commercial services [21]. Hence, more capital exists in the community and generates economic growth, i.e. rural development. There is a need for technical assistance, raising local community awareness for them to set up small enterprises. For instance, providing a cooler resulted in new business opportunities and opened up a market for dairy products in one of the visited rural communities. The government could support the local community by providing technical assistance and guidance for better operating small scale businesses.

Technological dimension

A hybrid mini-grid powered by hydropower and solar PV has been considered a critical factor since it is the most energy-effective combination of mini-grids [46]. The respondents mention that hybrid mini-grids with solar PV as a primary energy source are the most efficient solution in Kenya. The literature confirms that there exists a need for a transition from fossil fuel-based to renewable resources as diesel prices fluctuate and diesel generators are seen as costly and unreliable [44]. Considering hydropower is site-specific, if the geographical region is not optimal for this technology, solar power should be used instead. The government could support the firms to use green mini-grids instead of fossil-fuel driven mini-grids.

Establishing procedures for quality control has been considered to be a critical factor. The respondents from the firms mention the importance of utilising quality control procedures at the early stages. The government could analyse technical and operational reports and identify areas for improvement. The literature agrees and further states that quality significantly impacts the systems' lifetime. Thus, quality and operational control should be made to achieve the lowest generation costs [46]. Regardless of what type of facility that is operating, quality control ensures the processes are operating efficiently without harm or damage is critical. If eco-system thinking is utilised in the quality control procedure, the firms will potentially reduce their environmental footprints.

For the renewable energy sector to grow, there is a need for the government to promote the use of green and sustainable technologies, i.e. technologies with minor to no harm to the environment. The literature does not mention this as a critical factor. However, respondents from the firms mention that the private firms utilise green technologies whereas public firms have technical equipment that is fossil-fuel based. The use of green and sustainable technology has been considered to be a critical factor. The government could support the firms by promoting the use of green technologies. Hence, the energy sector becomes less reliant on fossil-fuel based resources.

Moving towards a sustainable energy transition requires learning about renewable energy and educating operators, and personnel with new responsibilities and acknowledgements, i.e. technical assistance [54]. From the interview, technical assistance was highlighted to be critical. However, the mini-grid facilities in the rural areas that the firms have established are managed by the firms. Regarding technical assistance, the government only plays a minor role in their facilities. However, for the community-based actors, this may be regarded as a critical factor since the government could assist by providing technical services and up-to-date training.

Environmental dimension

Protection of the local environment has been considered a critical factor. The literature specifies the surrounding environment of hydropower facilities since using hydropower can harm the environment [23]. The respondents from the firms for this research operate mini-grids with mostly the help of solar PV and, therefore, cannot state the protection of the local environment with the same reasoning. However, the respondents were generally questioned about the surrounding environment of all mini-grid facilities. The interviews mentioned that all energy firms should focus on ecosystem protection and managing the mini-grid installations' surrounding environment. The government has a government body, NEMA, responsible for the industry's environment.

The respondents further mentioned that the management of waste and battery recycling from the mini-grids is poorly defined. There exist hazardous chemicals, and heavy metals have polluted these batteries. Despite its importance for the environment, this has not been mentioned in the literature. There seems to be a need for a waste management scheme since today. There are no specifics on how the government disposes of batteries when they are no longer usable. The firms can quickly get away with recycling fraud. Hence recycling batteries has been considered to be a critical factor. The government could support the firms by creating an industrial waste management system for better recycling.

Legal dimension

Strive for legal acknowledgement has been considered to be a critical factor. Respondents mentioned that authorities are often built on corruption and, in reality, do not work as they appear in documents. When the legal system is under corruption, it becomes more challenging for businesses, particularly private firms, to stay and grow in the energy sector. The literature agrees and states that within an unjustifiable energy sector, there exists a need for controlling the authorities and pressuring the government for a legal recognition [56]. This corruption is not particular to Kenya and can be seen throughout Sub-Saharan Africa.

The literature further mentions that the authorities require a licence for the mini-grid developers to operate legally [22]. With a licence, the firms obtain legitimacy as they receive access to bank loans and potential funding for their mini-grid operations to be established. However, the literature highlights that the regulators, on the other hand, become obligated to defend those clients. At this point, a balance between the regulator and mini-grid developer must exist for corruption to not occur. As respondents mention, bribery occurs behind closed doors when the waiting time for a license is long and can burden the firms' operational costs. Therefore, the government should, if possible, evaluate the possibility of having a third party or representative who controls and manages the licensing for the developers.

