Department of Entrepreneurship and Innovation

Success Story M-pesa

An analysis of the evolution of the off-grid solar industry through M-pesa, and its socioeconomic impact in rural areas

A case study of Pawame Ltd. in Kenya

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Table of Contents

LIST OF FIGURES

LIST OF TABLES

List of Abbreviations an Acronyms

AML	*Anti-Money Laundering*
BRECSU	*Building Research Energy Conservation Support Unit*
CDF	*Constituency Development Fund*
CFT	*Combating the Financing of Terrorism*
CIDP	*County Integrated Development Plan*
CO	*Carbon Monoxide*
CO_2	*Carbon Dioxide*
CRA	*Commission on Revenue Allocation*
EAC	*East African Community*
GNESD	*Global Network on Energy for Sustainable Development*
GoK	*Government of Kenya*
GSMA	*Groupe Speciale Mobile Association*
HMIS	*Health Management Information Systems*
KIHBS	*Kenya Integrated Household Baseline Survey*
IREK	*Innovation and Renewable Electrification in Kenya*
IRENA	*International Renewable Energy Agency*
KNBS	*Kenya National Bureau of Statistics*
MFI	*Microfinance Institution*
OECD	*Organisation for Economic Co-operation and Development*
PayGo	*Pay as you go*
PE	*Private Equity*
PV	*Photovoltaic*
REP	*Rural Electrification Program*
SID	*Society for International Development*
SSA	*Sub-Saharan Africa*
VC	*Venture Capital*

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Abstract

Africa a continent rich in history, known for its breath-taking nature and unestimated resources but still unable to offer modern day essential to its population. There are 620 million people in Africa that don't have access to a basic development need, electricity. The major challenge is not generation but connectivity and even when available it's unreliable, connection costs are too high and cannot be spread over time. As a consequence, the only lighting source within reach are generators, candles or traditional fossil fuel kerosene lamps which release toxic gases, are inefficient and expensive.

In Kenya, the energy industry has immense potential for growth due to a recent technological innovation. Namely M-pesa, (translates to "money wallet" in Swahili) Vodafone's mobile money platform, has enabled electronic payments to and from people around the world. This has revolutionized the energy sector by allowing individuals to easily make payments for different utilities/services and to repay loans. In particular, the off-grid solar sector has used M-pesa to address energy scarcity in rural Africa. Companies can now "rent to own" small solar home systems (generally consisting of a battery, TV, mobile phone charging cables, two to four light bulbs, a radio and a torch) to customers at the bottom of the pyramid (BOP). M-pesa enables these companies to easily recoup payments over time from their customers that would not be able to afford the one-off investment, but can pay over the course of a longer loan period through instalments.

This paper analyses the socio-economic impact of off-grid solar systems on rural people's lives by looking at M-pesa and how the mobile money payment platform has facilitated this transition. In particular, it investigates the social and economic improvements brought through the acquisition of off-grid solar systems via M-pesa payment plans. This analysis derived from a descriptive research design performed on a target population of off-grid solar system users in rural Kenya.

CHAPTER ONE: INTRODUCTION

1.1. Introduction

Modern economic development is anchored and driven by availability of energy, namely crude oil, electricity, natural gas and coal, and other renewable energy like solar, water, wind and geothermal. According to PwC (2016), there are close to one fifth of the world's population (18%), who live without access to electricity. Many of those people who do not have access to electricity live in locations that are beyond the reach of the current grid system and ninety-five percent (95%) of them (1.2 billion) are in Sub-Saharan Africa (SSA) and developing countries in Asia. In these countries, the rates at which electrification is taking place are lowest in rural areas and cannot keep pace with population growth. Sub-Saharan Africa has now overtaken Asia as having the largest number of people lacking electricity access.

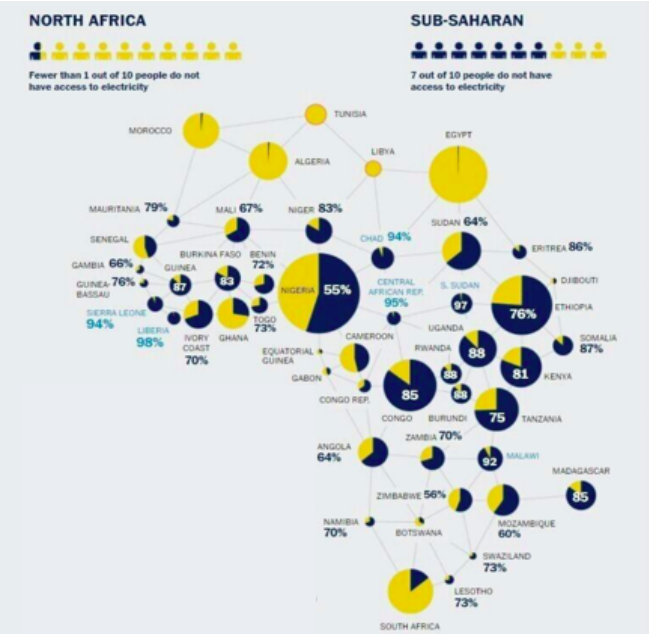

Figure 1.1: Electricity Access in Sub-Saharan Africa. Source: International Energy Agency (2015)

The African countries with the largest population currently without electricity are Nigeria, Ethiopia, Kenya, Côte d'Ivoire and the Democratic Republic of Congo (PwC, 2016).

In Kenya, close to thirty million people live in the dark once the sun falls. The major challenge is not generation of electricity but connectivity and even when available, it's mostly unreliable. As a consequence, the only lighting sources within reach are traditional but inefficient fossil fuel kerosene lamps, candles or generators which all come along with a hefty price tag. Out of those three energy alternatives, the most popular is kerosene (Tracy, Jacobson, 2012). According to a study made by a Kenyan based off-grid solar company called M-KOPA and InterMedia in 2014, kerosene purchases can soak up to 20% of the total income of rural households. On average each household spends around Kshs 13,651 (US$ 133) per annum which translates to Kshs 1,138 (US$ 11) per month (M-KOPA, 2014). On top of that most households spend around the same amount on batteries, third party phone charging, torches and candles.

Figure 1.2: Kerosene lamps. Source: Solar Aid (2018)

Just recently there was a disruption in the energy market. Off-grid solar companies saw an opportunity that they were lurking sine 2000's and finally found a way to enter due to the steady drop of solar panel costs and the existence of mobile money payment platforms. This enabled them to be price competitive to kerosene and to sell solar

home systems (generally consisting of a battery, TV, mobile phone charging cables, two to four light bulbs, a radio and a torch) to the BOP through micro-credit solutions that helped them split costs over time.

In Kenya specifically, M-pesa a mobile money payment platform, brought massive changes in terms of financial inclusion as well as affordability of products and services. Off-grid solar companies are nowadays able to lease SHS to low-income earners, who most likely had previously been denied a loan from institutional banks. This provides large opportunities for firms to enter the market and at the same time make significant profits, by offering products that have life-changing benefits to its inhabitants.

Today a vibrant private sector of small-scale SHS exists on the Kenyan market and it is estimated that over 620,000 rural households (8,2% of rural population in Kenya) has been electrified by SHS as of 2016. This number is exponentially increasing over time as more off-grid solar companies are entering the market and some big players have successfully run awareness campaigns within the county (GOGLA, 2016).

Solar energy remains the most affordable source of energy for lighting and low voltage appliances like radio, television, and/or phone charging especially in rural areas where access to electricity is still a major challenge. Therefore, off-grid solar systems improve the living standards of many people since the majority of the people in developing countries like Kenya live in rural areas. In line to these facts, this study sought to analyse the socio-economic impact of off-grid solar systems on rural people's life especially when making payments through mobile money platforms (M-pesa).

1.2. Purpose of the thesis

In February 2017, the researcher decided to take on an incredible opportunity to work in Africa, specifically Kenya, for an off-grid solar company named “Pawame”. Initially, the researcher’s plan was to stay in Kenya for a period of three months to complete his sales internship and return to Europe where he undertakes his studies. However, the spectacular and breath-taking nature of Kenya, career advancement plus the inspiring project at Pawame Ltd he was undertaking, motivated him to make a decision of staying in Kenya for an indeterminate period of time.

Pawame’s project of connecting many rural households to electricity through solar energy at an affordable price has been the most exciting, inspiring, and incredible project the researcher has ever participated. Due to the fact that the researcher travelled on a regular basis to Pawame’s customer base in rural Kenya, he experienced on first-hand how impactful off-grid solar companies are.

Based on this first-hand information, the researcher chose to conduct a research (thesis) to analyse the socio-economic impact of off-grid solar systems on rural people and how M-pesa has facilitated to the evolution and trend of the off-grid solar industry. Particular focus was on Pawame Ltd in Kenya. The choice to focus on M-pesa was made because it has enabled the existence of off-grid solar companies and on the other hand helped millions of Kenyans to escape financial exclusion.

1.3. Study Objectives

The following will be the objectives of this study:

1) To analyse how the off-grid solar industry in rural Kenya has evolved over time.
2) To analyse how M-pesa has facilitated the evolution of the off-grid solar industry in rural Kenya.
3) To analyse the trend of the off-grid solar industry in rural Kenya
4) To analyse socio-economic impact of the off-grid solar industry in rural Kenya.
5) To analyse socio-economic impact of M-pesa in facilitating evolution and trend of the off-grid solar industry in rural Kenya.

1.4. Study Questions

The researcher seeks to answer the following questions

1) How has the off-grid solar industry in rural Kenya evolved over time?
2) How does M-pesa facilitate the evolution of the off-grid solar industry in rural Kenya?
3) What is the trend of the off-grid solar industry in rural Kenya?
4) What are the socio-economic impact of the off-grid solar industry in rural Kenya on people's lives?
5) What is the socio-economic impact of M-pesa in facilitating the evolution and trend of the off-grid solar industry in rural Kenya?

1.5. Study Area

The study was conducted in rural Kenya where Pawame Ltd has developed its network. This includes Western Kenya region, Nyanza region, and Rift Valley region. Western Kenya has four counties, namely Vihiga County, Busia County, Kakamega County, and Bungoma County. Nyanza region has six counties, namely Kisumu, Migori, Homabay, Siaya County, Kisii, and Nyamira. North Rift Valley region has eight counties, namely Turkana, Nandi, West Pokot, Uasin Gishu, Baringo, Trans Nzoia, Samburu, and Elgeyo Marakwet.

Figure 1.3: Provinces of Kenya. Source: Lifeway Mission International (2017)

The study will put an emphasis on six counties where Pawame Ltd has connected rural people to off-grid solar systems for at least one month. This includes Kakamega and Bungoma in Western Kenya, Kisumu and Siaya in Nyanza region, and Uasin Gishu and Turkana in North Rift Valley region.

1.5.1. Bungoma County

Bungoma County is located in Western Kenya and it comprises of 9 constituencies and 45 electoral County Assembly Wards, covering a surface area of 3,593 km^2 (CRA, 2011). It has a population of 1,630,934 people, 321,628 households, and a population density of 454 people per km^2 (KNBS, 2010). The County has an urban population of 21.7%, while the rural population is 79.3% (CRA, 2011). On energy consumption, only 1% of the residents of Bungoma County use liquefied petroleum gas (LPG), 2% use paraffin, 85% use firewood, and 11% use charcoal (KNBS & SID, 2013). Only 4% of residents in Bungoma County use electricity as their main source of lighting, 27% use lanterns, 67% use tin lamps, and 1% use fuelwood.

1.5.2. Kakamega County

Kakamega County is located in Western region of Kenya with a population of 1,660,651 people, an area of 3,051 km^2, a population density of 544 persons per km^2, and 355,679 households (KNBS, 2010). The county borders Vihiga County to the south, Siaya County to the West, Bungoma County to the North, and Nandi County to the East. It has 12 constituencies and 60 electoral County Assembly Ward (CRA, 2011). Kakamega County has an urban population of 15.2%, while the rural population is 84.8% (KNBS, 2010). On energy consumption, 1% of the residents of Kakamega County use liquefied petroleum gas (LPG), 2% use paraffin, 87% use firewood, and 9% use charcoal (KNBS & SID, 2013). A total of 6% of residents in Kakamega County use electricity as their main source of lighting, 28% use lanterns, 64% use tin lamps, and 1% use fuelwood.

1.5.3. Kisumu County

Kisumu County is in Nyanza region and it has a population of 968,909 people, covering a surface area of 2,086 km^2, a population density of 465 persons per km^2, and 226,19 households (KNBS, 2010). The county is divided into 7 constituencies and 35 electoral County Assembly Wards (CRA, 2011). The county borders Vihiga County to the north, Homabay County to the south-west, Siaya County to the west, Nandi County to the north-east, and Kericho County to the east (CRA, 2011). The county has an urban population of 52.4% and rural population of 47.6% (KNBS, 2010). On energy consumption, 7% of Kisumu County residents use paraffin, 58% use firewood, and 29% use charcoal. On lighting, 18% of the residents use electricity as their main source of lighting, 23% use lanterns, 56% use tin lamps, and less than 1% use fuelwood.

1.5.4. Siaya County

Siaya County is located in Nyanza region bordering Kakamega County and Vihiga County to the north-east, Kisumu County to the south-east, and Busia County to the north (CRA, 2011). It has a population of 842,304 people, 199,034 households, covers a surface area of 2,530 km^2 with a population density of 333 people per km^2 (KNBS, 2010). The county has an urban population of 10.8% and a rural population of 89.2%. The county has six (6) constituencies and 30 electoral County Assembly Wards (CRA, 2011). On energy consumption, less than 1% of Siaya County residents use Liquefied Petroleum Gas (LPG), 2% use paraffin, 83% use firewood, and 15% use charcoal. In lighting, 4% of residents in Siaya County use electricity as their main source, 21% use lanterns, 73% use tin lamps and less than 1% use fuelwood (KNBS & SID, 2013).

1.5.5. Uasin Gishu County

Uasin Gishu County is located in North Rift Valley region with 6 sub-counties and 30 electoral county assembly wards, its capital being Eldoret town. It borders Nandi County to the south-west, Kericho County to the south, Trans Nzoia County to the north, and Bungoma County to the West (CRA, 2011). It has a population of 894,179 people, covers an area of 3,345 km^2, a population density of 26 people per km^2, and 202,291 households (KNBS, 2010). Uasin Gishu County has an urban population of 38.6% and rural population of 71.4%. (CRA, 2011). On energy consumption, 5% of residents use liquefied petroleum gas (LPG), 7% use paraffin, 55% use firewood, and 32% use charcoal (KNBS & SID, 2013). For lighting, 28% of residents in Uasin Gishu County use electricity as their main source, 44% use lanterns, 25% use tin lamps, and less than 1% use fuelwood (KNBS & SID, 2013).

1.5.6. Turkana County

Turkana County is located in North Rift Valley region of Kenya and it is the largest County in Kenya with 6 sub-counties and 30 electoral County Assembly Wards (CRA, 2011). It borders Samburu County to the south-east, Baringo and West Pokot Counties to the south-west and Marsabit County to the east (CRA, 2011). The county has a population of 855,399 people, covers an area of 68,680 km, a population density of 13 people per km and 123,191 households (KNBS, 2010). On energy consumption, 1% of residents in Turkana County use liquefied petroleum gas (LPG), 4% use paraffin, 78% use firewood and 17% use charcoal. On lighting, 5% of residents in Turkana County use electricity as their main source of lighting, 15% use lanterns, 77% use tin lamps, and less than 3% use fuelwood.

1.6. Target population

This study targeted residents in six selected counties who had acquired an off-grid solar system and have used it for at least one month. In each of the six selected counties, the researcher randomly picked 20 respondents making a total of 120 respondents who participated in this study.

1.7. Research Approach

A research is an organized inquiry that seeks to find answers to questions and solutions to problems with a view of generating new knowledge or understanding the subject (Krishnaswam & Sayaprasal, 2010; Bushaway, 2003; & Roberts, 2007). Research is classified into two basic approaches, namely quantitative and qualitative, with the third dimension referred to a mixed method approach (Kothari, 2004). In quantitative approach, a research is based on the measurement of quantity or amount (Patton, 2002). The qualitative approach on the other hand uses a naturalistic approach to understand a phenomenon in a "real world setting" without manipulating the phenomenon of interest (Patton, 2002). The mixed method approach encompasses both quantitative and qualitative methods.

