ACKNOWLEDGEMENT

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Secondly we would like to acknowledge the relentless effort made by our consultant, Africa Center for Energy and Environment Solutions (ACEES) and the entire KCIC management team in bringing this report to fruition.

It is our hope that this report will be a value addition to the body of knowledge already in existence in this sector.

Climate Innovation

ACCELERATING INNOVATION IN CLEAN TECHNOLOGIES IN KENYA
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LIST OF ABBREVIATIONS

ACDT  -  Action for Child Development Trust
ACEES -  Africa Centre for Energy and Environment Solutions
BoP   -  Base of pyramid
CBO   -  Community Based Organisation
ERC   -  Energy Regulatory Commission
FIT   -  Feed in Tariff
KCIC  -  Kenya Climate Innovation Centre
KWFT  -  Kenya Women Finance Trust
kWh   -  Kilowatt hour
LED   -  Light Emitting Diode
MFI   -  Micro Finance Investment
MoE   -  Ministry of Energy
MWp   -  Mega watt peak
NGO   -  Non-Governmental Organisations
PAYG  -  Pay As You Go
PPA   -  Power Purchase Agreement
PV    -  Photovoltaic
REA   -  Rural Electrification Authority
SHS   -  Solar Home System
SLP   -  Solar Lighting Products
VAT   -  Value Added Tax
VEP   -  Visionary Empowerment Program
Wp    -  Watt peak
VSLA  -  Village Saving and Loans Association
EXECUTIVE SUMMARY

Analysis of Sustainable Development Goals isolates, sustainable energy (SDG 7) and combating climate change (SDG13) as critical to transformational challenges facing developing nations – Kenya included. Sustainable energy for all (SE4ALL) estimates one billion people in the world without access to energy and 2.9 billion relying on unclean energy sources in developing nations. And over 90% of Kenyan rural households still rely on kerosene lamps for lighting in spite of being classified as a high adopter of micro-solar home system kits and solar lanterns. The local kerosene tin lamp, ‘Keroboi’ still exists as the main lighting alternate in-case of a blackout, extra-demand or to complement existing clean sources of lighting technology.

This study builds on past evidences on the solar photovoltaic market in Kenya. It expounds and clarifies underlying facts for a successful sustainable business model for Kenya Climate Innovation Centre (KCIC) entrepreneurs’. Integrating both fieldwork and intensive desk study on solar PV products in Kenya. We capitalize on extensive researches done by key stakeholders, informant’s opinions and market value chain actors interviews as we validate and qualify the findings with primary data from actual field survey. A sample size of 1200 respondents was selected in 4 provinces, employing Yamane’s sample size for proportions at 95% confidence level in our field study. Case studies of emerging solar PV marketing strategies were studied. Our findings sort to answer and synthesis key research questions including, who are the main actors and what linkages exist between the actors? What are the existing business models, barriers, and opportunities for increased adoption? Who are the main consumer segments and what is their satisfaction levels with solar as an alternative energy source? What are the existing national policies, standards and how can this influence growth or fall of the sector as well as identifying main market barriers?

Market Actors

Solar PV actors are broadly classified as state and non-state actors. State actors include the line - Ministry of Energy and Petroleum and other direct government institutions. They are responsible for policy and regulation creating a conducive business environment, necessary infrastructures and providing non-profit oriented support structures such as capacity building, awareness creation and research and development. Non-state actors have been broadly divided into two; a) service level actors, providing education, financial facilities, business development services, consumer organisation and public media, b) market value chain actors – manufacturers, distributors/retails and consumers. The actors are connected in a web of complex influencing and dependent actors, where market value chain actors are largely dependent on state actors. On direct market value chain actors, the study pointed out that globally there are only 42 solar PV manufacturers with a portfolio of about 90 different products tested and approved by global lighting testing protocols. Some of them have built distribution networks in Kenya such as barefoot, M-KOPA and Solar-works. Other manufacturing companies have built distribution networks with local distributors through agreements. About 52% of the actors run sole proprietor businesses, and 60% of the solar lighting products have been sold through retail outlets. Although majority of the distributors sale their products in cash basis, credit financing is gaining root in the Kenya market. About 23% of solar product in the market have been sold through credit schemes, and commonly mobile phone supported PAYG system accounts for about 63% of total solar products sold on credit. Other credit systems include village savings and loans associations (VSLA), Micro-finance institutions (MFIs), and trusted networks such as schools. Focus is in the rural areas forming 57% of the market share and peri-urban (35%) where there is widely lack of access to grid electricity, and it is in this market segment where the upfront purchase cost of the product is an issue to tackle as you access the market.

Distribution model

Four main distribution models were identified but common is the PAYG credit financing model and direct cash sales model. Looking
at the base of the pyramid most companies and distributors are embracing PAYG model. Kenya is advantaged in the model due to the extensively built mobile money transfer across all networks. This has seen growth in solar lighting products dissemination grow by over 100% for MKOPA in a span of one year.