Table 6.1: Critical factors for success in Kenya, and how the government could support them.

Dimensions	**Critical factors**	**Governments support**
Political	Design a dynamic business model adjustable for a changing political environment.	Financial support and transition-regulation.
	Promote a collaboration database gathering information between multi-stakeholders concerning mini-grid development.	Safe environment and establishments of communication platforms.
Economical	Utilise an efficient metering system such as a smart metering.	Efficient metering system regulated by EPRA.
	Utilise a payment model that impose simple upfront payment.	Design for efficient payment model, e.g. Take and Pay model.
Socio-cultural	Engage and involve the local community.	Include the local community as official stakeholder in the decision-making process. CSR report if possible.
	Stimulate development of income generating activities.	Technical assistance and guidance for better operating small scale businesses.
Technical	Hybrid mini-grid powered by hydropower and solar PV.	Transition to use of green mini-grids instead of fossil-fuel driven grids.
	Green and sustainable technology.	Promotion of green technology. Reduce the cost of imported solar PV.
	Establish procedure for quality control.	Quality control of mini-grid operations.
	Technology assistant.	Assist firms with technical guidance and information.
Environmental	Protection of local environment.	Environmental protection by NEMA.
	Recycling of batteries.	Create industrial waste management systems for better recycling of batteries.
Legal	Strive for legal acknowledgement.	Safeguards to decrease corruption. A third party or representative who controls and manages the licensing.

6.5 What support could be implemented for the mini-grids operations to enable a socio-technical transition?

For the energy sector to grow in the future, the support needs to primarily favour the private sector since they are currently operating and providing energy access in remote rural areas. The respondents mention that more funding should be allocated to the private sector to strengthen their work. The government should give more space and enable private firms to develop, innovate, and grow using renewable energy sources. The literature confirms that regulatory frameworks and strategic plans need to be directed to encourage the growth of the energy sector [45]. Promoting the growth of the private sector can be depicted as significant for the socio-technical transition since providing energy and operating mini-grid facilities in remote rural communities is highly costly for the government. Hence, the private firms are the ones who contribute to rural electrification in these communities. Since they are growing in the market and becoming more established, the government should make them an official stakeholder in the future decision-making process for the energy sector. In addition, the energy sector's growth favours investors to participate in the market.

Furthermore, respondents mention that support and policies in the future should focus more on renewable and green energy systems in the future. Promoting green technologies has already been highlighted as a critical success factor. As the literature confirms, there exists a substantial potential for renewable energy power generation in the country to expand [9]. The literature further claims that mini-grids driven by green energy have the potential to successively replace fossil-fueled mini-grid operations if the necessary support and investment are given by the government [36]. Policy instruments supporting the growth of the renewable energy sector are highly critical for reducing the reliance on fossil-fuel sources, decreasing GHG and protecting the environment.

A respondent highlighted that minor mini-grid firms, referred to as newly entered mini-grid firms in the market, find it challenging to establish themselves on the same level as other firms. The government should assist the minor mini-grid firms through incentives or subsidies. The literature mentions a similar case for newly entered SPP in the market, referring to light-handed regulations [22]. Since light-handed regulations are minimised, and frameworks have been standardised for simple operations, this regulation will benefit the minor mini-grid firms until they have established themselves. However, these regulations need to be adequately monitored since there is a risk of receiving overwhelming amounts of paper projects that could clog the system. For instance, as the situations were in Sri Lanka or Nepal.

The literature did not mention the standardisation of the working process. However, this has been brought up in the interviews by the respondents from the firms to be essential. Respondents have mentioned the abundance of standardisation as a barrier to succeeding. In contrast, the respondents from the government seem to believe that a standardised working process could hinder the firms from innovating and becoming competitive. It could prevent innovation growth since there exists a risk for a lock-in system where only one way of operating a mini-grid exists. The firms may have different types of technology and still be competitive, but they are limited for such matters. However, if standardisation is adequately assessed, this could accelerate the socio-technical transition toward renewable electrification. In such cases, the processes for the mini-grid developer to receive a licence to operate occurs at a faster pace, and thereby more mini-grid operators will have the possibility to enter the market and operate. Since they will operate in a somewhat similar process, technical assistance and policies would be more uniform. Further research must be assessed to understand the role of government in this particular area.