In this study, the researcher adopted both quantitative and qualitative approach in order to gather facts and in-depth understanding of selected participants' behaviour, opinions and perceptions in view of the subject under research. The researcher's experience in the field under study (off-grid solar energy industry), his interaction with participants of this study before making a decision of conducting research on the subject and his closeness to the social reality with regard to off-grid solar energy industry helped in reducing the gap between reality and representation. Furthermore, the enthusiasm, inspiration and attention of understanding the context of the study offered detailed data that is rich in depth. By applying mixed (both qualitative and

quantitative) approach, the research under study examined specific issues such as the evolution of the off-grid solar energy industry over time, how M-pesa has facilitated the evolution of the off-grid solar industry, the trend of the off-grid solar industry, socio-economic impact of the off-grid solar industry and socio-economic impact of the mobile money platform M-pesa in facilitating the evolution and trend of the off-grid solar industry in rural Kenya.

1.8. Structure of the study

The structure of this study shows how the chapters are arranged and defines the scope covered by each chapter. The thesis has preliminary pages and consists of five chapters as follows:

1.8.1. Preliminaries

This include the title page, table of contents, list of figures, list of tables, list of abbreviations & acronyms, acknowledgements and the abstract.

1.8.2. Introduction

This sets the stage by giving a brief general background to the study, the purpose of the study, the objectives of the study, the research questions, the study area and the research approach adopted. This chapter sets the foundation for the other chapters, by narrowing down and presenting the issues to be investigated.

1.8.3. Literature Review

This includes a review of literature on relevant subjects based on the set objectives of the study. It looked at the electrification in general and its status in rural areas, the off-grid solar industry, the evolution of the off-grid solar industry, the trend of the off-grid solar industry in the current market and financial inclusion and exclusion in rural areas.

This chapter also explored the socio-economic impact of the off-grid solar sector through the use of the mobile money payment solution called M-pesa.

1.8.4. Presentation of the Firm: Pawame Ltd

This contains a description and presentation of the particular case under study. It provides the origin, purpose and unique selling proposition of Pawame Ltd, its activities in rural Kenya and the solution if offers towards access to affordable energy.

1.8.5. The Project: The Project

This chapter provides the research methodology adopted by this study. If further provides the analysis, the presentation and interpretation of the research findings from the field.

1.8.6. Conclusions

The chapter provides the researcher's conclusions and recommendations of the study based on the findings of the research**.**

CHAPTER TWO: LITERATURE REVIEW

2.1. Electrification

The electrification rate (the percentage of the population with access to electricity) in Sub-Saharan Africa is the lowest of any developing region (World Bank, 2015a). The total primary energy supply in Africa has more than tripled since 1971 and has been growing at around 3% per year being one of the most rapid rates for any region (International Renewable Energy Agency, IRENA, 2015a). The electrification rates in Sub-Saharan Africa rose from 22.7% in 1990 to 26.1% in 2000, and reached 35% in 2012 (World Bank, 2015a).

According to Todd (2016), World Bank Group (2013), and IRENA (2015a), approximately 622.6 million of the 1.1 billion population in Sub-Saharan Africa do not have access to electricity. The situation is particularly acute in rural areas; rural electrification rates can be as low as 14% compared to 60% in urban environments. In total, 38 of the 49 Sub-Saharan countries have an off-grid level above 50%, with many East-African countries above the 75% line (Todd, 2016). This is illustrated in Figure 2.1.

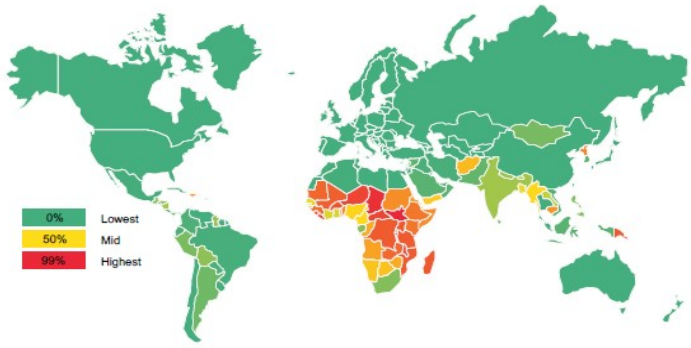

Figure 2. 1 Share of population without grid access. Source: World Bank Group (2013)

Due to lack of access to electricity by approximately 600 million people in Sub-Saharan Africa especially in rural areas, off-grid populations are counting on alternatives to grid-electricity. These alternatives are mostly unreliable, expensive or unsuitable for their needs. The most commonly used include:

Fossil-fuel based lamps for lighting which are harmful to both the user and the environment. Estimates suggest that spend a few hours with a kerosene lamp causes the same damage to someone's lungs and as smoking 40 cigarettes. Furthermore, an average kerosene lamps emits 340 kg of CO2 per year (Solar Aid, 2018). Fossil fuel lamps also place a heavy financial burden of off-grid communities. The estimated average annual lighting spend by the off-grid household in Africa is between $100 and $140 per year (incl. essentially Kerosene lamps & candles). In Kenya this figure can be as high as $157 per year (see Figure 2.2.).

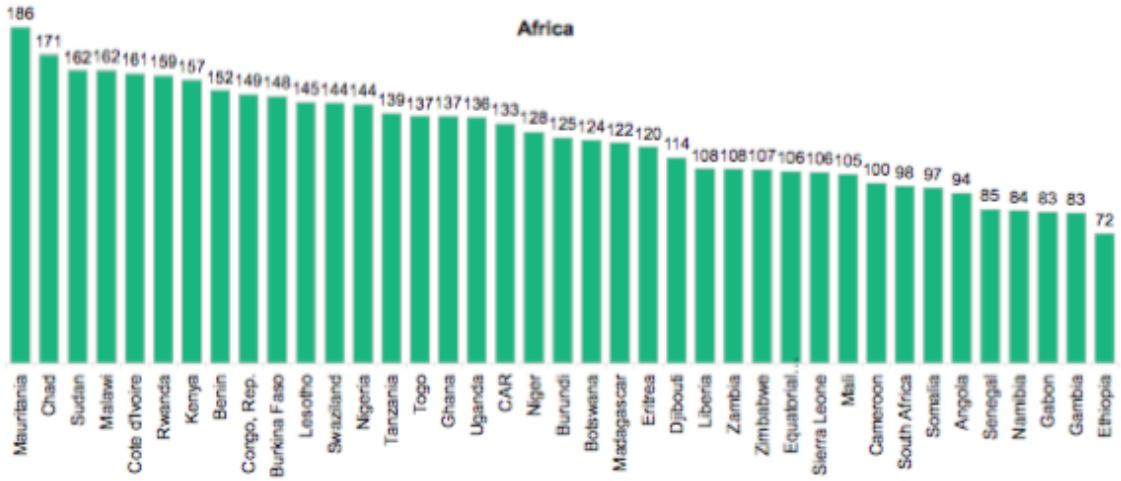

Figure 2.2: *Estimated average annual lighting spend by the off-grid household ($/ year, 2012).*

Source: World Bank Group (2016)

Reliance on dry cell batteries is increasing throughout Sub-Saharan Africa with many households replacing Kerosene lamps and other appliances with dry-cell battery powered alternatives. While this is undoubtedly an improvement from Kerosene, it is

still far from optimal. Purchasing batteries is expensive, particularly given their short lifetime. Plus, the mass usage of batteries has grave implications for the environment, particularly given the paucity of recycling or effective waste management options in SSA.

To conclude, the electricity production options available to off-grid communities have deeply damaging social and environmental consequences and cost households a significant proportion of their monthly incomes.

2.2 Off-grid Solar Industry

A dependable source of energy and fuel has always formed the bedrock of any society; however, modern society's deep-seeded and multi-faceted dependence on a vast and easily accessible energy infrastructure bears no historical parallel. (Vannini & Taggart, 2015). While this increased power availability has improved average quality of life in many sectors, the associated infrastructure has also introduced a host of sociopolitical and environmental issues. (Vannini & Taggart, 2015). First, the creation and maintenance of grids requires a stable and concentrated source of politico-economic power, which affects their costs and reliability. Secondly, user-overdependence results in the global exploitation and depletion of often non-renewable natural resources. Thus, developing secure and sustainable energy sources has become an international priority. (Harun, 2015). In response to decreased fossil fuel availability and increased pressure to reduce global carbon emissions, a shift towards renewable, particularly solar energy is underway in the energy sector. In addition to its environmental benefits, renewable energy offers increased security and economic opportunity through carbon trading. (Harun, 2015). As a result, 'off-grid' populations have new access to power and energy sources. (Vannini & Taggart, 2015).

According to Vannini and Taggart (2015), 'off-grid' describes facilities disconnected from electricity and natural gas networks. This term primarily describes power distribution in countries and/or regions with limited access to electricity due to scattered and dispersed populations. The term can also refer to a lifestyle choice wherein individuals live in a self-sufficient manner and voluntarily forego one or more public utilities. People who adopt this lifestyle are called 'off-gridders'. While voluntary off-gridders technically have the same amenities as off-grid populations with limited power and electric resources in developing regions, their ability to choose differentiates them from the target population in this study. The off-grid population described in this study refers exclusively to the latter group.

2.2.1 Evolution of the Off-grid Solar Industry Over Time

The off-grid solar energy movement emerged in the late 1980s and early 1990s, when privatization and market solutions for utilities became popular. (Kapur, Lewis, & Webb, 1997; Peet & Watts, 1993). This resulted in decreased external support for state-sponsored electricity infrastructure and increased investment in private sector energy projects. As publicly-financed grid-based rural electrification schemes declined in many countries, market-based solar electrification gained a foothold and increased prominence (Dubash, 2003; Karekezi, Kimani, Mutiga, & Amenya, 2004).

The market for solar products in Kenya dates back to the 1980s, when solar home systems began to be sold on a commercial basis. The demand for photovoltaic systems (PV) has grown exponentially since the mid 1980s when Kenyan entrepreneurs realized that photovoltaics could meet rural demand to operate electric lights, radios, televisions, or stereos often at a lesser cost than grid connections, systems driven by generators, or by using kerosene and dry cell batteries (Robert, 1994). The market

grew as mainly rural-based electricians linked up with urban businessmen and formed business agreements with solar electric suppliers primarily in Nairobi.

While early sales were based primarily on crystalline silicon PV modules, the market grew in the 1990s based largely on sales of small (12 to 15 Watt-rated) amorphous silicon modules. By earlier 1990s, more than 1 MW of photovoltaic power has been installed in Kenya and around 20,000 households have purchased solar energy for their homes compared to the 17,000 connected to the official rural electrification program (Robert, 1994). By the early 2000s, an estimated 200,000 household solar systems had been sold in only Kenya. Market sales of Pico-solar products that utilize LED lighting technology began to emerge in 2008 (IRENA, 2016).

2.2.2 The Trend of the Off-grid Solar Industry

With recent cost reductions, the off-grid solar industry now offers a rapid, cost-effective pathway to providing modern energy services to the approximately 600 million Africans who lack access to electricity and utility-scale electricity for the grid (Todd, 2016; IRENA, 2016).

Currently new mobile and solar technologies have been developed to make access to basic electricity possible. The technologies are being applied, especially in rural areas, in connecting many people to off-grid solar energy. They are being implemented by various pioneers who have created a vibrant market for off-grid solar systems. Venture capitalists and social entrepreneurs are increasingly using new financing models to drive these new business models, capitalising on the digital revolution to provide services through decentralised renewables-based energy systems and to secure payment for those services. In most instances, these new systems do not compete directly with on-grid solutions, either in terms of market share or financing, but have

instead introduced new entities and funding streams that are able to provide energy access in some places that were previously too difficult and costly to reach. To date the output from these new business models is small, but their existence is helping to bring about change (IEA, 2017). The main current technology that is trending in the off-grid solar energy industry is the PayGo (Pay-as-you-go*)* technology which is further discussed here in after (Lighting Global, 2015).

PayGo (Pay-as-you-go) Technology: In a 'pay-as-you-go' (PayGo) business model, a company essentially rents consumers a solar home system that comes with a battery, a charge controller, a solar panel, two to four LED bulbs, a radio and a mobile charger. Basic systems have enough power to charge phones and lights and larger ones could power small appliances like TVs. Consumers use basic mobile phones – widespread in East Africa – to make payments on a daily, weekly or monthly basis (Lighting Global, 2015). Through this model, companies can minimize the cost of collections by automating the receipt of payments, while remote rural customers get immediate access to basic electricity without having to take out a loan.

The PayGo model in the EAC (East African Community) is reliant on mobile infrastructure for mobile payments, the submission of customer data and customer engagement through SMS campaigns. Thus the growth of mobile phones and mobile networks is one of the key factors to consider while assessing the potential of PayGo SHS providers. In Kenya, M-pesa - a mobile money transfer platform introduced by Safaricom Ltd is used by many off-grid solar companies to facilitate the PayGo technology.

The PayGo solar technology is gaining in complexity every year, with new niche-actors starting with a very targeted value proposition to the other players (Lighting global, 2015). In order to assess the competitive landscape of the off-grid SHS industry, it is

essential to first understand the different development stages of the off-grid solar industry as illustrated in Figure 2.3.

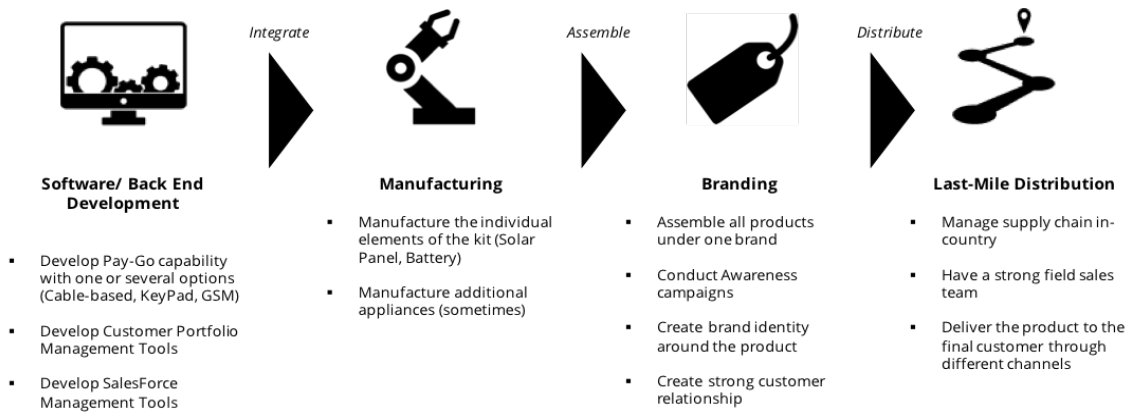

Figure 2.3: The four stages of development in the off-grid solar industry. *Source: Pawame Ltd (2017)*

From the four stages of development shown in Figure 2.3, a number of different strategies are possible, which can be attributed to two different types of Off-grid solar companies (Lighting Global, 2015):

- Integrated companies: These are companies that have integrated two, three or all the steps of the value chain into their business model.
- Pure Players: These companies focus on one specific part of the value chain and are therefore not considered as competitors

Different strategies co-exist amongst the integrated actors

- Starting directly under a fully integrated model, an approach adopted by off-grid solar companies called M-Kopa, Off-grid Electric and BBox. This strategy allows the company to keep control of all the value chain and therefore cut

costs. However, it is very capital intensive and exposes the company to a variety of risks throughout the value chain.

- Start as a manufacturer before expanding, an approach adopted by off-grid solar companies called Sunking and D-Light, who started by focusing only on the hardware (essentially battery + panel). Now they are trying to expand upwards and downwards on the value chain, either by developing their own distribution and brand or by developing proprietary software to license.
- Currently there are many off-grid solar companies that participate in connecting people to off-grid solar systems with great focus on rural areas.