**Consumer satisfaction**

Solar PV products are widely known. About 90% of people have seen the products either in the markets places, community groups or through media. At least 50% of Kenyan have owned a solar product for lighting, mobile charging or other application. New application of solar such as water pumping, irrigation and sterilization are promoted majorly through NGOs. Their penetration in the market, however, remains low. The consumers cited battery maintenance as the major challenge experienced in the solar market, and although they are aware of the warranty, very few use it to get a replacement of their faulty products. At least 90% of Kenyans would prefer solar PV system to other technology due to cost saving potential.

**Policy and regulations**

On policy and Regulation, the government has put its right foot forward towards regulation and promotion of solar PV market by introducing the Energy (solar photovoltaic) regulation, 2012, draft energy bill (2015), draft energy policy (2015), solar PV standards and VAT Act of 2013. The FiT policy of 2012 has greatly encouraged private sector involvement in solar energy generation. With all the good strides, there is not so much for the micro-solar system players. The study prioritises policy on micro-solar PV systems to enhance rapid diffusion of SLP and SHS. Adopting net metering shall not only promote national energy security and increased access to clean energy but shall leverage government expenditure on household energy demand that forms a bigger percentage of peak demand in Kenya and also increase income levels of communities. Other policy aspects could include, incentivising the market value chain while mitigating against negative impacts, government grants for research and development and capacity building for local technicians and dealers of solar products.

1.0 Introduction

Kenya Climate Innovation Center (KCIC) supports entrepreneurs dealing with solar products through advisory and capacity building services that help them refine their business models, improve their business skills and test their stoves. However, there still exist limited market information that is available and other market constraints affecting this sector. This study was been commissioned by KCIC to assess the status of the solar sector in Kenya and make recommendations on the best technologies, business models, marketing strategies, financing models, regulatory framework and other opportunities available for entrepreneurs and interested parties in the sector. The study report will be widely disseminated to create public awareness on the potential of the solar sector both for business and improved livelihoods.

1.1 Background Information of the Study

Kenya is endowed with high solar insulation averaging at 4.5kWh/m2/day. Generally, being in the equator, Kenya has a higher potential of solar PV than many other nations. As a means of promoting private sector involvement in solar PV, the government has provided for an opportunity for local and international investors under Feed in Tariff (FiT) regulation. The move seeks to enhance national energy security as well as the promotion of entrepreneurship and clean energy connectivity. Immense opportunities exist in the off-grid solar market and solar lighting products as the demand rises sparked by devolution, international energy access programme, and urbanization. Stand alone and off grid solar

---

PVs have dominated institutional alternative lighting solutions mainly supported by government and donors as lantern widely used in households. Two decades ago institutional solar PV market segment accounted for approximately two-third of installed capacity, however, recently there is an observed increase in the market for standalone SHS, and solar lighting products (SLP). The falling global price of PV from USD 5 per watt in 2000 to USD 0.5 per watt in 2014, has led to the national solar market increase by more than 100 percent (Muok et al. 2015). Hansen (2014) provides a chronology of solar market development as 1980-1990 the installed capacity rose to 1.5MWp, 1990-2000 it rose to 3.9MWp and a decade later in 2009, the installed capacity rose to 10MWp and a 20MWp by 2013.

Micro-solar kits such as D.light, barefoot, Sun-King and M-Kopa amongst many other solar home systems have been widely disseminated in urban and rural areas also contributing to 26% of rural electrification and access to clean energy. However, there is a huge information gap in regard to the level of market penetrations, working business models, sustainability of existing programmes, the effect of market distortion due to donor funding and effect of reducing electricity cost from the grid. It is against this backdrop that we build on past studies and market assessment survey to understand the working strategies and business models for double digit growth of the solar PV market. We seek to assess the market situation, actors, supply chain and working business models in the solar PV market segments. We shall also seek consumer insight to understand the statement in the sector on double growth of the sector.

1.2 Objectives of the Study

The overall objective of the assignment was to provide a detailed analysis of the status of the solar PV sector in Kenya. The specific objectives were to:

I. Provide a high level snapshot of the sector that can be used in conjunction with a number of research papers, consumer surveys and other sources to enhance sector market understanding;

II. Identify and list provisions in different statutes, standards, rules, policies and practices which govern the solar sector in Kenya;

III. Quantify and qualify the demand for solar products; assess the main market barriers to building a thriving market;

IV. Establish key customer segments and profiles;

V. Scope and identify the barriers that currently prevent the creation of a thriving market for solar products;

VI. Scope the major business models (including marketing and distribution strategies), while analysing the success and failures of the solar sector; and