7
Conclusion

Previous energy targets have repeatedly not been achieved within the time limit, e.g. clean and renewable energy by 2020 and energy access to all Kenyans by 2022. Even if development is occurring and the access rate is increasing in rural communities, there is a need for more strict policies and regulations for the energy sector to grow. Mini-grid operations have been defined as a niche in this socio-technical transition, and the use of green mini-grids is one of the solutions to meeting the energy demand. The transition can be accomplished by planning, monitoring, and controlling the mini-grid operations, providing them with the proper support. The purpose of this research aims to understand what could be the role of the government in supporting firms to establish activities and be able to grow within the mini-grid sector in Kenya successfully.

The current role of the government in supporting green mini-grid firms is to facilitate and build policies that support the firms to establish and grow within the energy sector. Several energy policies and strategies, for instance, Energy Act 2019 and K-OSAP, have been implemented to reach their new target Kenya Vision 2030, which aims to industrialise the nation into a middle-income country and provide energy access to all people by 2030. It was recognised that these strategy plans had some faults, particularly Energy Act 2019, which did not give the renewable energy sector as much attention as the fossil-fuel sector. The respondents were satisfied with the current support given by the government, and they seem to be fulfilling their function. However, since previous energy targets have not been reached, it was concluded that the previous targets were too ambitious to be reached within the time limit. As the existing market for mini-grid firms is still under development, some firms struggle to become profitable due to the high tariffs.

Internal conflicts within the board of decision-makers and stakeholders were confirmed to be a significant challenge since they have the power to construct and implement policies. With biased opinions and government officials not being united, what direction the energy sector should move forward tends to be poorly coordinated. It has been concluded that a united decision is nearly impossible to achieve. However, direction should be coordinated to sustain an environmental economy and promote the use of renewable energy. Hence, there is a need for more effective collaboration between stakeholders, regulators, decision-makers, and authorities to build solid frameworks.

The grid extension threat was another critical challenge for mini-grid developers in Kenya, where the firms operate in uncertainty. The government concluded that no strict regulations or frameworks are available for private firms in Kenya today, even if documents exist. Firms and investors do not want to risk participating in mini-grid projects without an explicit agreement and transparent policy instrument regarding grid extension.

Private firms will need to play a more prominent role in the future since they are now operating in isolated rural communities where neither the public sector nor the main grid has reached. The role of the government could be to develop a more detailed strategic plan that facilitates mini-grid operations and give the private firms more space. Further, there is a need to understand the people of the communities' behaviour and ability to pay to tailor the mini-grid project according to their needs and utilise a suitable payment plan. The role of the government could be to include all stakeholders in the decision-making process, including the private firms and people living in rural communities. Without the assistance of external investors and donors, developing mini-grid operations could be financially challenging for the government of Kenya. It may be inferred that the government must develop regulations that make it easier for investors to participate in the energy sector. In the current state, investors are insecure about engaging in a dynamic political environment. The role of the government could be to favour investors to participate in the sector.

For the renewable energy sector to grow, there is a need for the government to encourage and promote energy corporations to utilise more renewable energy sources. Since the energy demand is increasing with population and economic growth, this demand is currently being satisfied with the help of imported crude oil. There is a need for change to transit towards clean and green energy. The role of the government could be to promote green technologies, assist with financial support for firms to transit and increase their use of renewable resources. Only by using renewable energy can the socio-technical transition become sustainable in the long run.

In conclusion, the government of Kenya plays a critical role in assisting mini-grid firms in establishing and growing in the energy industry. Mini-grid operations are considered a precursor to electrification to achieve Kenya Vision 2030. At the current state, it is uncertain how the regime will develop in the future, e.g. a smart-grid, super-grid or off-grid system. It is impossible to predict how this niche will be innovated since the regime's future is uncertain. Mini-grids are viewed as a beneficial instrument, a catalyst, providing electricity to those living in isolated rural areas until or if reached by the main grid. Given that Kenya's energy transition can serve as a model for other countries in the region, the government's role in paving the path for renewable electrification in Sub-Saharan Africa.

7.1 Future research

Standardisation

Respondents from the government and the firms gave diverse opinions regarding whether standardisation of the working processes should be implemented or not. The literature did not mention any specifics about standardised mini-grid operations. The respondents provided information and arguments that support their statements in this matter. Where the government believes there is a risk of a lock-in system, the firms believe that a standardised way of working is essential to succeed. Therefore, it would be interesting for future research to understand more in-depth this conflict and what would be preferred for Kenya.

Licence or concessions

Another field of research that would be interesting to investigate further is if Kenya would be better off using a concession framework or a licensing that is currently in place. A respondent from the firms brought up an interesting argument regarding licensing and its inefficiency in a highly dynamic political environment. According to the respondent, it would be preferable for mini-grid firms in Kenya if licensing were implemented.