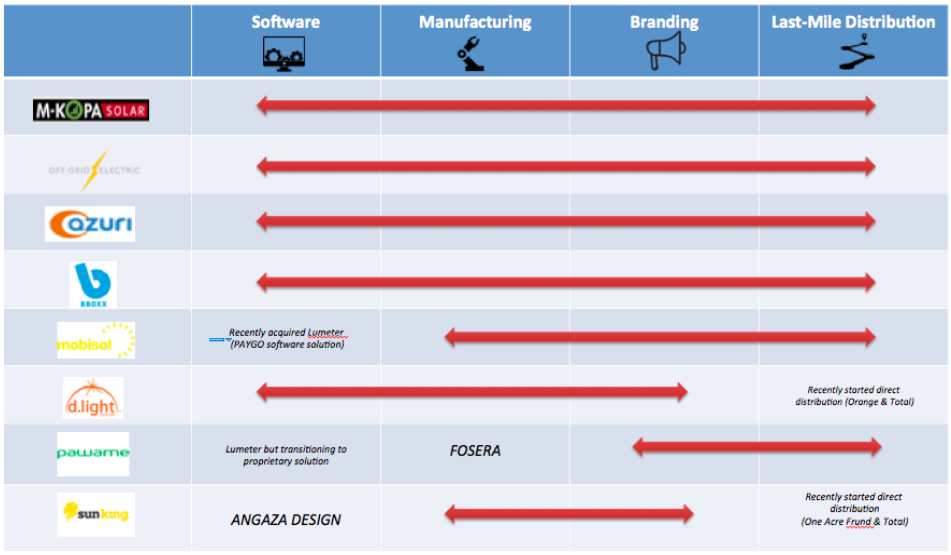

Figure 2.4: Introduction into other players - Position on the value chain (Pawame Business Plan (2017)

M-KOPA: It is the dominant provider of off-grid solar systems in Kenya. It has come to dominate the Kenyan SHS market through an approach that sacrifices product range and sophistication in favour of an emphasis on sheer distribution and achieving massive scale as quickly as possible. They offer a relatively basic home and a TV kit, but require self-installation of the system. Nonetheless, they claim to offer strong customer service through their large network of 578 retail outlets and call centre. M-KOPA recently celebrated their 600,000th kit sold, however growth has slowed significantly throughout the last year.

Off-Grid Electric: It is present as the largest off-grid solar energy company in its home market of Tanzania, where it has deployed more than 170,000 SHS. It has been one of the most prolific and high-profile fundraisers in the off-grid solar space, led by DBL Partners and SolarCity. Recently Off-Grid Electic also entered the Kenyan market.

Azuri: It is a large off-grid solar energy company in Kenya with most of its business spread across 10 other countries outside the country. Historically, Azuri has played at the lower end of the SHS market with units as small as 5W, but has recently been moving up-market with 10W and 15W systems and innovations such as HomeSmart, a control system which adapts its output depending on weather conditions and customer energy usage patterns. Azuri also plans to launch pay-as-you go solar irrigation systems to help farmers higher-value crops.

BBOX: Based in the UK, Bbox has a direct presence in Rwanda and Kenya and developed its strengths in product technology, back office and product management software. They feature a larger, 50W unit with bigger, cheaper lead-acid batteries.

Mobisol: Is at the high end of the SHS market, with a product line that starts at an 80W SHS and goes all the way up to 200W. The units are well suited to household appliances and for productive uses such as hair clippers. Mobisol recently acquired Lumeter, which is Pawame's mobile payment platform supplier.

D-Light: It is one of the pioneers in the solar lighting space and commands a truly global business. Its traditional business model has been to sell its solar lamps as one-off purchases via third-party distributors. However as of June 2016 D-Light has launched a PayGo offering in Kenya and appears to be growing rapidly.

The potential market of the off-grid solar industry is in a rise. Despite commitments from governments across Africa to increase the reach of their domestic power grids, it is envisaged that, in absolute numbers, the off-grid population in Africa will continue to rise until 2025, due to the high rates of population growth (World Bank Group, 2016; IRENA, 2016). Research suggests that about a third of this off-grid communities will be located in East Africa, making it one of the biggest addressable markets in Africa and the world (World Bank Group, 2016).

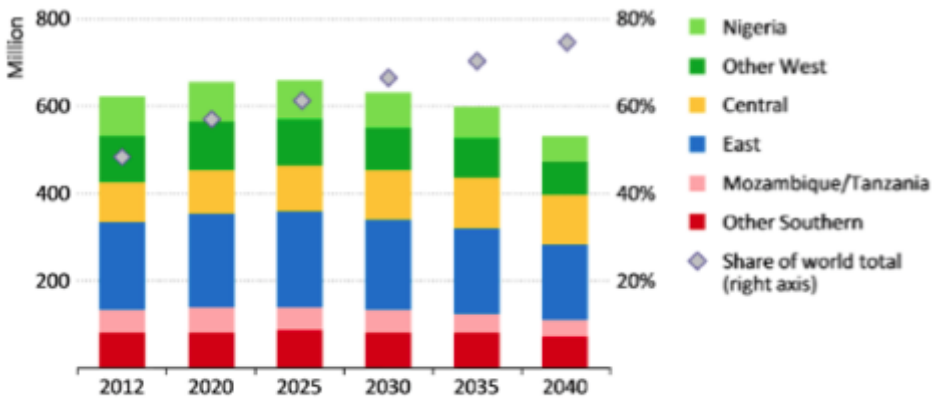

Figure 2.5: Population without access to electricity by sub-region in sub-Saharan Africa. Source: International Energy Agency (2014)

Consumer awareness on the importance of off-grid solar systems is also in the rise. Establishing the perception of solar solutions as a reliable, clean and affordable source of electricity option is a valuable form of market activation (IEA, 2017). This work has been partially conducted in East Africa where some big players, such as Lighting Africa and Sunny Money, have run successful awareness campaigns. However, these campaigns have remained focused on high-potential regions, leaving aside frontier markets such as Northern Kenya.

The current trend of the off-grid solar industry also looks at the technology cost reduction. Hardware still accounts for a major proportion of off-grid solar companies' costs and thus fluctuations in the price of hardware has a significant impact on the industry (IRENA, 2016). Generally, there has been a steady decrease in the cost of SHS. It is also anticipated that appliances powered by SHSs such as radios, TVs and fridges will increase in terms of their energy efficiency and decrease in price (IRENA, 2016). What is more, off-grid solar companies often participate in donor funding schemes designed to reduce costs even further by procuring sustainable and energy efficient appliances. Also technology used in SHS development is becoming increasingly commoditized, which is reducing the incentive for being involved in the technology production dimension of the supply chain. It can be observed that the fall in component costs is going to 1.) establish bigger margins for SHS distributors 2.) reduce the capability of competitors to differentiate themselves on price 3.) attract more players into the space 4.) ensure that competitive advantage will be driven by the quality of customer care, efficiency of the business model and the rate of commercial innovation.

Furthermore, reduction in battery costs are expected to have a significant impact as this accounts for more than half of the kit cost. Dependent of the type of batteries, the potential for cost reduction can be totally different. While lead-acid batteries are

relatively mature technologies with most cost reduction coming from economies of scale, there is a larger potential for Lithium-ion batteries, which costs are expected to dramatically decrease in the future.

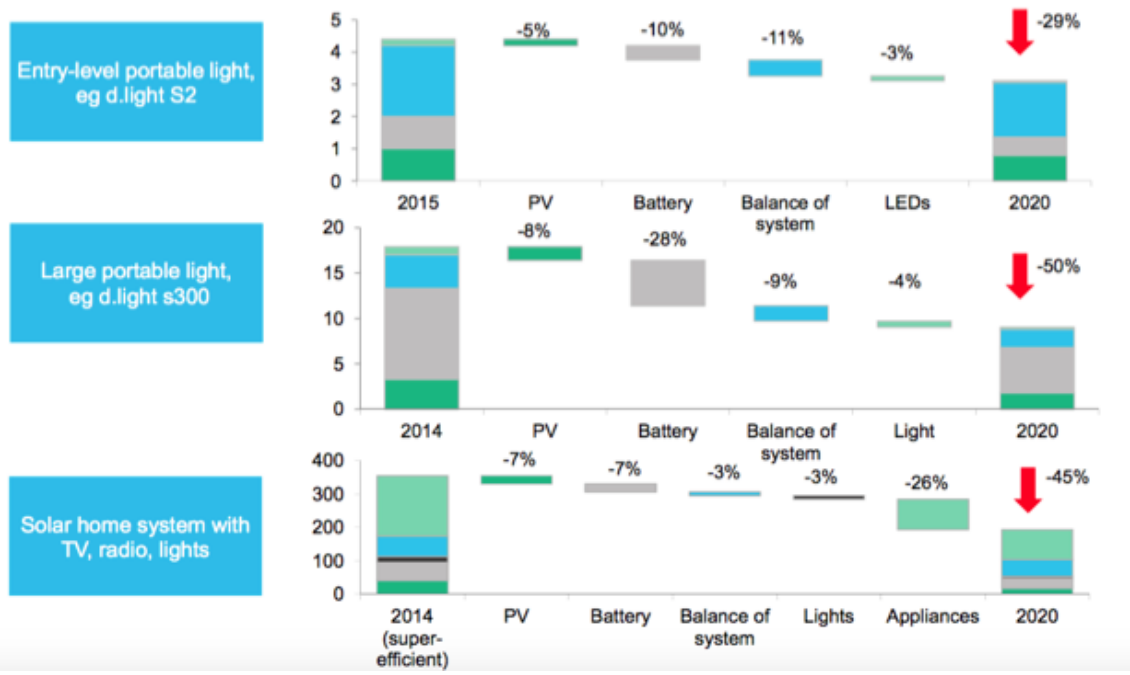

Figure 2.6: : Potential for costs reduction per type of product (nominal $ per unit). Source: World Bank Group (2016)

Last but not least it should be mentioned that the improved mobile phone infrastructure is a significant growth accelerator in the off-grid solar industry. This includes mobile phones subscription penetration, network expansion, and mobile payments for off-grid SHS. The usage of the internet among Kenyans is high; the Communications Authority of Kenya (CAK) estimates that 74% of the Kenyan population now has access to the internet and this figure is expected to rise yet further (CAK, 2015). The vast majority of internet access is conducted through mobile phones and it is therefore expected that mobile technology will continue to develop in Kenya

with a reduction in transaction and usage costs as the market becomes more competitive. Mobile internet subscriber penetration is expected to rise from 24% in 2015 to 39% in 2020 (with penetration of mobile only expected to reach 53%) (GSMA, 2016). Other factors include smartphone adoption (from 23% in 2015 to 57% penetration in 2020) and digital skills and literacy improvements.

2.2.3 Off-grid solar systems

There are several variations of off-grid solar systems, depending on the user's needs and budget. All variations of off-grid solar systems depend on a solar electric panel and store electricity in a bank of batteries (IRENA, 2016). They include single home off-grid solar systems, mini-scale off-grid solar systems, and utility-scale off-grid solar systems. This study mainly focuses on low voltage single home off-grid solar systems.

Single home off-grid Solar Systems are small off-grid solar devices with an energy capacity of 20-100 watts. They can be acquired on pay-as-you-go programs or as one-off purchases and typically offer energy services for lighting, mobile phone charging as well as other compact devices which are of high quality. In line with IRENA (2016), World Bank Group (2016) together with IEA (2016), the rapid expansion of single home off-grid solar home devices can be attributed to revolutionary new business models as well as a constant drop in costs. However, small devices under 100 W generally have higher cost per kilowatt than bigger variations due to the requirement of batteries and charge controllers which ensure stable output. Furthermore, they usually include several lights, radios, phone charging cables and torches.

2.3 Financial Factors in the off-grid Solar Energy Industry

2.3.1 The Bottom of the Pyramid

The bottom of the pyramid also referred as the bottom of the wealth/income pyramid is defined as the poorest and largest socio-economic group. According to Malik and Khalid (2014), around 2.7 billion people live on less than $ 2.50 a day. However, it should be mentioned that the definition and consequently the amount of people falling into this category is subject to numerous debates (Subhan & Khattak, 2017). The BOP still represents a large and untapped segment of the market and is primarily focused on developing nations (Prahalad, 2012). This provides large opportunities for firms to bring in economic activity and make significant profits by offering products or services at affordable prices. It should be clearly understood that the poorest market segment doesn't just generate problems for companies but offers the possibility to have a huge social impact and at the same time facilitate prosperity by improving people's lives (Prahalad, 2009).

Comparing the financial system to the progress made in transportation, telecommunication or other industries one can clearly see, that its development is lagging behind. Transportation enables nearly everybody on this planet to travel to any part of of this world by plane, ship, car or train and even visit Mars for an expedition. Telecommunication, which is made up by all telephone companies and Internet service providers was the epicentre of innovation and disruption of virtually any industry over the last century. Even the underdeveloped world is nowadays able to communicate due to enormously high mobile penetration rates, which reached standards of the developed world. But why is the financial industry so different to others? Is the financial system resistant to change? (Realini & Metha, 2015).

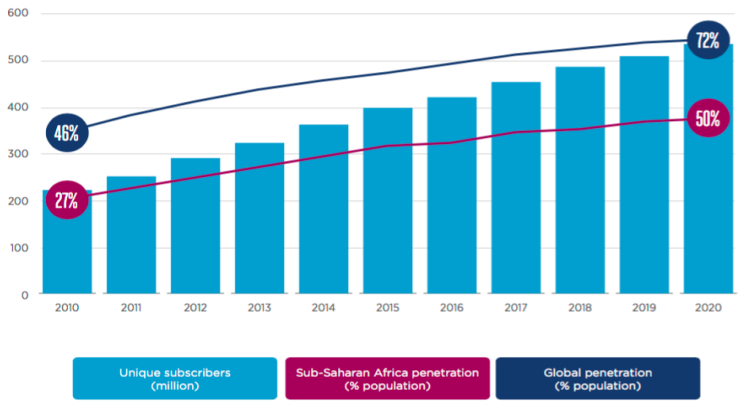

Figure 2.7: Sub Saharan unique mobile subscribers and market penetration Source: GSMA (2017)

2.3.2 Financial institutions

The financial industry can be described as a complex tangle of governmental, public and private entities available on the market (Realini & Metha, 2015). From the historic and more traditional institutions, which can be grouped under the term 'banks', to less traditional and affluent institutions like corner loan sharks to even global retailers who try to get a chunk of the cake. This dizzying array of providers on the market offers investment opportunities, mortgages, loans, deposits, money exchanges and many other different services. However, this creates instability and inconsistent quality of financial services across the globe. Some financial institutions are operating with the full faith and trust of their national government, others exploit legal loopholes and offer high-risk products which don't have any substance and some are even trying to get profits out of those who have little, the BOP (Realini & Metha, 2015).

Traditional banking systems usually cater for those on the top of the financial pyramid while marginalizing the bottom. It is far cheaper to do business with well-known financial service providers if you are wealthy than if you are someone who is just scraping by. As a big depositor, your expenditure is less, relative to your savings or

money you're borrowing. You'll be charged less interest or fees as you deposit or borrow more. By clearing loans on time, you receive better credit scores, providing you essentially with more capital at a more affordable price. However, the scales are tipped for those at the bottom of the financial pyramid as most times they end up paying a lot of exorbitant fees and charges in relation to their deposits. They don't have a sustainable and affordable system since the traditionally banking system has failed for the bottom of the financial pyramid, most of whom are located in the rural areas (Tiriki, 2003).

Lots of innovations and alternative options for banking are springing up in financial industries across the world. People are beginning to use mobile and branchless banks, which are far removed from the traditional pyramid systems and practices. These new models are affordable even for low-income earners; they're scalable while still making a profit for their providers and offer a lot of people, who had previously been denied institutional banking, a new path (Realini & Metha, 2015).

2.3.4 Financial Exclusion

According to Mas (2014), financial exclusion occurs because there are no or few financial institutions wishing to serve the poor or sustaining enough learning and experimentation about how best to serve them. Seven hundred years after the foundation of the first organised bank - the Medici Bank in Florence - half of the world's population is still living as financial nomads (Realini & Metha, 2015). This implies no access to the capital market and consequently no possibility to invest future earnings. Furthermore, two and a half million people who earn regular incomes and support their families have no access to any sort of formally recognized financial services (Realini & Metha, 2015).

Kenya is a low-income (as of 2016 Per capita GDP was estimated at $1,587/ 163,937 Kshs) country with a small and bank dominated financial sector. Starting in the 1980s, the government promoted non-bank financial institutions (NBFI) to reach low-income households, but prudential regulatory requirements were not stringent enough. The governmental NBFI policy failed within 5 years of its formulation as NBFI either were absorbed by big banks or collapsed, destroying the savings of many poor Kenyans. In the early 2000s, the microfinance model was introduced in Kenya. However, the legal framework for microfinance operations, the Microfinance Act, took a long time to enact. The first assessment of financial inclusion in Kenya from 2006 shows that less than 27% of adult Kenyans had access to formal financial services (World Bank, 2011). A considerable share of the population relied on informal services, but approximately 40% of Kenyans were completely excluded from the financial market. It is in this context that M-pesa was introduced to the market, catalyzing dramatic change in financial development and inclusion in Kenya (Mutiga, 2014).