VII. Identify major manufacturers and/or distributors in the solar sector with a deep dive on the technology used.
2.0 Overview of Solar Power Sector in Kenya

Kenya has abundant solar energy resources, and it has become a hotspot for the solar PV market place. Although the sector started with donor driven initiatives in the 1980s, today a vibrant private sector driven market exist. It is estimated that about 25,000 – 30,000 solar PV products are traded annually in the Kenyan market and that at least every household has owned at least one solar PV product. Both government and private sector are making great strides towards energy access through increased adoption of solar PV. The rural electrification programme by the Rural Electrification Authority (REA) of Kenya for example targeted schools and health centres with over 4000 schools installed and commissioned as at July 2015, Kenya power alongside off-grid electrification has also engaged in the distribution of solar lanterns in Northern Kenya. Moreover, international NGOs such as SNV, GVEP, and Lighting Africa have contributed immensely to the creation of solar PV market value chain through SACCO, social enterprise approaches in the dissemination of pico-solar PV for increasing adoption of alternative energy sources in rural areas.

Increased dissemination of solar PV in the local market is influenced by four main factors including, more consumer choices; falling global solar PV products prices such as inverters, modules, batteries and SLP; government’s efforts through regulation, policies, and standardization to harmonize the sector. There are also more players operating in more niches, including pumping, designed systems, portable systems, and micro-grids, resulting in a trend for better systems. On the other hand, there exist embedded challenges and barriers such as: Increasing number of non-trained technicians and installers giving false information and hopes to consumers, Increasing levels of counterfeits and mimics thus consumer dissatisfaction, Inadequate awareness and Technical and financial capacities.

Although solar PV products supply is on the rise, the gains are outpaced by rising population and industrialization. Solar products present a market-ready opportunity for meeting the lighting needs of today’s off-grid rural and peri-urban consumers and rising population. These products have momentum and are reaching a tipping point in Kenyan alternative energy market segment which justifies focused study and effort in commercializing their use. As such, the SPL market is poised for rapid growth in the coming years. Today SPL entrepreneurs are leading the solar lighting industry who often relying purely on market-based models, utilizing the latest technology, and designing based on consumer tastes (Wright, 2015). Technology is improving at a rapid rate, business models such as mobile phone enabled PAYG are maturing, and the focus by industry players and market facilitators on addressing key market failures means that the SPL market is ready for a substantial inflow of private sector investment and exponential growth. The impact of heightened campaign and awareness creation by lighting Global has seen the growth of SLP to close to a million by 2014. Most of these modern solar lighting products incorporate features such as mobile charging and consumer credit systems such as the pay-as-you-go (PAYG). These products, which do not require a technician to install, retail for US$ 10 to about US$ 150 (Yarime et.al, 2015). The SPL products are typically modular with the following key components.

• An electricity source, most commonly a solar panel/module.
• A modern rechargeable battery, increasingly lithium-ion.
• One or more lamps, usually with modern, energy-saving LED (light emitting diode) bulbs.
• A power control unit, in the case of solar home system kits.

With these components, SPL products have been differentiated to meet the growing need of a cheap source of renewable energy for lighting, radio and charging of phones by BoP consumers. The M-KOPA micro-SHS intend to introduce the additional function of television support by 2017. Common types of SLP products in Kenyan market is show in Table 1 below.

---


<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flashlight/Torch</td>
<td>This is a portable handheld device that offers directional lighting at low-lumen output.</td>
</tr>
<tr>
<td>Task lamps/Work lights</td>
<td>Portable or stationary handheld devices, including solar desk lamps, in a range of panel sizes and light output levels utilized for specific tasks.</td>
</tr>
<tr>
<td>Ambient lambs/lanterns</td>
<td>Portable or stationary devices that offer multi-directional light along with a wide variety of size and functionality depending on technology.</td>
</tr>
<tr>
<td>Multi-functional device</td>
<td>Portable or stationary devices that can provide directional and multi directional light with a variety of value-added features.</td>
</tr>
<tr>
<td>Micro-SHS</td>
<td>Semi-portable lighting devices associated with a small portable solar panel that powers or charges 1-3 small lights, mobile phones, and other low-power accessories.</td>
</tr>
</tbody>
</table>

2.1 Policy and regulation framework in the solar PV sector

The chapter briefly describes key government institution with direct influence in the solar energy sector. It focuses on key policy, regulation, standardization and taxation issues in the solar energy sector that have positive and negative impacts on solar PV market structure.