Recycling of batteries from mini-grids

Currently, the government has no solid policy or precise regulation on managing the disposal of batteries from the mini-grid operations. Therefore, a significant research area for the future could be to investigate how the government could support and construct waste management schemes for mini-grid batteries and industrial waste. As the firm highlights a critical issue regarding recycling batteries, and there is no detailed plan available, there is assumed to exist a research gap within this area. Thus future research is assumed to be necessary.

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A

Interview guides

A.1 Experts/Researcher

The purpose of our thesis

- The purpose of this master's thesis is to understand what could be the role of the government in supporting firms to establish activities and enable mini-grid firms to grow within the energy sector of Kenya successfully? We want to understand how mini-grid can play an influential role in the energy transition.

The purpose of this interview

- The purpose of this interview is to gain in-depth knowledge of the subject from a person with hands-on experience and work within this research area to supplement our study.

Introductory questions

- Tell us a little bit about yourself? What is your profession?
- What is your experience within the field of Kenya's electrification and renewable mini-grids?

General questions

- Tell us about what you believe the role of the government in Kenya is towards energy firms working with mini-grids today?
- From your point of view, which challenges do you believe the government see today when supporting energy firms, and how would you define the problem?
- What policies or activities have the government put into supporting firms to establish activities and grow in the energy sector? Have they fulfilled their function, and how can you measure the success of a policy?

Specific questions

- How do you view the government's policies and activities put in place? Have they been directed to some specific type of firm?
- Previous literature and findings depict that critical authorities are not involved enough in the energy transition. From your point of view, how can both the government and the mini-grid firms collaboratively work for successful energy access for all Kenyans?
- What could be the role of government in the future? What areas could the government give more attention to and why?
- How can mini-grid operations play an influential role in the energy transition?

A.2 Government

The purpose of our thesis

- The purpose of this master's thesis is to understand what could be the role of the government in supporting firms to establish activities and enable mini-grid firms to grow within the energy sector of Kenya successfully? We want to understand how mini-grid can play an influential role in the energy transition.

The purpose of this interview

- The purpose of this interview is to gain in-depth knowledge of the subject from a person with hands-on experience and work within this research area to supplement our study.

Introductory questions

- Tell us a little bit about yourself? What is your profession?
- What is your experience within the field of Kenya's electrification and renewable mini-grids?

General questions

- Tell us about what you believe the role of the government in Kenya is towards energy firms working with mini-grids today?
- Which challenges does the government see today when supporting energy firms, and how does the government define the problem?
- What policies or activities have the government put in place to support firms to establish activities and successfully grow within the sector of mini-grids in Kenya?
- To which type of firms are these policies or activities directed?

Specific questions

- Are there any differences between the policies and regulations considering public and private firms? E.g. How do you work with REREC and KPLC to distinguish them from private firms? Do you see different patterns of need and requirements?
- By the support given today, how do you measure them? Have they helped and fulfilled the function it is supposed to? Where do you see improvements or areas of change?
- From the literature, there are several critical factors for a successful mini-grids operation and development. Are they important for Kenya, and how do you work with these factors?
- Are there combinations of policies, regulations and support that have been or could be effective?
- How can mini-grid operations play an influential role in the energy transition?
- How do you support these mini-grid operations more specific?

A.3 Firms

The purpose of our thesis

- The purpose of this master's thesis is to understand what could be the role of the government in supporting firms to establish activities and enable mini-grid firms to grow within the energy sector of Kenya successfully? We want to understand how mini-grid can play an influential role in the energy transition.

The purpose of this interview

- The purpose of this interview is to gain in-depth knowledge of the subject from a person with hands-on experience and work within this research area to supplement our study.

Introductory questions

- Tell us a little bit about yourself? What is your profession?
- What is your experience within the field of Kenya's electrification and renewable mini-grids?
- What does your firm do?

General questions

- From your point of view, how do you view the role of the government in supporting your company?
- Tell us about what you believe are the challenges when receiving support from the government?
- How has your firm perceived the policies or activities the government has put in place to support your firm to establish activities and successfully grow?

Specific questions

- By the support given today, have they helped and fulfilled the function it is supposed to? Where do you see improvements or areas of change?
- From the literature, there are several critical factors for a successful mini-grids operation and development. Are they of importance to your business? What are of more significant value, and how do you work with them?
- Do you feel that you receive the right support to work with these critical factors successfully? Have the firms been privy to such policies or activities?
- What combinations of policies, regulations, and support do you believe would benefit your company?
- How can mini-grid operations play an influential role in the energy transition?

DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS
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