2.3.5 Financial Exclusion in off-grid communities

Off-grid communities do not just suffer low electrification rates, these populations have also historically had very limited access to formal financial services. This is largely due to the preconception that rural communities have such a low or irregular income that they will be unable to meet repayment terms for loans. This implies that there is a lack of meaningful credit history in these communities (World Bank, 2011). In Kenya, as of 2011, only 42% of the population had a bank account and 10% had a credit card. Furthermore, just 10% of the overall population were able to secure a formal loan (World Bank, 2011). This figure is drastically lower among rural communities.

Since established income and access barriers prevent most of the rural poor from engaging the services of formal financial institutions, people have developed other means to obtain credit, save money and conduct informal financial transactions such

as saving groups (e.g. Chamas - informal cooperative society used to pool and invest savings by their members), traders etc. Some of theses mechanisms are often very expensive (they usually charge very high rates of interest) and only provide a narrow range of services, making most households dependent on self-finance and insurance, thereby limiting stability, investment & growth (Dubus & Van Hove, 2017).

2.3.6 Financial Inclusion

The ultimate goal is for everybody to be able to access financial services to better their lives. This theory including the examples presented here can be seen in practice. The Kenyan project M-pesa is just one example of this movement and change in architecture.

2.4 M-pesa - A Flourishing Mobile Payment Operator

In 2007, Vodafone in partnership with Safaricom, the largest mobile operator in Kenya, launched a new decentralized mobile money transfer service called M-pesa (M for mobile, pesa is Swahili for money) which has turned the traditional banking rhetoric on its head, now changing how Kenyans keep, use and transfer money. It is an electronic money transfer product that enables users to store value on their mobile phones or mobile accounts. It is based on a platform of electronic units of money that can be used for multiple purposes including transfers to other users, payments for goods and services, and conversion to and from cash (Njuguna, 2017). The payments technology has now developed to become efficient, transparent and effective and has covered other markets and sectors like insurance, capital markets and even targeted social protection programs (Dubus & Van Hove, 2017).

A financial inclusion survey conducted by Njuguna (2017) shows its remarkable success in Kenya and brings evidence that M-pesa has catalyzed a profound transformation in

Kenya's financial system. By 2016 about 75% of the population were able to access financial services (William &Tavneet, 2010). Moreover, the proportion of the adult population included in formal financial services increased from 26.4% in 2006 to 75.3% in 2016. Those preferring the informal financial services have declined from 35.2% in 2006 to 7.2% in 2016 (Njuguna, 2017). Today, Kenyans are able to access their bank accounts, save money, buy insurance and take out credit using their mobile phones.

2.4.1 Development of M-pesa

Competition of existing mobile network operators and new entrants was limited and for Kenyans the only way to send money other than through M-pesa remained costly, unreliable and difficult to access. In fact, the most prominent competitor of M-pesa was the public transport system, where Kenyans entrusted money to bus drivers and asked them for delivery while passing by their towns or villages. Without too much of a surprise this system was prone to fraud and robbery and considered as extremely unreliable (Buku & Meredith, 2013).

M-pesa was first developed as bank product in partnership between SAFARICOM (a leading mobile network operator in Kenya) and the Commercial Bank of Africa (Michael, 2012). In subsequent years, it has further evolved into a platform for a wide range of financial services such as virtual savings accounts in commercial banks. In addition to domestic financial services, M-pesa allows users to send and receive cross border remittances using their mobile phones. M-pesa and similar digital financial services represent a significant improvement in the national payments technology, reducing transaction costs and lowering the barriers to entry into the formal financial system. As a consequence, Kenya has emerged as a leader in financial inclusion in Sub-Saharan Africa (Michael, 2012)

The number of active monthly M-PESA customers worldwide stands at more than 29.5 million customers (Safaricom, 2016). They are being served through a network of around 287,400 agents in the ten countries. During 2016, the service processed around 6 billion transactions, peaking in December 2016 at 529 transactions every second (Safaricom, 2016).

Figure 2.8: Ten years of M-pesa - Figures correct as of December 2016 Source: Safaricom (2016)

2.4.2 Functionalities of M-pesa

M-Pesa allows users to deposit money into an account stored on their cell phones, to send balances using PIN-secured SMS text messages to other users, including sellers of goods and services and to redeem deposits for regular money from airtime resellers or retail outlets. Users are charged a small fee for sending and withdrawing money using the service. (Murithi, 2014).

2.4.2.1 Payments and Transfers of M-pesa

Prior to M-Pesa, mobile phone customers had engaged in trading pre-paid airtime (Hughes & Lonie, 2010). M-Pesa thus built on a pre-existing understanding of value transfer via mobile phone among Kenyans that provided an enabling environment for rapid adoption by both agents and customers. Safaricom established a network of agents who form the point of service where customers can convert cash into electronic units of money to load onto their mobile SIM card and vice versa (Hughes & Lonie, 2010).

2.4.2.2 Savings Accounts of M-pesa

Commercial banks started negotiations with Safaricom in order to link their services to M-Pesa. They began offering savings accounts and attracting more individual customers with interest rates on deposits. Thus, Mpesa evolved from using a common trust account for all users to providing a connection with individual savings accounts. The innovation attracted a large number of target savers, who locked-in their savings for a defined period. The growing depositor base allowed Kenya's commercial and microfinance banks to grow and strengthen their balance sheets (Starita, 2009).

2.4.2.3 Remittances of M-pesa

In recent years M-Pesa has expanded from domestic money transfer into cross-border remittance services. This development is especially beneficial for customers that rely on international remittances. Mobile-based remittance services have started replacing the informal Hawala money transfer system that was prevalent in Kenya before. This transformation carries important implications for financial sector formalities and adherence to anti-money laundering and terrorist financing (AML/CFT) standards (World Bank Group & European Commission, 2011)

2.4.3 M-pesa: A Service with an International Presence

M-pesa has gained around six million active users outside Kenya by launching the service in various choice markets around the world. As of now the mobile phone based cash and payments service is present in South Africa, Democratic Republic of Congo, Tanzania, Mozambique, Egypt, Lesotho, Ghana, India, Romania and Albania. This means M-pesa has presence not just in Africa but also in Asia and Europe (Gikunju, 2016).

M-pesa operates through innovative partnerships outside of Kenya. In Mozambique for example it was adopted by global development agencies as well as television companies who use the service to pay out employee salaries and collect payments. Lesotho on the other hand utilizes the Ministry of Social Development to pay for welfare grants and India uses M-pesa to promote financial inclusion for women's groups through the Rural Livelihoods Mission (Gikunju, 2016).

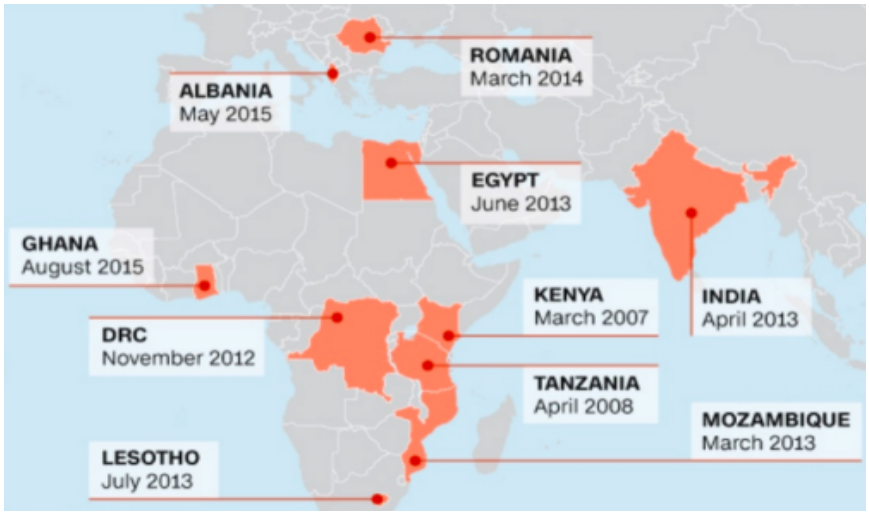

Figure 2.9: : M-pesa around the world - Launch dates. Source: Safaricom (2017)

Unfortunately, M-pesa was relatively low to gain toehold and attract customers in its expansion regions. Kenya remains the stronghold and the only county where the mobile money payment platform was adopted countrywide (Gikunju, 2016).

2.4.4 M-pesa's Advantages for companies

By using M-pesa, many institutions have been able to achieve cost reductions because all part of the cost is borne by the customer. For example, a Microfinance Institution (MFI) that pays loans through its branches spends huge sums on cash logistics, insurance and risk management of carrying cash. Disbursement through cheques is also costly as MFIs have current accounts and are charged for each cheque leaf and cheque clearing. Using the Business–to-Consumer (B2C) service of Safaricom, the MFI only has to deposit money in its M-pesa account and provide a list of recipients and the amount to be paid to each. For this service Safaricom charges the MFI on a per transaction basis, but the charges are much lower than what the MFI would incur for any other traditional mode of disbursement. Similarly, accepting deposits at a bank branch is more expensive on a per transaction basis to the institution as it incurs expenses for branch infrastructure, manpower, equipment and security arrangements. By asking customers to deposit or repay loans through M-pesa, the financial institution is essentially outsourcing teller activities to the M-pesa agent. This logic also applies to other financial institutions like insurance agencies, investment and pension plan providers or pre-paid instrument providers using the M-pesa platform and agents to collect premiums and deposits (Dubus & Van Hove, 2017).

2.4.5 Advantages of M-pesa for customers

Among the biggest benefits for customers is that they don't need to travel to a bank branch or an MFI designated point for transacting into their accounts. Customers can

just deposit money into their M-pesa account at the nearest agent and transfer from M-pesa to their bank account. This brings to them the following benefits:

- Cost savings on travel expenses, opportunity cost of losing wages or turnover etc. (it should be noted, clients may need to pay transfer and withdrawal fees to Safaricom which may lessen the benefit).
- Convenience of transacting whenever/wherever: M-pesa agents are ubiquitous and if a customer already has sufficient balance in his/her M-pesa account for the loan repayment, then he/she does not even need to go to an agent.
- Reduced risk of carrying cash. M-pesa agents are nearer than the bank/financial institution's branch.

2.4.6 Downsides of M-pesa

M-pesa has also its downsides. Urban users complain that they are sometimes frustrated by failed transactions which are often the result of network problems as M-pesa relies on the same technology that supports text messaging. Furthermore, it is difficult to get through to Safaricom's busy customer care M-pesa support phone number, meaning that a failed transaction may require the user to turn to the M-pesa agent network, which is often far away and struggles to resolve the problem. Another downside reported from rural users are that agents sometimes lack cash on hand, resulting in a non-fulfilment of withdrawal requests. (Njuguna, 2017).

An unexpected consequence of M-pesa is also that some men working in the cities have cut back on the number of visits to their rural homes, which they used to make frequently before M-pesa was available to deliver funds to their wives and relatives (World Bank Group, 2015).

2.5 Socio-Economic Impact of Off-grid Solar Systems through M-pesa

2.5.1 Socio-Economic Impact Off-grid Solar Systems

Facilitated by and also pulled by the increase of mobile money, small 20-100 W off-grid solar home systems can be acquired on pay-as-you-go schemes. These systems are able to supply modern energy services for lights, mobile charging as well as other devices and are usually cheaper on a month-to-month cost compared to traditional energy sources (e.g. kerosene lanterns) (IRENA, 2016).

Off-grid solar home systems are among the shortest of the power generation technology and can be distributed a lot quicker compared to other generation possibilities. Bearing in mind the high number of people across Africa with no electricity access or poor-quality electrical power supply (e.g. regular blackouts), the capability to swiftly size up off-grid solar home systems is an important advantage (IRENA, 2016).

Also the decreasing prices of PV modules have made SHS a cost-effective option for the around six hundred million Africans without a proper grid connection. For instance, Kenya has experienced accelerated, market-based development in SHS, with a variety of homes making use of SHS, doubling or even tripling between 2010 and 2014. Yearly expenses these days for off-grid lightning and mobile phone charging can range between $ 84 dollars (e.g. Ethiopia) and $ 270 dollars (e.g. Mauritania) each year. Comparing these amounts with alternative energy sources, one can clearly say that SHS are a very economical alternative (IRENA, 2016).

Furthermore, off-grid solar systems have resulted in lower transportation costs for journeys committed to mobile phone charging, which could add up to $ 25 per month in some cases (IRENA, 2016). Also LED lighting improved the quality of energy from 380 to 400 light lumens as opposed to kerosene lamps which exhibit around a tenth of light lumens (IEA, 2017).

Also the PayGo technology gave off a chance to reduce transaction and management costs on loan and energy service payments, hence allowing customer funding for loan sizes which are much smaller compared to previously possible (IEA, 2017). This use of consumer-level funding had always been known as a serious key factor for improving power accessibility of cash-poor customers particularly in rural areas (IEA, 2017).

Health benefits of off-grid solar systems are also important to mention, as they represent a clean and non-pollutant source of power as opposed to fossil fuel lanterns. Indoor air pollution caused through kerosene lamps and CO2 emissions have been significantly reduced by users of off-grid SHS. Furthermore, nearby warehouse of vaccines in solar operated refrigerators, prolonged length of evening health companies, as well as solar lightning for safe child delivery are among further health benefits (IEA, 2015; Harun, 2015).

For long periods, a lot of people, particularly in countryside places, happen to be making use of kerosene and also firewood for lighting. Off-grid solar home systems give and enable students to complete their home study even after sunset. Moreover, off-grid solar power lights improve accessibility to the educative course in TV and radio stations and foster social gatherings (Harun, 2015).

2.5.2 Social-Economic Impact of using M-pesa

Social value Generation: Prior to M-pesa many people would have to resort to sending money with someone (possibly a stranger) who was travelling to their village. In Kenya 38% of people didn't use any form of financial service; formal, semi formal or informal prior to the launch of M-pesa while only 19% of the population had access to formal financial services. National remittance is the main product offering of M-pesa. Safaricom positioned the product as a fast, safe and easy way to 'send money home'. The service also enables airtime purchase, bill payment, ATM withdrawal and purchase of goods and services. A ten year study by Njuguna (2017) shows that M-pesa's impact is immense. Its social value generated by grew from $0.85 million in 2007, to $1.7 million by the end of March 2016. (Njuguna, 2017).

Women Empowerment: M-pesa empowering rural women (usually recipients) because it makes it easier for them to solicit and get money from their husbands (usually senders) and other contacts in Kenyan cities. Remittances through M-pesa relieve women in rural areas of the burden to travel by bus to cities to receive money from their husbands, a process that for some could take as long as one week. Transactions made by urban senders are usually small and are intended to support rural family members financially. However, sometimes transactions happen also as lump sum transfers, when big expenses arise, for example the payment of school fees (World Bank Group, 2014). By making smaller but more frequent transfers, urban migrants on average are sending more money home than ever before. This represents a substantial boost for rural recipients, for whom remittances can represent up to 70% of their household income (Bigman, 2002).

Positive Change in Savings: M-pesa also results in a positive change in savings. The financial business diaries reveal that many customers are integrating M-pesa with

popular savings tools, such as bank accounts and informal savings clubs. The most frequent users who keep financial diaries were making on average 15 to 20 small deposits to their M-pesa accounts each month. Some used these savings to invest in their rural home, for example by purchasing cattle or building a home, while others transferred the money into bank accounts to earn some interest (World Bank Group, 2014). The mobile phone is also the preferred mode of savings in the country, with 60% of Kenyans having their savings in services such as M-pesa, M-Shwari and KCB M-pesa - a mobile based bank account offered exclusively to M-pesa customers (Vaughan, 2008).

Poverty Eradication: M-pesa has lifted 194,000 Kenyan households out of extreme poverty through 2006-2016 (Omwansa, 2016). As a stakeholder group, M-pesa agents experienced the second highest social value from $2 million in the year ending March 2016. The number of agents increased from 2,000 in 2007 to more than 101,000 at the end of March 2016 in Kenya. M-pesa's agents become the greatest beneficiaries, experiencing an average social value of $134 each year in the last ten years (Omwansa, 2016).