Table 2. Policy and regulatory issues in the solar PV market

The rural electrification programme by the Rural Electrification Authority (REA) of Kenya for example targeted schools and health centres with over 4000 schools installed and commissioned as at July 2015.
<table>
<thead>
<tr>
<th>Legal document</th>
<th>Key Policy/regulation statement</th>
<th>Section</th>
<th>Positive Effect in the Value chain</th>
<th>Negative Effect in the Value chain</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Energy and Petroleum Policy, final draft 2015</td>
<td>Tax and other concessions are planned to encourage investment in oil and gas, exploitation of coal and geothermal, development of hydroelectric power as well as other forms of renewable energy such as wind, solar and biomass.</td>
<td>Introduction, bullet 7</td>
<td>• Reduced prices of solar products</td>
<td>• Tax concession on oil and gas exploration might shift the focus to industrial energy needs neglecting micro-level systems</td>
</tr>
<tr>
<td>Uncoordinated approach in policy implementation and promotion of solar energy projects.</td>
<td></td>
<td>Section 3.7.2</td>
<td></td>
<td>• Drag rapid diffusion of solar PV products</td>
</tr>
<tr>
<td>The existing FiT structure for each technology</td>
<td></td>
<td>Section 3.11.5</td>
<td>• Review of FiT to accommodate net metering shall promote SHS</td>
<td></td>
</tr>
<tr>
<td>Energy (Solar photovoltaics) regulation, 2012</td>
<td>The regulations shall apply to a solar PV system manufacturer, importer, vendor, technician, contractor, system owner, a solar PV system installation and consumer devices.</td>
<td>Article 2</td>
<td>• Improve quality of solar product in the market</td>
<td></td>
</tr>
<tr>
<td>A solar PV system technician or contractor shall issue an installation completion certificate, showing as a minimum, the date of installation, details of the person installing, details of the owner, the location, capacity and warranty upon the commissioning of the solar PV system.</td>
<td></td>
<td>Article 2</td>
<td>• Ensure traceability and reduced quacks in the market</td>
<td></td>
</tr>
<tr>
<td>Any person by himself, servant, or agent undertakes or carries out any solar PV system manufacture, import, vending or installation work without being the holder of a license then in force appropriate to the work undertaken or carried out or without being under the direction of such a license-holder;</td>
<td></td>
<td>Article 16(a)</td>
<td>• Ensure quality of imported products</td>
<td>• Reduced existing actors creating shock on the upword adoption trend of solar PV</td>
</tr>
<tr>
<td>Legal document</td>
<td>Key Policy/regulation statement</td>
<td>Section</td>
<td>Positive Effect in the Value chain</td>
<td>Negative Effect in the Value chain</td>
</tr>
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<td>--------------------------------</td>
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<td>--------------------------</td>
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<td>-----------------------------------</td>
</tr>
<tr>
<td>Energy Bill, 2015</td>
<td>Rural electrification and renewable energy cooperation shall be established to provide an enabling framework for the efficient and sustainable production, conversion, distribution, marketing and utilization of biomass, solar, wind, small hydros, municipal waste;</td>
<td>Article 44, section 1m</td>
<td>• A dedicated department will pay more attention on the sector</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Function of the central government energy regulation is to Certification of petroleum tanker drivers, electrical workers and contractors, solar system installation technicians and contractors.</td>
<td>Sixth Schedule article A section 2m</td>
<td>• Functional devolution shall enable counties assess their own resources and put in place strategies to promote RE such as solar PV</td>
<td></td>
</tr>
<tr>
<td>Sessional paper No.4 on Energy, 2004</td>
<td>No rigorous attempts have been made to project cost effective demand for the other renewable energy sources including solar, wind, biogas and municipal wastes.</td>
<td>Article 3.6</td>
<td></td>
<td>• Dragging on rapid diffusion of solar PV product</td>
</tr>
<tr>
<td></td>
<td>lack of awareness on the potential opportunities and economic benefits offered by solar technologies; and,</td>
<td>Article 3.6</td>
<td>• PAYG credit models like MKOPA have transformed the sector</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lack of appropriate credit and financing mechanisms to facilitate acquisition of solar technology by the rural population and urban poor.</td>
<td>Article 3.6, section 6 e and f</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
It is estimated that about 25,000 – 30,000 solar PV products are traded annually in the Kenyan market and that at least every household has owned at least one solar PV product in Northern Kenya. Moreover, international NGOs such as SNV, GVEP, and Lighting Africa have contributed immensely to the creation of solar PV market value chain through SACCO, social enterprise approaches in the dissemination of pico-solar PV for increasing adoption of alternative energy sources in rural areas.
The impact of heightened campaign and awareness creation by lighting Global has seen the growth of SLP to close to a million by 2014.