CHAPTER THREE: PAWAME LIMITED

3.1 Introduction

Pawame provides solar home systems (SHSs) and more to off-grid communities in Africa on a rent-to-own basis. Starting from its base in Kenya Pawame is tackling the still virtually untapped >$35b opportunity to electrify and serve over 600 million people in sub-Saharan Africa that don't have access to grid power (IRENA, 2016; Todd, 2016). Pawame also aims to foster financial inclusion in communities where banking opportunities are limited and credit history is practically non-existent. Their product is not only cheaper, cleaner, and more convenient than traditional solutions, it's also transformational.

Starting in August 2016, Pawame has deployed over 4,000 off-grid solar home systems till February 2018 and plans to sustainably reach 20,000 by the end of the year and 250,000 by 2021 (Pawame, 2017). By the time a customer has paid off a Pawame SHS systems (after about 18 months), the company can profitably lease them other life changing products and services that they would usually not be able to access or afford. The company also seeks to increase customers' financial resilience through micro insurance and targeted loans, improving their ability to pay (Pawame, 2017).

Pawame's vision is to be not just an energy access company but a consumer products and services company for the BOP, a trusted life partner for their customers and become one of the strongest and most respected brands in Africa. Currently Pawame is active in more than ten counties across Kenya and operates in remote and frontier regions like Turkana, deemed inaccessible and unprofitable by competitors. Unlike Pawame's competitors, every kit is installed by a professional technician, customers then receive a follow up call to assess their levels of satisfaction and are capable of

raising questions to the customer care team, who are accessible seven days a week (Pawame, 2017).

Pawame's SHS are built in Germany before an exclusive freight forwarding agent delivers them to the central warehouse in Nairobi. From there, the kits are transported to local storage units across the county so they can be sold and distributed.

The off-grid solar industry is capital intensive; each of SHS have to be paid for up front with profits only recouped when customers are in advanced stages of their repayment plan. Fundraising is therefore a key focus for the company and one in which Pawame has made significant progress. With over $1.3million raised in their second seed round. Pawame envisages to complete its Series A round March 2018, where $8 million should be raised. Series B will begin in August 2019 and the target is $3 million (Pawame, 2017).

3.2 Origins and Purpose

According to Pawame's Business Plan (2017), Pawame was born from a common will of four founders. They had all roots in the Middle East and expertise in the Energy industry. All very interested in the matter, they met several times in Renewable Energy Conferences around the world. Throughout their exchanges over 4 years, they always had an aura of ambition which drove them to collaborate in some way around this passion in the future. After learning about new business models in the off-grid space, one of the co-founders initiated conversations on starting a social enterprise. Finally, they touched down in Kenya in April 2016 to start Pawame with one clear purpose:

"To use technology to dramatically improve the lives of off-grid communities and make a meaningful contribution to the social and financial inclusion of these communities in the globalized world."

Pawame has chosen a for-profit model as the most effective and sustainable means of achieving its mission and the strategic goals. Its vision articulates a long-term, credible and aspirational end-state beyond the accomplishment of their mission. It is an outcome to be reasonably expected as a result of Pawame (and other like-minded enterprises) succeeding over a sustained period. Its vision is:

"A world where rural communities participate fully in the march of human progress"

This vision is born of (a) a realisation that while the trade and technology-driven global economic growth of the past 50 years has undeniably left the average human being far better off, the benefits have been unevenly distributed, with urban centers benefiting disproportionately and accentuating the urban-rural divide; and (b) a conviction that technology is a critical component of the solution to rebalance those benefits.

3.3 Pawame's Business Model

According to Pawame's 2017 Business Plan, Pawame's business model is based on 2 pillars:

1. Capturing the customers by selling high-quality SHSs on an 18-month repayment plan, with monthly repayments designed to equate to existing monthly expenditure on Kerosene and mobile phone charging.

2. Retain the customers by establishing a transformative platform offering other life changing products and services that they would not otherwise be able to afford. This is based on the firm's belief that it is going to create a long term

relationship and strengthen their customer's credit profile over the 18-month repayment period. This way, Pawame will be able to expand the range of products & services offered to the customers and upgrade them to new products and services, still under the PayGo model.

3.4 Offer High-Quality and Affordable Solar Home System

Pawame's first and core product is a Solar Home System called PawaHome. The PawaHome is the basis of the platform and will be the starting point of any additional offering to customers. Thus, it is extremely important for Pawame to continually improve the quality of the constituent parts in order to get the best-in-class solution, which is both reliable and affordable. The current Pawahome system is comprised of the following components: a 12v Battery pack with 2 USB mobile charging ports, a solar panel, 4x high efficiency LED bulbs, a remote control device, a torch with an in-built rechargeable battery and a high frequency FM radio with rechargeable battery

The total price of the manufactured product is set at $267, which will be paid back as follows:

Figure 3.1: PawaHome System. Source: Pawame (2017)

- Ensure customer payment upfront ($30): Conduct initial credit assessment to assess the customer's ability and willingness to pay, and collect $30 upfront to prove his/her commitment.
- Build payment habit and credit history: By collecting daily, weekly or monthly payments ($0,45 - daily, $3 - weekly, $12,50 - monthly) and progressively building a customer's credit profile.

3.5 Pawame's Positioning

Pawame was born from the intuition that there is space and demand for a middle-product. The company aims to bridge the gap between the low performance products under $215 and the premium standards products above $400. Its target customers are similar to M-Kopa, D-Light or Sunking, even though it tries to appeal to the upper end of the market too. The general belief is that these customers are left with no alternatives if they want to buy higher quality products, as they are still not able to afford upper end products like those of BBox or Mobisol.

Pawame offers a higher quality and more durable product. This requires a longer customer repayment period than its competitors (18 months), without the impact on the customer's ability to repay (as daily payments are similar to its competitors)

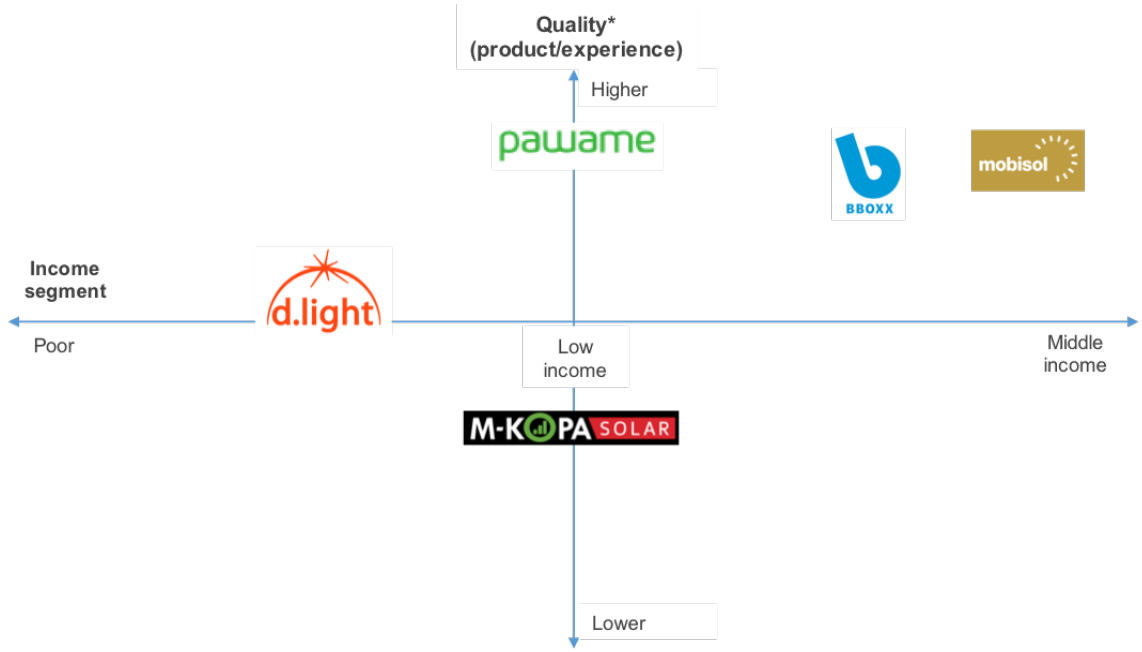

Figure 3.2: Assessment of appeal relative to our competitors. Source: Pawame (2017)

Pawame's strategy is to focus on branding and distribution by providing a customer experience and creating an intimate link with the customer. Having established intimate relationships with suppliers and a single freight forwarding agent, Pawame is able to keep costs low. Future plans of the company don't rule out the possibility of developing its own SHS.

3.6 Pawame's Strength and Unique Selling Proposition (USP)

Pawame is at the forefront of a new wave of off-grid solar companies. Whereas competitors have pursued sales at the expense of quality of service, Pawame has developed a business model that places the customer at the heart of everything they do. Pawame is the only player in the field that is trying to provide a premium product and a premium service to the low income segment. Furthermore, the company tries to be more than just a solar energy provider by being a comprehensive consumer product and services provider for the bottom of the pyramid and therefore a trusted life

partner for their customers. Pawame relentlessly focus on understanding who are their customers, what they want and how to reach them.

Pawame believes that people who live in the remotest and most hostile parts of Africa should not be excluded from the march of human progress. Therefore, the company has refined its operations and logistical functions to allow their solar kits to be sold in frontier markets deemed inaccessible and unprofitable by its competitors. This means that Pawame is well placed to sell their products in regions that are truly off-grid all across Africa.

The cornerstone of Pawame's strategy is the development of a trusted and enduring brand. This brand building is undoubtedly a slow process that requires investment, expertise and obsessive attention to meeting customers' needs over and over again. Once established, however, a strong brand is one of the most defensible and lasting sources of competitive advantage.

The brand building process is multifold and consists of different elements: (1) intimately knowing customer (2) designing a flawless and nuanced customer experience (3) offering a responsive, friendly and knowledgeable service, available at anytime, to support the customer and meet his or her needs. The company's belief is that this will translate into trust, loyalty and most importantly a strong positive emotional connection to its brand. The rent-to-own plan for Pawame's SHS ensures that Pawame maintains a direct relationship with the customer for at least 18 months and provides a natural window of opportunity to upgrade them to other products that are currently offered or are under development. Many of these, such as micro insurance and remote health services and perhaps even a proprietary media offering, lend themselves to open-ended fee-for-service arrangements that customers could only access via the PAYG platform built into the SHS. Offering service agreements and

extended warranty service on the kits themselves is another opportunity, as it is allowing customers to refinance the kits and enable access other products.

3.7 Advantages of a Pawame's SHS

3.7.1 Cheaper

Pawame's analysis indicates that the cost of light and phone charging can equate to $188/year for a Kenyan household. By comparison, the Pawame SHS equates to a cost of $164. per year. All in all, Pawame's solution is around 15% cheaper for an off-grid household and brings along many other social benefits as follows:

3.7.2 Better Lighting

LED lamps provided by Pawame's SHS provides a brighter (100 lumens) light than most Kerosene or Dry-Cell Powered lighting options

3.7.3 Cleaner

The usage of a Pawame's SHS is much cleaner and more environmentally friendly and incurs less waste than the use of either kerosene lamps or dry cell batteries. Furthermore, the increase of solar power over kerosene leads to huge long term health benefits.

3.7.4 Transformative

Beyond the direct impact of providing a better energy source for the off-grid household, the SHS is designed to have a much wider impact, in particular through the innovative Pay-Go Model. This model allows a customer to pay for a product on a predefined period, through mobile payments or local collection when mobile payments are not available. As a result, individuals can access products they would not be able to afford without this payment facility.

3.7.5 Convenient

Both dry cell batteries and kerosene need to be regularly replaced and therefore require the consumers to make regular trips to sales points, which can be of significant distances from their household. Furthermore, in many off-grid communities' consumers have to charge their phone at communal charging points. By centralising energy access in one appliance that does not depend on an expendable fuel resource, Pawame's SHS offers off-grid consumers a huge potential time saving. What is more, Pawame customers can also use their batteries to charge their neighbours phones and ask for a small fee ($ 0,10 per charging) comparable to what they would otherwise need to pay in city centres where electricity is available

3.8 Being a First Mover in Frontier Markets

The nature of the PayGo solar business model makes being a first mover in new regions a significant competitive advantage. With each new customer, Pawame makes a customer unavailable to its competitors for at least 18 months andeffectively earns 'right of first refusal' for extending the relationship with him or her.

The first wave of SHS companies focused on the relatively wealthier and more densely populated markets of Lake Victoria, Northern and Southern Rift Valley and the regions surrounding Mount Kenya. While Pawame has forever lost the opportunity to be a first mover in these areas, they are aiming to expand into the untouched Northern and Eastern regions, also known as the underserved counties. Pawame believes that this approach will yield long-term benefits; the initial logistical challenges will help to refine its business model and leave Pawame well prepared to expand into frontier and inaccessible markets across Africa.

Figure 3.3: Turkana Pawame sales agent demonstrating the product to local community members. Source: Pawame (2017)

3.9 Untapped Capital Base

The PayGo Solar industry is extremely capital intensive as the cost of inventory needs to be purchased upfront and will only be recouped in the advanced stage of the customers' repayment plans. This means that the capability for growth is closely linked to the ability to secure additional sources of capital as well as having ready sources of capital can translate directly into a competitive advantage in the marketplace.

The vast majority of the capital that has flowed into the off-grid SHS industry since its inception has come from the US and Europe. Many potential investors in these regions are largely unavailable to Pawame and other later market entrants because they have already been tapped by the first-wave players.

This makes Pawame's links to the Middle East, a region with ample private liquidity, a valuable asset. All four of Pawame's co-founders as well as its CEO have extensive experience and wide-ranging connections in the Gulf. Most of Pawame's investment to

date has come from this region and the company recently received strong expressions of interest from a handful of respected Gulf VC/PE players.

It should be noted however that while these investors can bring capital, they cannot normally bring strategic expertise in the form of knowledge of the social impact space, off-grid solar industry or the African market. As a result, while they are willing to co-invest, they are not in most cases suitable lead investors.

3.10 Creation of a Platform for Diverse Products/Service Offering

Once Pawame has established a relationship with its customers through the PawaHome system, the company aims to strengthen and develop this connection by offering a range of other transformational and life-changing products and services at affordable prices. Pawame's vision is not to be just an energy access company but a consumer products and services company for the BOP. Specifically, Pawame attempts to retain customers through the quality of its core PawaHome system and a targeted and expanding line of products based on in depth understanding of customer needs, ascertained through data collected over the 18-month repayment period.

Figure 3.4: A family observes the installation of a PawaHome kit in their house. Source: Pawame (2017)

Furthermore, the establishment of a trusted relationship through its premium customer care offer, including professional installations and proactive post sales check-up calls should help to retain Pawame's existing customer base.

While creating the pipeline of products and services to offer, Pawame constantly keeps in mind its strategic objectives which are impact, financial Inclusion and financial performance.

The pipeline for future products can be divided into the following three categories:

1. Financial services: building on the payment data that Pawame has collected and aggregated it will be able to offer a suite of financial service to its customers.
2. Additional appliances: Pawame already offers a TV SHS kit to customers and plans to expand the line of appliances that it offers to customers
3. Network Enabled Services: Pawame intends to offer e-education and e-health services as well as media applications within its product portfolio in the near future

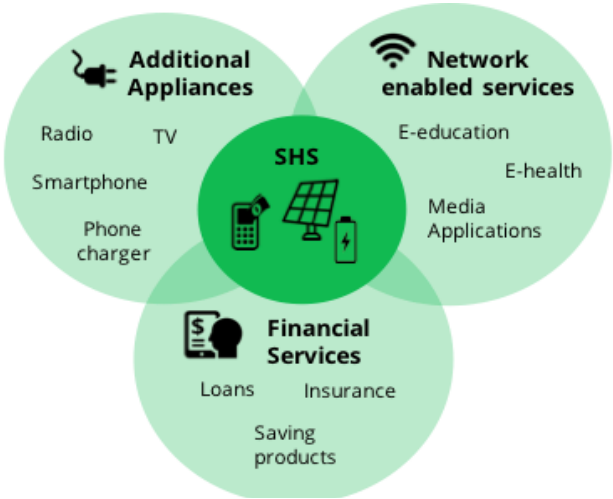

Figure 3.5: Pawame's product diversification strategy. Source: Pawame (2017)

CHAPTER FOUR: THE PROJECT

4.1 Introduction

The survey for this study was carried out in rural Kenya with particular focus on counties that Pawame Ltd has had access in terms of connecting rural people to off-grid solar systems. A descriptive research design was adopted whereby both a qualitative and quantitative approach was applied in collecting data from the field. The target population included rural people who had been connected to off-grid solar systems for at least one month. A total of six counties were selected through purposive sampling technique and they include Bungoma, Kakamega, Kisumu, Siaya, Turkana and Uasin Gishu. From each of the six counties, the researcher randomly sampled 20 respondents making a total sample size of 120 people. The researcher used structured questionnaires for primary data collection from the consumers of the off-grid solar systems in the six selected counties. The questions were designed in a manner that most of them were closed-ended with a few open-ended. The questionnaires were administered by research assistants who were recruited and trained. The research assistants were compiled sales agents of Pawame Ltd working in the study area. Collected data was analyzed using the Statistical Package for Social Sciences (SPSS) version 23.0. The findings are presented in form of frequency tables, charts, and graphs.