BY 2014

1,000,000
3.0 Barriers to adoption of Solar PV Products in Kenya

Despite the increasing adoption of solar PV products by consumers coupled with the attraction of a large number of market players, the sector is prone to some challenges. These barriers range from policy, personnel, financial, technological, and consumer related challenges. They include:

3.1 Policy Barriers

The Government policy does not specify a role of solar PV for Solar Home Systems in “pre-electrification” of areas proximate to the grid (where >300 kWp/year demand for SHS is located). Unlike Tanzania or Uganda, Kenya does not provide incentives or subsidies for household solar PV systems. This has led to the following:

- It limits PV implementation to public sector procurement in remote areas where there is little commercial interest (when most PV business in Kenya is currently in the private sector in high potential cash crop area).
- It does not provide a role for PV in support of grid electrification in high potential areas. Given that there are 4 million un-electrified off-grid rural households, mostly located in high potential farming areas, and grid-based rural electrification is only completing (at most) 100,000 connections per year, there is a largely suppressed demand for electricity.

3.2 Unskilled Technicians

The sector is also experiencing challenges from solar technicians who do not have formal skills, and yet they have connections with solar distributors and retailers who sub-contract them. These ‘behind the scenes’ operations are contrary to the government regulations which require that only licensed technicians are allowed to design and install solar PV systems; and to be licensed, technicians have to undertake a solar training course, gazette solar PV regulations 2012.

3.3 Sociotechnical Barriers

Although PV technology has advanced tremendously in the last decades, there are still several sociotechnical barriers to adoption. It can be influenced by not only the local conditions of the user’s environment but also the political and financial arrangements that may change from country to country. For instance, in Kenya, various fake solar PV products have infiltrated the market.

3.4 Economic Barriers

Economic barriers are usually related to the high cost of solar PV modules. Since these products are distributed by retail networks, additional cost is added by middlemen, and this is felt by the end user. As such, this creates an economic burden to BoP households. Moreover other economic burdens including regional competition, difficulty to access finance, low purchasing power of consumers and rising counterfeit products build on the already strained market.

3.5 Growth Potential of Solar PV Market in Kenya

The market potential for PV is excellent in Kenya for a number reasons that echo across East Africa. The study listed the following opportunities in the growth of solar market sector:

I. Reducing trend of solar PV products such as panels and batteries and continuing to increase the affordability of the product to more middle-income Kenyan.
II. Tax exception to solar PV products has similarly reduced product costing
III. The growing credit financing of solar PV product has enabled gradual payment of solar product hence reduced shock on high upfront cost that has led to a low adoption of the technology for decades.
4.0 Study Approach and Methodology

4.1 Study Area
The study design focused on old administrative demarcation. The survey was carried out in twelve counties within four regions (Western, Nyanza, Coast and Central) namely Kisumu, Homabay, Migori, Kakamega, Bungoma, Nairobi, Kiambu, Mombasa, Kilifi, Kwale, Machakos, and Kajiado. The locations have been purposively and objectively selected and include areas which have high population density and concentration of solar PV devices.

4.2 Data Collection Methods
The researcher applied an integrated approach for data collection of desk reviews, key informants interviews, and administration of questionnaire.

4.2.1 Literature Review
Secondary data on the adoption of solar PV in rural and urban areas was undertaken, and this included reviewing the following documents: legislation and policy documents, past studies relating to solar PV, policy briefs, and best practices drawn from other jurisdictions. The information informed primary data collection and was used to argue primary facts that were gathered.

4.2.2 Administration of Questionnaire
A semi-structured questionnaire were used to generate information on the following: demographic data of the respondents, and their overall experiences in the field of study. The questionnaire farther sought to assess the reasons for preference for preference of the various PV, identify the barriers and also recommendations for improvement.

4.3 Field Survey
The study was enriched by primary data collection in the field. Consumer sample questionnaires (Annex 1) were administered in 12 counties in Kenya and other questionnaires for manufacturers, retailers and stockist. (Annex 2)

4.3.1 Key informants Interviews
About 12 key informants were identified and selected from a database of 42 identified key actors in the solar PV sector for interviews using a semi-structured interview guide (annex 3). They were drawn from government ministries, private sector and civil society organizations. We also visited county officials from the three regions in the Ministry of Energy, Water and Natural Resources.

4.3.2 Consumer survey
Consumer survey was motivated by the reasons to why consumers purchase a given solar product and not the other, their understanding of the benefits of solar products and visualisation on an opinion basis of the future of Kenya household lighting energy of choice.

4.3.3 Retail and Manufacturers Interviews
The retailers, resellers, and distributors of solar products are at the core of dissemination of solar PV. The interviews were tailored to understand the scale of the business, geographical coverage and products. As a reflection of whether the business was value driven we assessed on the consumer linkages and after sale services offered to consumer. Insight was also sought on whether they ensured that the products they sold were of good quality and if they are aware of regulations baring sales of substandard products.

4.4 Stakeholder validation workshop
A stakeholder workshop was held to verify information and validate the study report. The comments from stakeholders were incorporated into the final report. The list of attendants to the workshop is attached as Annex 4.

4.5 Organisation of Study Findings
The study findings have been divided into five main sections answering the research questions under six subsections. The six sections include: providing a high-level snapshot of the actors in the solar PV sector, identifying the commonly traded technologies, analysing the business and financial models and reviewing the policy and regulatory framework in the sector, towards completely understanding the solar PV market sector.
5.0 Solar PV Actors

There are various Solar PV market players in Kenya classified as state and non-state actors. State actors comprise of the government organs that have direct influence to the importers and distributors of solar PV product they include: Ministry of Energy and Petroleum (MoEP), Energy Regulatory Commission (ERC), Rural Electrification Authority (REA) and Kenya Bureau of Standards (KEBS). Non-State Actors (NSA) are mainly classified as service level actors and the market value chain. Service level actors include financiers, donors, capacity building and training institutes etc. whereas the market value chain actors are the direct traders and distributors of solar products (Figure 1) adopted from EnDev annual plan (2016).

Figure 2: Actors in the solar PV sector
5.1 Solar PV manufacturers, retail and distribution networks

Globally 42 manufacturers have had their products tested and approved by the lighting global test standards and issued with a certificate of conformance. Against this test, the products are issued with KEBS mark of standardization. There is only one solar manufacturer in Kenya located in Naivasha - Ubbink East Africa that assembles solar PV modules for SHS. However, some of the global manufacturing companies have local distributor partners under an agreement to distribute their products.

Most of the manufacturers have distribution networks in Kenya. According to IREK report, there are over 40 solar PV - product distribution companies with thousands of retail outlets in retail shops, supermarkets, and stockists. The study illustrates market share distribution of 52% sole proprietors, 17% limited companies, 22% partnership, 7% franchise and NGOs (Annex 4). The survey also showed that most solar PV products are sold through retail outlets, about 60% are sold through retail outlets whereas 24% are sold through major distributor networks such as schools and 10% and 4% respectively are reseller’s and manufacturers.

Figure 3 below list some of the identified non-state actors in the solar PV sector:

- **Local NGOs Actors**
  - Mainly they are involved in distribution of pico SLP and water treatment products through donor support
  - Example:
    1. Sunny money
    2. Visionary
    3. Community Action on Environment and Development

- **International NGOs**
  - They are particular on lighting global certified products. They employ both social enterprise and community table banking for products distribution. Support entrepreneurs build market value chain and business models. Also provide guarantee loan for user financing
  - Example:
    1. SNV
    2. GVEP
    3. Practical Action
    4. Solar Aid
    5. GIZ-EnDev

- **Over the counter organisations**
  - They are market driven sales outlets. Majorly work on cash sale basis or formalised credit financing arrangement e.g. M-KOPA PAYG model
  - Examples:
    1. One Acre Fund
    2. Raj Ushanga
    3. D. Light Kenya Limited
    4. Barefoot Power (Africa) Limited
    5. Apple Logistics Limited
    6. Sun Transfer Kenya Investment Limited
    7. S3C Kenya Limited
    8. Total Kenya Limited
    9. Thrive Energy Technologies (EA) Limited (N
    10. Krystalline Salt Limited

**Figure 3: Some of the identified Non-state actors**
5.1.1 Solar PV financing
Whereas manufacturers and distributors are adopting PAYG market strategy most retail outlets sell the products on a cash basis. From the survey, 77% of the retail outlets sold their solar lighting products on the cash basis and 23% on credit. The study showed that 33% of the consumers obtain their loans from VSLA and table banking whereas 63% use the PAYG mobile payment mode. M-Kopa agents are the main distributor network with an effective and successful PAYG financing scheme in Kenya. However, other distributors are making entry into the systems such as Green Light Planet Company, Barefoot solar, and Pamoja life.

5.1.2 Product quality verification and assurance
Solar PV system quality has been one of the major drawbacks in the dissemination of the technology. Once a consumer purchases the product, and it doesn’t meet the expectation they get disappointed and wouldn’t want to spend more money on the similar product. Most of the products come with certification on product quality according to the Lighting global quality standard against which to obtain KEBS standard of quality. From the study about 90% of the products have KEBS mark of quality however about 50% of solar products entering the market have not been approved by lighting Global. About 44million pico solar products – solar lanterns and solar home systems smaller than 10W – have been sold worldwide. However, only a third were Light global quality verified products. The survey showed that most PV systems problems emanate from the charging systems. About 57% of the solar PV systems that gets in the market develop complication on the charging systems, damages on the bulbs account for 22% and other unknown defects accounted for 14% (figure 5).
There are two testing facilities for solar lighting products in Kenya however still inadequately equipped to offer commercial testing services locally to manufacturers and stockiest – the University of Nairobi and Strathmore Solar Research Centre. Today there is no distributor or a retail that take their products for quality verification test and main reason is that they don’t know where to test the product and speculate that the cost will be expensive.