4.2 Analysis, Presentation and Interpretation of the Findings

The section comprises of the response rate of the respondents, demographic information, evolution of off-grid solar system, how M-pesa has facilitated the evolution of the off-grid solar industry in rural Kenya, the trend of the off-grid solar industry in rural Kenya, socio-economic impact of the off-grid solar industry in rural

Kenya and the socio-economic impact of M-pesa in facilitating evolution and trend of the off-grid solar industry in rural Kenya.

4.3 Response Rate

The researcher targeted 120 respondents. However, 106 questionnaires were fully filled and returned to the researcher making the response rate to be 88.3% as shown in Table 4.1. For generalization, Mugenda and Mugenda (2003) and Neuman (1997) noted that a response rate of 50% is adequate for analysis and reporting, 60% is good, while 70% and above is excellent. Therefore, this study's response rate of 88.3% was satisfactory enough and a representative of the study population.

County of resident	**Target Sample size**	**Actual Response**	**Response Rate**
Bungoma	20	20	100%
Kakamega	20	20	100%
Kisumu	20	18	90%
Siaya	20	17	85%
Uasin Gishu	20	16	80%
Turkana	20	15	75%
Total	**120**	**106**	**88.3%**

Table 4.1: Response Rate

4.4 Demographic Profile of the Respondents

The researcher sought to find out the demographic information of the respondents in order to ascertain their suitability to undertake the study. Focus was on the gender, age, marital status, highest level of education and occupation of the respondents.

4.4.1 Gender

Findings on the gender distribution of the respondents indicate that 56% of the respondents were male while 44% were female as shown in Figure 4.1. This shows that all gender were included in this research thus providing a reasonable representation for the study.

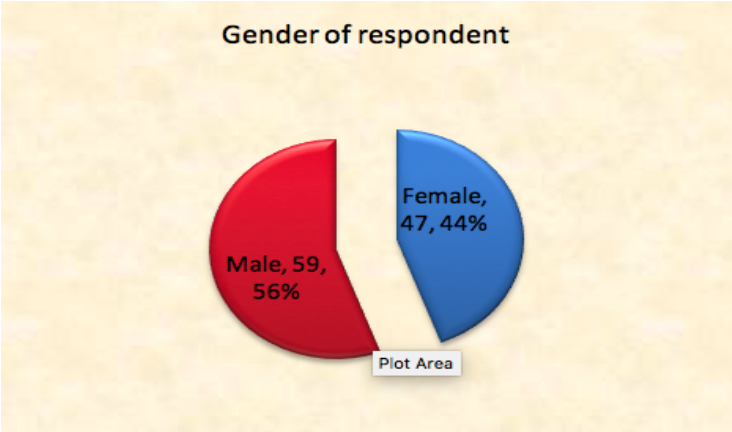

Figure 4.1: Gender distribution of the respondents

4.4.2 Age

Findings on the age distribution of the respondents indicate that most (40.6%) were 31-40 years, followed by those who were 21-30 years at 29.2%, then 41-50 years at 17.9%, 51-60 years at 10.4%, and a few (1.9%) who were above 60 years as shown in Figure 4.2. These findings indicate that all age groups were covered and represented in this study thus the information provided was reliable.

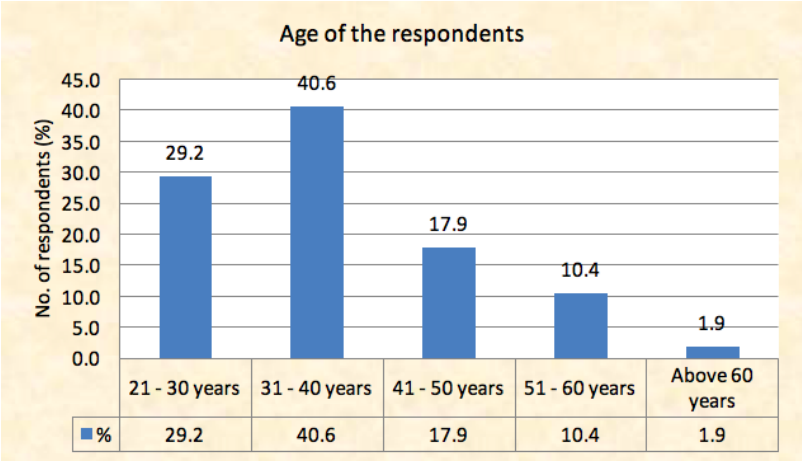

Figure 4.2: Age distribution of the respondents

4.4.3 Marital Status

The researcher also sought to know the marital status of the respondents in order to understand the accessibility and affordability of off-grid solar systems based on people's marital status. Findings in Figure 4.3 show that majority (83.0%) of the respondents who were connected to off-grid solar systems in rural Kenya were married people, followed by those who were single at 12.3%, then a few were those that were divorced, separated or widowed. These findings imply off-grid solar systems are accessible and affordable to many people in rural areas regardless of their marital status.

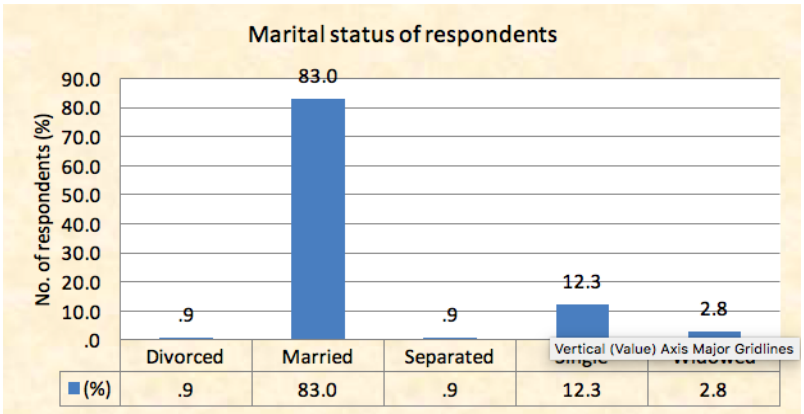

Figure 4.3: Marital status of the respondents

4.4.4 Highest Level of Education

On level of education, most (38.7%) of the respondents had attained secondary education, followed by 25.5% who had attained diploma level education, then those who had attained only primary education at 15.1%, undergraduate (bachelors) level of education at 6.6%, and very few (0.9%) had attained postgraduate (masters) level education as shown in Figure 4.4. Only 1.9% of the respondents had no education at all. These findings imply that most of the respondents were knowledgeable hence could understand the evolution, trend and socio-economic impact of the off-grid solar systems on their life.

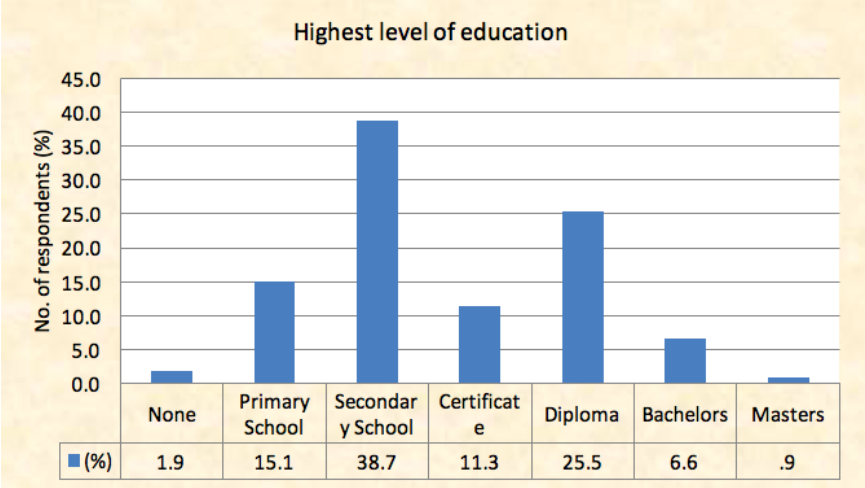

Figure 4.4: Highest level of education of the respondents

4.4.5 Occupation

Last but not least, the research sought to understand the occupation of the respondents that enabled them afford the off-grid solar systems. Findings in Table 4.2 show that most of the consumers of the off-grid solar systems were self-employed persons at 46.2%, followed by those who were carrying out farming activities at 24.5%,

then those that were employed in the private sector at 13.2%, civil servants at 12.3%, and a few who were engaged in other activities as shown in table 4.5.

Occupation	Frequency	Percentage
Self-employed	49	46.2
Farmer	26	24.5
Employed (private)	14	13.2
Civil Servant	13	12.3
Hostel manager	1	.9
House Wife	1	.9
Pastor	1	.9
Others	1	.9
Total	**106**	**100.0**

Table 4.2: Occupation of the respondents

4.5 Evolution of Off-Grid Solar Industry in Kenya

Off-grid solar systems are currently widely available in Kenya especially in rural areas where access to electricity is still a challenge. The researcher sought to understand how off-grid solar systems have evolved in Kenya over time.

4.5.1 Sources of Energy Used before the Off-Grid Solar Energy

To start with, the researcher sought to understand the various sources of energy that were used for lighting before acquiring off-grid solar energy systems. Findings presented in Figure 4.5 indicate that majority (41.5%) of the users of the off-grid solar systems used tin lamps (kerosene lamps) before the introduction of the off-grid solar systems. Others used electricity (18.9%), lanterns (18.9%), firewood (4.7%), and torch (1.9%). The findings also indicate that 14.2% of the respondents had used multiple sources of energy before the introduction of the off-grid solar systems.

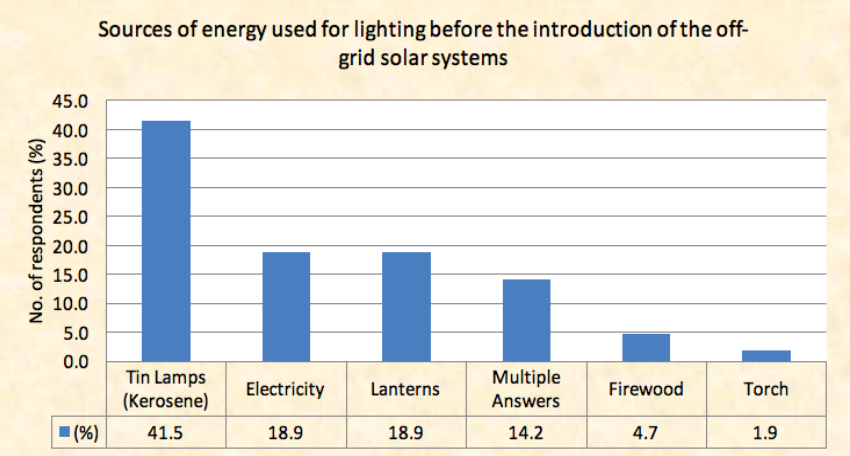

Figure 4.5: Sources of energy used for lighting before the introduction of the off-grid solar systems

4.5.2 The Introduction of the Off-grid Solar Energy in Rural Kenya

The customers of off-grid solar systems were asked to indicate the year they first heard of the off-grid solar systems. Study findings indicate that majority (68.8%) of the customers of the off-grid solar systems heard about the products between the current decade (2011 – 2018), followed by some (26.4%) who heard about off-grid solar

systems in the previous decade (between 2001 – 2010), then a few (4.8%) who heard about it two decades ago (1991 – 2000) as shown in Table 4.3.

Year respondents first heard of off-grid solar system	Frequency	Percentage (%)
2011 - 2018	73	68.8
2001 - 2010	28	26.4
1991 - 2000	5	4.8
Total	106	100.0

Table 4.3: The year the respondents first heard of the off-grid solar systems

Literature review reveals that off-grid solar industry was first introduced in Kenya at the beginning of the 20th century. However, as years went by, more people became aware of the off-grid solar energy hence the increased accessibility and affordability in the last decade (2011 – 2018). This could be due to advanced technology and reduced pricing in the solar energy industry and emergence of off-grid solar energy companies whose work is to connect as many people as possible to their products. For example, M-kopa was introduced in Kenya in 2011 but it has connected many people (around 600.000 systems - by 31.12.2017) to off-grid solar systems especially in Western, Rift Valley and Nyanza regions of Kenya. In addition, the introduction of mobile money platform like M-pesa in 2007 has facilitated the connectivity of many people especially in rural Kenya to the off-grid solar systems.

4.5.3 The Year Users Bought Off-grid Solar Systems

The researcher sought to understand the exact year the respondents acquired the off-grid solar systems. Study findings shown in Table 4.4 indicate that most (83.0%) of the

customers of the off-grid solar systems in rural Kenya had bought the systems in the last three years (2016 – 2018), followed by 12.3% who bought the off-grid solar systems between 2011 – 2012, and a few (4.5%) who had acquired the off-grid system between 2000 – 2010. These findings imply that the off-grid solar industry started diversifying its market from 2010 by reaching as many people as possible especially in rural Kenya. This could be due to the fact that more companies came into the Kenyan market hence more investment was made and more off-grid solar energy products were brought into the country.

The year users bought the off-grid solar systems	**Frequency**	**Percentage**
2016 - 2018	88	83.0
2011-2015	13	12.3
2006 - 2010	3	2.8
2000 - 2005	2	1.9
Total	**106**	**100.0**

Table 4.4: : The year users bought the off-grid solar systems

4.5.4 Use of the Off-grid Solar Systems in the Next Five Years

Last but not least on the evolution of the off-grid solar energy, the researcher sought to establish the likelihood that the users of the off-grid solar services will use solar energy systems in the next five years. From the findings in Figure 4.6, slightly more than half (52.8%) indicated that they will be 'very likely' to use solar energy systems in

the next five years, followed by 32.1% who said they will be 'likely' use them for the next five years, 12.3% were not sure, while very few (2.8%) were unlikely to use off-grid solar energy systems for the next five years.

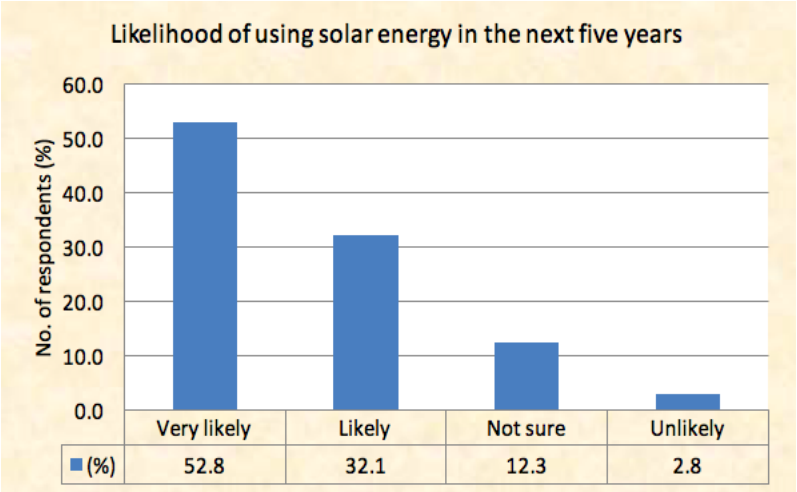

Figure 4.6: Likelihood of using solar energy in the next five years

Generally, findings in Figure 4.6 show majority (84.9%) are likely to use off-grid solar system services for the next five years compared to a few (15.1%) who were not sure or unlikely to use them for the next five years. These findings imply that off-grid solar systems have positively impacted on people's life especially those in rural areas hence the assurance from them that they are likely to use them for the next five years. Therefore, reaching as many people as possible people especially in rural areas and connecting them to off-grid solar systems is a tremendous investment currently with a promising future.