5.1.3 Challenges and Opportunities as sited by manufacturers and retails
The study identified access to finance; public awareness and marketing strategies as the challenges to the entrepreneurs to access the market. To a lesser extent government policy also has an influence on the adoption of solar PV systems for lighting; Other issues were on technical challenges respondents siting the licensed technicians and competency of the technicians in the installation of the panels. Unavailability of solar PV system to meet other needs such as ironing, running TV and refrigeration, etc. depending on installed capacity and intermittency of the power source is equally a disadvantage on dissemination of the technology.

They, however, sited, market opportunity, increasingly reducing the price of solar products, and the heightened demand for solar products as a result of rampant blackouts, low access to grid electricity in rural areas and the high connection cost of grid electricity. They listed the following as possible interventions: areas -

a. Business/entrepreneurs financing (affordable loans)
b. Improved regulatory and policy framework
c. Enhancing on standards and labelling
d. Support in the marketing of solar products
e. Awareness creation and
f. Capacity building of local technicians and technologist

5.2 Market Segment
The transition towards market-based diffusion has been facilitated to varying degrees by conducive enabling frameworks comprising innovative financing schemes, exemptions from VAT and import taxes, standardized power-purchasing agreements and feed-in tariffs (FIT), although few analyses have been conducted on the effects of these general measures. Most of the solar products are sold in the rural and peri-urban areas where there is low access to electricity. About 57% of sales are made in the rural area and 35% in the peri-urban areas this conforms to the field survey as illustrated in figure 6 below. However, some solar products such as the solar lantern, solar mobile chargers, and solar torches have been widely bought in urban areas to substitute electricity upon blackouts. The study showed that on average 53% of Kenyans had owned/own solar PV product and 94% use solar product for lighting, and this explains the rise in adoption of micro-solar home system kits and sola lanterns. About 24% of Kenyans also use solar PV for mobile charging and 15% for reading. Solar cook kits have been promoted however with low adoption rate due to inter-alia, cultural practice, cooking habits and believes, product specific attributes including the cost of the cook kits, user ability, and accessibility.

The solar market segment in Kenya is diverse attracting various market players as shown in the following discussions.
5.2.1 Small Pico Systems
SLP and solar charging systems have dominated this market segment. As such, household lighting and charging of batteries and mobile phones are the driving forces. The capacity of these systems range from 1 to 10 Wp. However, these products are prone to failure and short lifespan. These small Pico systems have assumed the largest portion of the market. To this end, thousands of outlets including, retail shops, super markets and street side hawkers are involved in the segment with about 1million quality verified SLP sold by end 2014. Most pico - kits come with additional features of mobile phone charging, playing small radio. Generic products, which comprise no-names, copycats and counterfeits account for at least half of the pico-solar market. Solar Aid in collaboration with sunny money believes in trusted networks to implement pay as you go distribution model in schools. The distribution rose by 2500% in one year from 9000 sales in 2011 to 234,600 sales by end of 2013. Mainly their product portfolio is D.light S2, D.light S20 and Sun-king pro.

5.2.2 Micro Solar Home Systems
Micro Solar Home Systems (M-SHS) are semi-portable systems associated with a portable solar panel and the battery that power 1-4 lights, radio and mobile phone. Their capacity if between 5 and 10Wp. M-SHS technologies include smart metering like barefoot such as in M-kopa and D.Light solar kits. It is estimated that M-kopa sells 500 units in Kenya per day (Nygaard et al., 2016). Such systems realize high sales volume since they are distributed mainly on credit basis using smart meters. M-KOPA targets to hit a 1million target by 2017 having met a 200,000 target in 2015 with a 100% diffusion rate from the 2014, 100,000 connections. The study showed a 7% penetration of M-KOPA solar kits in Kenyan households.

5.2.3 Solar Home Systems
Solar home systems (SHS) are mainly driven by an individual decision to acquire and install solar PV. Such systems have a capacity of between 10 and 100Wp. Solar Home Systems (SHS) are the oldest in the Kenyan market, and have been used for charging wet batteries and lighting. Total installation capacity was estimated by Cossen at 20MWp cumulative in 2013. The actual statistics, however, is not able to obtain due to the increasing adoption rate. The study observed that about 5500 new SHS installations are done annually. Muok, Makokha, & Palit, 2015) report gives an estimate of 300,000 solar home systems, Hansen (2014) provides an estimation of 320,000 SHS being operational by 2010.