The respondents (15.1%) who indicated that they were not sure or they were unlikely to use off-grid solar systems in the next five years were asked to give reasons. Their responses were equally spread among the following reasons: the introduction of electricity, frequent breakdown of the off-grid solar systems hence unreliable, the

government's promise of availing electricity soon, and that off-grid solar energy services are not trustworthy. Therefore, these reasons need to be addressed by the off-grid solar energy companies in order to enhance the likelihood of customers using off-grid solar services for the next five years and even more.

4.6 The trend of the off-grid solar industry in Kenya

The researcher sought to establish the trend of the off-grid solar industry in Kenya. To achieve this, the researcher designed five statements to analyse the trend of the off-grid solar industry in Kenya and asked the respondents to indicate the extent to which they agree or disagree. Their responses were as shown in Table 4.5.

Statement about the trend of the Off-grid solar industry in Kenya		**Responses**					
		SA	**A**	**N**	**D**	**SD**	**Total**
Solar Systems are very affordable compared to other sources of energy for lighting like electricity	N	73	28	4	1	0	106
	%	68.9	26.4	3.8	.9	0.0	100.0
Sola Systems is very effective in lighting and using it for simple appliances like TV, Radio and Mobile Phones	N	50	45	8	1	2	106
	%	47.2	42.5	7.5	.9	1.9	100.0
Many people especially in rural areas are likely to purchase off-grid solar systems in the near future	N	64	33	8	1	0	106
	%	60.4	31.1	7.5	.9	0.0	100.0

If Solar Energy Industry move with speed, it is likely to connect more people compared to other sources of energy like electricity	N	61	35	8	2	0	106
	%	57.5	33.0	7.5	1.9	0.0	100.0
Solar energy will soon be the main source of energy for lighting for many people in rural area	N	53	28	20	4	1	106
	%	50.0	26.4	18.9	3.8	.9	100.0

Table 4.5: The trend of the Off-grid solar industry in Kenya

From the findings in Table 4.5, the majority (at least 75%) of the respondents 'strongly agreed' and 'agreed' to all the statements that were provided in the table with regard to the trend of the off-grid solar industry in Kenya. The customers generally agreed and appreciated that off-grid solar systems are very affordable compared to other sources of energy for lighting like electricity. They also generally agreed that off-grid solar systems are very effective in lighting and using it for simple appliances like TV, radio and mobile phones. Further, they generally agreed that many people especially in rural areas are likely to purchase off-grid solar systems in the near future and that if solar energy industry moves with speed, it is likely to connect more people compared to other sources of energy like electricity. The customers ascertained that solar energy will soon be the main source of energy for lighting for many people in rural areas. All these findings show that the off-grid solar industry is penetrating into the energy market as a source of energy that is affordable, reliable, and efficient especially in lighting and for household electronic appliances such as radios, TVs, mobile phones, among others. With this trend, especially in a competitive market, there are signs that the off-grid solar industry is advancing very fast in Kenya.

4.6.1 Probability of Purchasing Other Appliances/Services

This study sought to establish whether the users of the off-grid solar systems are willing to buy other appliances in addition to their off-grid solar systems. Therefore, respondents were asked to indicate whether they need, or have purchased, or do not need some appliances and services like TVs, Health Insurances, cash loans, water pumps, water tanks, fridges, jikos (charcoal-burning stove used for cooking) and mobile phones. The researcher was particularly interested in establishing the products that the users of off-grid solar products would like to buy. The findings are presented in Table 4.6.

Product		***I would buy this product***	***I have this product already***	***I don't need this product***	***Total***
TV upgrade	*N*	*68*	*31*	*7*	*106*
	%	*64.2*	*29.2*	*6.6*	*100.0*
Health Insurance	*N*	*64*	*21*	*21*	*106*
	%	*60.4*	*19.8*	*19.8*	*100.0*
Cash loan	*N*	*67*	*14*	*25*	*106*
	%	*63.2*	*13.2*	*23.6*	*100.0*
Water pump	*N*	*40*	*10*	*56*	*106*
	%	*37.7*	*9.4*	*52.8*	*100.0*
Water tanks	*N*	*69*	*32*	*5*	*106*

	%	*65.1*	*30.2*	*4.7*	*100.0*
Fridge	*N*	*43*	*11*	*52*	*106*
	%	*40.6*	*10.4*	*49.1*	*100.0*
Jiko	*N*	*60*	*32*	*14*	*106*
	%	*56.6*	*30.2*	*13.2*	*100.0*
Mobile phone	*N*	*36*	*61*	*9*	*106*
	%	*34.0*	*57.5*	*8.5*	*100.0*

Table 4.6: *Products users of off-grid solar energy have, or would like to buy, or do not need.*

Table 4.6 above shows that most of the users of the off-grid solar systems (at least 55%) would like to buy TV upgrade package, health insurance, cash loan, water tanks, and jikos. Also, 37.7% of the users of the off-grid solar systems would like to buy fridges, 37.7% would like to buy water pumps, while 34.0% would like to buy mobile phones. Generally, these findings imply that most users are willing to upgrade their systems to TV packages and also buy other appliances. As a result it can be further interpreted that the business model of upselling and providing future products used by off-grid solar companies is ratified.

4.7 Facilitation of Mobile Money Platform in the Evolution and trend of the Off-Grid Solar Industry in Rural Kenya

M-pesa has highly contributed to easy delivery of various services both in the public and private sectors. One of the sectors that M-pesa has worked effectively is the financial sector. Through mobile money platforms, payment for products has been

made easier with improved security on loss and theft of money. On this regard, the researcher sought to examine how M-pesa has facilitated in the evolution and trend of the Off-grid solar industry in rural Kenya and its socio-economic impact on people's life.

4.7.1 How Often M-pesa is used to Pay for Off-grid Solar Systems

The users of the off-grid solar systems were asked to indicate how often they use M-pesa to pay for their Off-grid solar systems. Findings shown in Table 4.7 indicate that 53.8% of the users of off-grid solar systems use M-pesa once a month to pay for their products, 14.2% use it once a week, 14.2% use it several times a week, 9.4% use it daily, 4.7% use it every two weeks, while 3.8% never use M-pesa to pay. These findings indicate that M-pesa is highly used by users of off-grid solar systems to make payments, an indication that M-pesa is highly contributing to connectivity of many people in rural Kenya. The users who indicated that they never use M-pesa in paying for the off-grid solar systems could be those who bought the system one-off and therefore do not take part in the repayment scheme.

How often respondents use M-pesa to pay for their Off-grid solar system	***Frequency***	***Percentage (%)***
Never	*4*	*3.8*
Daily	*10*	*9.4*
Several times a week	*15*	*14.2*
Once a week	*15*	*14.2*
Every two weeks	*5*	*4.7*

Once a month	*57*	*53.8*
Total	*106*	*100.0*

Table 4.7: How often respondents use M-pesa to pay for their Off-grid solar system

4.7.2 Accessibility of M-pesa Agents

The researcher wanted to understand how far users of the off-grid solar systems travel to access a nearest bank branch or M-pesa agent. Findings in Table 4.8 indicate that majority (90.6%) of the users of the off-grid solar systems are 5 km or less from the nearest bank branch or M-pesa agent. In particular, 45.3% of the users indicated that they are less than 1km away from the nearest bank branch or M-pesa agent, another 45.3% are between 1 – 5 km away, 7.5% are 6 – 10 km away, while very few (1.9%) are more than 10 km away from the nearest bank branch or M-pesa agent. These findings clearly show that M-pesa services have been made easily accessible even to rural areas in Kenya hence the effective facilitation of the evolution, trend and development of the off-grid solar industry.

Distance to the nearest bank branch or M-pesa agent	***Frequency***	***Percentage (%)***
Less than 1km	*48*	*45.3*
Between 1-5 km	*48*	*45.3*
Between 6-10 km	*8*	*7.5*
Between 11-20 km	*1*	*.9*

Between 21-50 km	*1*	*.9*
Total	***106***	***100.0***

Table 4.8: Distance to the nearest bank branch or M-pesa agent

To measure the effectiveness of M-pesa services in the evolution, development and trend of the off-grid solar industry, the users of the off-grid solar systems were asked to indicate how effective is M-pesa in paying for off-grid solar energy systems. Their responses were as presented in Figure 4.7.

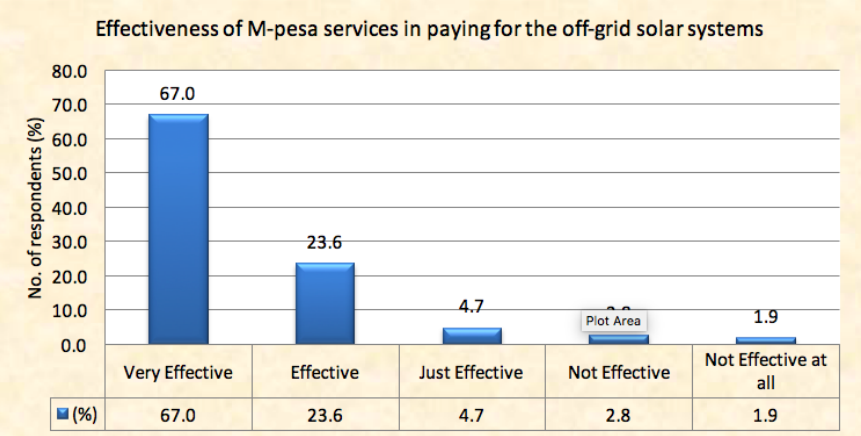

Figure 4.7: Effectiveness of M-pesa services in paying for the off-grid solar systems

Findings shown in Figure 4.7 indicate that the majority (67.0%) of the respondents agreed that M-pesa services have been very effective in paying for the off-grid solar systems, 23.6% said they have been effective, 4.7% said they have been just effective, 2.8% said they have not been effective, while very few (1.9%) said they have been not effective at all. Cumulatively, 90.6% of the respondents ascertained that M-pesa services have been generally effective. This implies that most Kenyans regard M-pesa as an appropriate tool to pay for their SHSs and value the possibility of paying back in instalments. Kenyans who voted for either 'non-effective' or 'not effective at all' are

most likely located in areas with poor network connection, where they have to travel to an official M-pesa agent or a location with network coverage every time they make a payment.

4.7.3 The Future of the Off-grid Solar Industry and M-pesa

For future purposes, the researcher sought to find out whether users of off-grid solar systems thought M-pesa will make many people in rural areas get connected to off-grid solar systems. From their responses, 54% agreed that that through accessibility and use of mobile money platforms (M-pesa), many people in rural Kenya are going to be connected to the off-grid solar energy. However, 44% of the users of the off-grid solar systems were not sure whether through M-pesa, many people in rural area are going to be connected to off-grid solar systems or not, while 2% of them disagreed as shown in Figure 4.8. These findings imply that M-pesa is a major driving force behind connecting many people to off-grid solar systems especially in rural areas. Competition from other mobile money platforms in Kenya like Airtel Money and introduction of bank agents in rural areas could be the reason why 44% of the users of the off-grid solar systems were not sure that many people in rural area are going to be connected to off-grid solar systems through M-pesa.

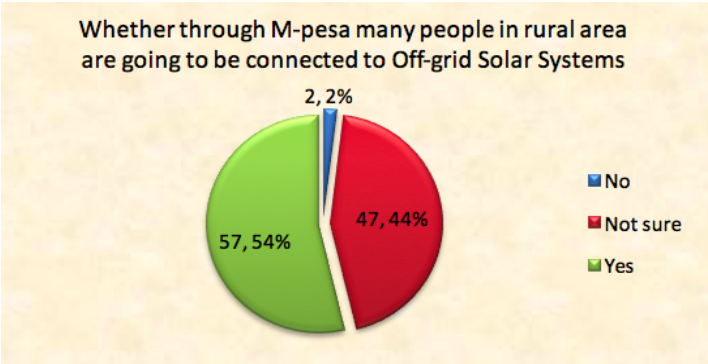

Figure 4.8: Whether through M-pesa many people in rural area are going to be connected to off-grid solar systems

The researcher went further and asked the respondents to give reasons why they accepted that through M-pesa many people in rural area are going to be connected to off-grid solar systems. The reasons given can be summarized with the major reason being that use of M-pesa in paying for the off-grid solar systems is convenient, i.e. easy, affordable, and secure.

4.8 Socio-economic Impact of M-pesa in Off-grid Solar Industry in Kenya

The researcher sought to establish the socio-economic impact of mobile money platform (M-pesa) in facilitating evolution and trend of the off-grid solar industry in rural Kenya. In a Likert scale of 1 – 5 where 1=strongly disagree and 5=strongly agree, the users of the off-grid solar system were asked to indicate the extent to which they agreed or disagreed to the listed statements with regard to socio-economic impact of the mobile money platform (M-pesa) in facilitating the evolution and trend of the off-grid solar industry. The findings are shown in Table 4.9.

Statement about the the socio-economic impact of mobile money platform (M-pesa)		***Responses***				
		SA	***A***	***N***	***D***	***Total***
Through use of M-pesa in paying for Solar Energy Systems, I have saved a lot of transportation costs.	N	86	15	3	2	106
	%	81.1	14.2	2.8	1.9	100.0
Use of M-pesa is very secure when making payments compared to paying cash due to theft or money lost	N	68	34	4	0	106
	%	64.2	32.1	3.8	0.0	100.0

Through M-pesa, am or I was able to pay for Solar Energy systems in instalments hence making it affordable than when paying cash at once	N	74	22	9	2	106
	%	69.8	19.7	8.5	0.9	100.0
Due to mobile money banking (M-pesa), there is social and financial inclusion of all people in paying for various services especially in rural areas e.g. paying solar energy systems is now cheap and affordable to all people.	N	62	35	9	0	106
	%	58.5	33.0	8.5	0.0	100.0

Table 4.9: Socio-economic impact of mobile money platform (M-pesa) in facilitating evolution and trend of the off-grid solar industry.

From Table 4.9, the majority of the respondents (at least 84%) 'agreed' and 'strongly agreed' that: they had saved a lot of transportation costs because of the use of M-pesa in paying for solar energy systems; use of M-pesa is very secure when making payments compared to paying cash due to theft or loss of money; M-pesa has enabled them to pay for solar energy systems in instalments hence making it affordable than when paying cash at once and that there use of M-pesa has enhanced social and financial inclusion of all people in paying for various services especially in rural areas. These findings ascertain that use of M-pesa has a highly positive impact on people's life. Most (44.3%) of the users of the off-grid solar systems confirmed that they save an average of Kshs 100 – 500 per month, 24.5% save Kshs 501 – 1000 per month, 4.7% save Kshs 1001 – 5000 per month, 8.5% save less than Kshs 100 per month, while 0.9% save above Kshs 5000 per month due to use M-pesa in making transactions for their off-grid solar systems (as shown in Table 4.10). This shows how the positive economic impact of M-pesa on people's life and assures that customers of the off-grid solar

industry effectively save money compared to their previous incurred expenditures (mobile charging, alternative lighting sources, transportation costs).

Average monthly savings (Kshs)	***Frequency***	***Percentage (%)***
No savings	*18*	*17.0*
Less than 100	*9*	*8.5*
100-500	*47*	*44.3*
501-1000	*26*	*24.5*
1001-5000	*5*	*4.7*
Above 5000	*1*	*.9*
Total	***106***	***100.0***

Table 4.10: Average monthly savings (Kshs)

According to this study's findings, money saved due to use of M-pesa in making transactions for their off-grid solar systems is utilized in other activities like investing in businesses, buying food for their families, off-setting other bills like rent and water, paying school fees for children, investing in agricultural activities, paying the instalments of the off-grid solar systems, among others. This shows how socially M-pesa has positively impacted on people's life especially in rural areas.

4.9 Socio-Economic Impact of the Off-grid Solar Industry in Rural Kenya

Last but not least, the researcher sought to establish the socio-economic impact of the off-grid solar industry in rural Kenya. Users of Off-grid Solar System were asked to indicate the extent to which they agreed or disagreed to the statements that were listed with regard to socio-economic impact of the off-grid solar industry in rural Kenya. Findings were as shown in Table 4.11.

Statement about the the socio-economic impact of off-grid solar system in rural Kenya		**Responses**				
		SA	A	N	D	Total
Through solar energy home system, am connected to the world through watching TV and listening to Radio	N	70	28	3	5	106
	%	66.0	26.4	2.8	4.7	100.0
Solar energy systems have reduced air pollution since I no longer use sources of energy that emit a lot of smoke that pollute air.	N	65	30	10	1	106
	%	61.3	28.3	9.4	0.9	100.0
By using Solar Energy systems, I no longer inhale toxic gases emitted from energy generated from fossil fuels.	N	69	26	7	4	106
	%	65.1	24.5	6.6	3.8	100.0
Solar energy has enhanced security in home compound due to sufficient lighting including security lights.	N	44	44	15	3	106
	%	41.5	41.5	14.2	2.8	100.0

I feel my household has experienced a good development since I own the solar system	N	63	29	11	3	106
	%	59.4	27.4	10.4	2.8	100.0
Evolution of solar energy has created employment opportunities because there many people employed in companies in the Solar Energy Industry	N	76	22	7	1	106
	%	71.7	20.8	6.6	.9	100.0
Manufacturing and generating solar energy is less expensive than manufacturing and generating other sources of energy like electricity	N	59	33	13	1	106
	%	55.7	31.1	12.3	.9	100.0
Use solar energy systems saves a lot of money homes or buildings compared to electric bills incurred when using energy generated from fossil fuels like geothermal power.	N	71	30	5	0	106
	%	67.0	28.3	4.7	0.0	100.0
Use of solar energy saves transportation costs incurred when acquiring and using energy generated from fossil fuels like geothermal power e.g. paying for mobile phone charging in city/town centres, transport involved to and from city/town/market centres, kerosene costs or paying for other lighting sources like torches	N	66	24	13	3	106
	%	62.3	22.6	12.3	2.8	100.0

Table 4.11: Socio-economic impact of off-grid solar system in rural Kenya

From Table 4.11, the majority of the users of the off-grid solar energy systems agreed that the products have a tremendous socio-economic impact on people's life especially in rural Kenya. For instance, majority (92.4%) of the respondents 'agreed' and 'strongly agreed' that off-grid solar systems enable many people get connected to what happens all over the world through mainstream media like radios and watching TVs. For example, in Kenya's 2017 general election, most rural people relied on radios and TVs in receiving information on the election progress before and after results were released. Also, the electoral body and the government relied on radios and TVs in informing rural people about the electoral process before and after election.

Furthermore, from the study's findings, 89.6% of the users of the off-grid solar systems 'agreed' and 'strongly agreed' that by using solar energy systems, they no longer inhale toxic gases emitted from energy generated from fossil fuels like kerosene. Also, 89.6% of the users of the off-grid solar agreed' and 'strongly agreed' that solar energy systems have reduced air pollution since they no longer use sources of energy that emit a lot of smoke that pollute air. Gases like carbon monoxide that are emitted by other sources of energy like kerosene and charcoal are unhealthy when inhaled and cause death. Therefore, solar energy eliminates the risk of inhaling such gases hence improving people's health.

Off-grid solar energy industry has also empowered many people economically through savings made out of its affordability compared to being connected to the power grid. This is because there are no electric bills to be paid monthly. From the study findings, 95.3% of the users of the off-grid solar systems indicated that use solar home systems save a lot of money in homes or buildings compared to electric bills incurred when using energy generated from fossil fuels like geothermal power. These savings could be used for other to pay for other bills like rent, water, school fees for children, buy food stuffs for the family among others.

Also, off-grid solar energy industry has created employment opportunities to many people who are working in the industry as sales agent, technicians, sales managers or shop and kiosk managers. These people's living standards have improved by generating a source of income for them.

The findings in table 4.11 also indicate that security in rural areas has been enhanced through security lightings in people's homes. Intruders that could be targeting homes are deterred by the presence of security lights in the rural off-grid homes. Therefore safety is enhanced through minimizing hiding spots and increasing physical detection of the intruders. In addition, members of the family, especially children and women feel safer with security lights in their homes.

5. Chapter Five: CONCLUSION

This paper focussed on analysing the socio-economic impact of off-grid solar systems on people's life especially through the facilitation of the mobile money platform M-pesa. Particular concentration was on the rural population of Kenya and the use of M-pesa in facilitating connectivity of people to off-grid solar systems. Pawame Ltd was the case study. The study's objectives were to analyse how the off-grid solar industry has evolved over time, how M-pesa has facilitated the evolution of the off-grid solar industry and its socio-economic impact, the trend of the off-grid solar industry and the socio-economic impact of the off-grid solar industry in rural Kenya.

The motivation of this study was from the fact that many people, especially in Sub-Saharan Africa, live without access to electricity yet there is existence of modern technology that provides accessible and affordable solutions. The majority of these people live in rural areas where the electrification rate is low due to poor infrastructure, inadequate government support and financial instability of many rural people to cover capital and operating costs for generation, transmission and distribution. Kenya is among the countries in Sub-Saharan Africa facing energy dilemmas. Limited access to electricity for households, particularly in rural areas as well as frequent power blackouts has led to a shift to modern alternatives. One of them are so called off-grid solar systems that are easily accessible and affordable because of of the adoption of the PAGO technology.

Various recent empirical studies have revealed that rural electrification, from solar power in particular, has helped in socio-economic development of many countries in several ways. A study by Harun (2015) on *'the role of solar home systems (SHS) in socio-economic development of rural Bangladesh'* formed the empirical context of this

study. Similar to this study, Harun (2015) focussed the socio-economic impact of off-grid solar systems in rural set-ups. They include improved household conditions for education, health, household work, access to information, communication, entertainment and perception on safety bring about radical changes in the traditional social life and quality of live of rural people. At the same time, a large number of people not owning an off-grid solar system benefited indirectly from visiting households with SHS to watch TVs, listen to radio, charge their mobile phone and laptops, and get studying facilities. Therefore, Harun's study pointed out various socio-economic developments that have taken place in rural areas as a result of the introduction of the off-grid solar technology. In addition, it was learnt that solar energy is widely perceived as a promising technology for electricity generation in rural areas especially in developing countries.

A descriptive research design was adopted in collecting primary data. The target population was users of the off-grid solar systems in three regions of Kenya (Nyanza, Western, and North Rift Valley) where Pawame Ltd has created market networks. Questionnaires were primarily used to collect data from the field and statistical analysis was conducted using the SPSS software version 23.0.

The researcher has experienced the socio-economic impact of off-grid solar systems as well as M-pesa throughout his employment time at Pawame Ltd Kenya. As the Deputy Sales Director the researcher's main tasks include the development of sales strategies as well as processes and to drive sales growth for the company. Furthermore, recruitment of a highly effective sales force on the ground, training activities as well as performance measurement to maximise talent effectiveness were among the main duties of the researcher. Most of these activities required the researcher to travel on a regular basis to Pawame's customer base in rural Kenya. During those visits the

researcher experienced on first-hand how impactful off-grid solar systems as well as mobile money payment platforms can be and decided to make it topic of his thesis.

The study found that before the introduction of the off-grid solar systems, most people in rural Kenya used tin kerosene lamps, while some used lanterns, firewood and torches. The number of people who first heard about off-grid solar home systems increased gradually over time and quite a number of people in rural Kenya have bought off-grid solar systems from 2010 onwards.

The study also concludes that M-pesa was found to be the driving force behind successful connectivity of many rural people in Kenya to off-grid solar systems. Most users of off-grid solar systems in Kenya use M-pesa either daily, weekly or once a month in making instalment payments for their products. Further, M-pesa has minimized transportation costs due to the possibility of transferring money through text messages and being able to charge mobile phones at home. Subsequently, the use of M-pesa has led to social and economic benefits as well as financial inclusion when paying for various services especially in rural areas.

One of the social benefits among the study under research found that solar home systems have enabled rural people to be connected to what is happening locally, nationally, regionally and internationally through watching TV and listening to radio. It further found that solar energy systems have helped in reducing air pollution since people no longer use sources of energy that emit pollutants like smoke and toxic gases. Furthermore, having solar energy systems in the house is considered by some people as social development since they help in social events like entertainment and other leisure activities. Economically, the evolution of solar energy has led to creation

of employment opportunities because there many people employed in off-grid solar companies.

In addition to connecting rural people to off-grid solar systems, the study found that users of the off-grid solar systems are willing to buy other products such as upgrading TVs, water tanks, water pumps, fridges, jikos, mobile phones, health insurances and cash loans. This is value addition especially to the off-grid solar energy companies and ratifies also their business models with the aim to establish long-term relationships with customers.

From the study findings, it is crystal clear that off-grid solar systems are acceptable as the best energy alternative that are accessible and affordable compared to power grid systems hence the need to connect more rural people to off-grid solar systems. This is similar to most of the literature which points out that off-grid solar energy is affordable and easily accessible. The socio-economic impact of the off-grid solar systems on people's life especially in rural areas is massive. This positively contributes to the development among rural people which in turn benefits economic growth of the country. As noted by Global Network on Energy for Sustainable Development (GNESD, 2007), without adequate supplies of affordable energy, it is difficult to improve health, education and reduction of poverty. Renewable energy sources like the off-grid solar industry is helping in that regard and positively contributes to the development of rural communities.

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Appendix: Questionnaire for Users of the Off-grid Solar Systems

SUBJECT: Socio-Economic Impact Using Off-grid Solar Systems through the Use of Mobile Money (M-pesa)

Dear Sir/Madam,

My name is HANNES ECKMAYR, a Masters Student at the University of Luiss Guido Carli in Rome (Italy). Am currently undertaking a Research Project that focuses on "The Socio-Economic Impact of Using Off-grid Solar Systems by Use of M-pesa in Paying for the Services." Therefore, this questionnaire seeks information on your personal background and the socio-economic impact you are experiencing in your lives as a result of using Off-grid Solar Systems. I kindly request you to take a few minutes to fill out this questionnaire. Please be as honest and truthful as possible. Be assured that your responses will be treated confidentially and will be used purely for academic purpose. If you have any questions about this Research Project or want to know about the results, please feel free to contact me on 0741439434 or email to Hannes.eckmayr@gmail.com.

Instructions

In some questions, choices are provided so please put a tick in the appropriate box. Where choices are not provided, answer using your own words in the most appropriate and comprehensive way.

SECTION A: DEMOGRAPHIC DATA

1. **Name (Optional):** ……
2. **Contacts (Optional):** ……
3. **County of Residence:**

Kakamega [ ] Bungoma [ ] Kisumu [ ] Siaya [ ] Turkana [ ] Uasin Gishu [ ]

4. **Gender:** Male [ ] Female [ ]

5. **Your age:** Below 20 years [ ] 21 – 30 years [ ] 31–40 years [ ]
   41 – 50 years [ ] 51 – 60 years [ ] above 60 years [ ]

6. **Marital Status:** Single [ ] Married [ ] Divorced [ ]
   Separated [ ] Widowed [ ]

7. **Highest Level of Education:**

   None [ ] Primary [ ] Secondary [ ] Certificate [ ]
   Diploma [ ] Bachelors [ ] Masters [ ]
   PhD [ ]

   Others (specify)……

8. **Occupation *(You can tick more than one):***

   Farmer [ ] Civil Servant [ ] Employed (private) [ ] Self-employed [ ]

   Any other (specify): ……

Section B: Evolution of Off-Grid Solar System

9. Which year did you first hear of Off-grid Solar Systems? ……..
10. Which year did you buy your Off-Grid Solar System? ……..

11. For how long have you used your Off-Grid Solar System?

Less than 3 months [ ] Between 3-6 months [ ] Between 6-12 months [ ]
Between 1-2 years [ ] More than 2 years [ ]

12. What source/sources of energy did you use for lighting before the introduction of Off-Grid Solar Systems in Kenya? *(You can tick more than one)*

Firewood [ ] Lanterns [ ] Tin Lamps [ ] Torch [ ] Electricity [ ]
Any other (specify): ……..

13. (a) Being a customer of an off-grid solar company, how likely that you are going to use solar energy in the next five years?

Very likely [ ] Likely [ ] Not sure [ ] Unlikely [ ] Very unlikely [ ]

(b) If your answer above is Not sure/Unlikely/Very unlikely, kindly give reason(s) for your answer:

i.

……

ii.

……

Section C: How Mobile Money Platform (M-pesa) has facilitated the Evolution of the Off-Grid Solar Industry in Rural Kenya

14. How often do you use M-pesa to pay for your Off-grid solar system?

Never [ ] Daily [ ] several times a week [ ] Once a week [ ] Every two weeks [ ] Once a month [ ]

15. How far is your nearest bank branch or M-pesa agent?

Less than 1000 m 1 – 5 km [ ] 6 – 10 km [ ]

11 – 20 km [ ] 21 – 50 km [ ] More than 50 km [ ]

16. How effective is M-pesa in paying for Off-grid Solar Systems?

Very effective [ ] Effective [ ] Just effective [ ]

Not effective [ ] Not effective at all [ ]

17. Do you think through M-pesa many people in rural area are going to be connected to Off-grid Solar Systems? Yes [ ] No [ ] Not sure [ ]

If yes, give reasons:

(i)

……

(ii)

……

(iii)

……..

Section D: The Trend of the Off-grid Solar Industry in Rural Kenya?

18. As a user or customer of Off-grid Solar System, kindly indicate the extent to which you agree or disagree to the following statements.

NB: 1= Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree and 5= SA.

Statement	5 SA	4 A	3 N	2 D	1 SD
Solar Systems are very affordable compared to other sources of energy for lighting like electricity					
Solar Systems is very effective in lighting and using it for simple appliances like TV, Radio and Mobile Phones					
Many people especially in rural areas are likely to purchase off-grid solar systems in the near future					
If Solar Energy Industry move with speed, it is likely to connect more people compared to other sources of energy like electricity					
Solar energy will soon be the main source of energy for lighting for many people in rural area					

19. Among the listed products in the table below, which one(s) would you consider buying and which would you not consider buying? (*Answer for each item)*

	I would buy this product	**I have this product already**	**I don't need this product**
TV upgrade			
Health Insurance			
Cash loan			
Water pump			

Water tanks			
Fridge			
Jiko			
Mobile phone			

Section E: Socio-Economic Impact of the Off-grid Solar Industry in Rural Kenya

20. As a user or customer of Off-grid Solar System, kindly indicate the extent to which you agree or disagree to the following statements with regard to Socio-Economic Impact of the Off-grid Solar Industry.

NB: 1= Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree and 5= SA.

Statement	**5 SA**	**4 A**	**3 N**	**2 D**	**1 SD**
Through my solar home system, am connected to the world through watching TV and listening to Radio					
Solar systems have reduced air pollution since I no longer use sources of energy that emit a lot of smoke that pollute air.					
By using Solar systems, I no longer inhale toxic gases emitted from energy generated from fossil fuels.					
Solar energy has enhanced security in home compound due to sufficient lighting including security lights.					
I feel my household has experienced a good development since I own the solar system					

Evolution of solar energy has created employment opportunities because there many people employed in companies in the Solar Energy Industry					
Manufacturing and generating solar energy is less expensive than manufacturing and generating other sources of energy like electricity					
Use solar systems saves a lot of money homes or buildings compared to electric bills incurred when using energy generated from fossil fuels like geothermal power.					
Use of solar energy saves transportation costs incurred when acquiring and using energy generated from fossil fuels like geothermal power e.g. paying for mobile phone charging in city/town centers, transport involved to and from city/town/market centres, kerosene costs or paying for other lighting sources like torches.					

21. If there are savings you make in using solar systems compared to other sources of energy, kindly indicate average monthly savings in Khs?

Less than 100 [ ] 100 – 500 [ ] 501 – 1000 [ ] 1001 – 5, 000 [ ]
5,001 – 10,000 [ ] No savings [ ]

22. What are the monthly savings used for?

i. ……

ii. ……..

Section E: socio-economic impact of mobile money platform (M-pesa) in facilitating evolution and trend of the off-grid solar industry in rural Kenya.

23. As a user or customer of Off-grid Solar System, kindly indicate the extent to which you agree or disagree to the following statements with regard to Socio-Economic Impact of mobile money platform (M-pesa) in facilitating evolution and trend of the off-grid solar industry

NB: 1= Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree and 5= SA**.**

Statement	**5 SA**	**4 A**	**3 N**	**2 D**	**1 SD**
Through use of M-pesa in paying for Solar Systems, I have saved a lot of transportation costs.					
Use of M-pesa is very secure when making payments compared to paying cash due to theft or money lost					
Through M-pesa, am or I was able to pay for Solar systems in installments hence making it affordable than when paying cash at once					
Due to mobile money banking (M-pesa), there is social and financial inclusion of all people in paying for various services especially in rural areas e.g. paying solar systems is now cheap and affordable to all people.					

END