5.2.4 Stand-alone Institutional PV Systems
They are governmental initiatives under REA electrification program to schools and hospitals without a grid. These systems have a capacity ranging from 500Wp – 2kWp, but is largely determined by demand and rural electrification master plan. Stand-alone PV systems are diffused through government plans and projections and implemented by private technicians. To-date there are over 4000 standalone solar PV installed in schools and about 500 earmarked for installation all over Kenya. Solar home systems are primarily used for lighting, television, and radios as well as mobile phone charging. The

**Figure 6: Target market for solar PVs**
5.2.5 Mini-Grids
Mini-grids connect villages and towns far from grid networks. They range between 5kW and 1MW, and about 12 mini-grids driven by donors and NGOs in Kenya (Nygaard, Hansen & Pedersen, 2016). A classic example is Kitonyoni mini-grid with a capacity of 13.5kW. Other mini-grids are SOS children home (60kW), Mandera (300kWp), Hola (60kWp), Helwak (50kWp), Nanyuki flower farm (60kWp), Azimuth flower solar project (72kWp), Kericho County solar plant project (1MWp), Powerhive East Africa Ltd, 4 mini grids (80kWp) etc.

5.2.6 Telecommunication Street and Market Lighting
This market segment is driven by private companies installing telecommunication networks in remote areas. Street lighting programs have however been taken up by the counties and municipal councils. Such a system ranges from 0.2kW to 15kW in capacity. Telecommunication street lighting is done by the booster stations that have adopted hybrid systems of diesel-solar powered systems such as in the case of Safaricom, Orange, and Airtel.

5.2.7 Grid Connect (Small and Large Scale)
These systems are driven by IPP and currently installed under the FiT policy of 2012. Small scale grid-connect ranges from 0.5MW - 3MW, whereas large scale from 4MW - 40MW. So far, grid-connect is dominated by small scale actors having a capacity of 0.6MW with over 1000 players in Kenya (Orlandi et al., 2016). Interest is growing amongst private actors – shopping malls, institutions, and private limited companies. About 800MW have been approved under FiT and expression of interest (EoI) issued for the implementation phase. Two registered projects under FiT are compared in below:

<table>
<thead>
<tr>
<th>Strathmore University Solar PV</th>
<th>Garden City solar carport</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity - 0.6MWp</td>
<td>Capacity - 0.85MWp</td>
</tr>
<tr>
<td>Estimated annual yield - 1730MWh</td>
<td>Estimated annual yield - 1450MWh</td>
</tr>
<tr>
<td>Area/roof cover - 4080m²</td>
<td>Area/roof cover - 6000m²</td>
</tr>
<tr>
<td>Reduced GHG emission - 1564 tonnes a year</td>
<td>Reduced GHG emission - 750 tonnes a year</td>
</tr>
<tr>
<td>Project cost - US$ 2.5M</td>
<td>Project cost - US$ 540m</td>
</tr>
</tbody>
</table>

Table 4 above shows glaring huge variations on installation cost and GHG emission reductions. The differences could be attributed to structural works in the budget and emission factors and calculation methodologies applied in the two cases.
6.0 Solar PV Business Models

The main actors of the solar product market value chain in Kenya include manufacturers, distributors, retailers, resellers and stockists. There are four delivery models as Lysen (2013), listed below:

(i) Commercially led approach where distributors and dealers/stockist develop market typically relying on cash sales

(ii) Programmes managed by various stakeholders and works on credit basis

(iii) Utility models and

(iv) Donor grant based models (typically used for institutions, highly managed and structured)

The mobile phone money transfer technology has made it easier for PAYG distribution system. Most manufacturers and major distributors are tending towards this direction with registered pre-determined distributor networks. Big manufacturers/distributors like D.Light solar and M-Kopa sell their products through their created supply chain registered vendors/retails outlets. For M-Kopa their products can also be found in all Safaricom outlets nationwide making it easily accessible to the market, similarly D.Light solar kits are distributed through the Total petrol stations nationwide. The existing networks make it easy to access the products. Field survey illustrated that individual orders, resellers, schools, and hotels are the main buyers of the solar lighting products in Kenya (Figure 7). The PAYG system creates the advantage of record keeping for statistical analysis, traceability and warranty claim hence building more user confidence and ease of regulation of the sector.
<table>
<thead>
<tr>
<th>Distribution Model</th>
<th>Features</th>
<th>Key Benefits</th>
<th>Key Challenges</th>
</tr>
</thead>
</table>
| Distributor-Dealer Channel  | • The company sells its solar PV products through existing networks or specialists distributors in the rural market. | • More market penetration.  
• It’s the most understood model in developing markets.  
• There is just-in-time delivery to the consumer.  
• Share in marketing and logistics expense. | • Gross margin is shared among multiple players.  
• Distributors/dealers are often SMEs with limited capital.  
• Brand dilution is possible.  
• Require qualified distributors for good sales volume |
| Propriety Distribution Channel | • The company distributes its products through salaried/contracted workforce to consumers. | • Complete control over pricing and quality by the company.  
• Robust generation of gross margins.  
• Close proximity with customers | • Requires extensive sales team which is expensive.  
• It is difficult to establish sales locations.  
• Market penetration takes quite long time. |
| Institutional Partnership   | • A company partners with a relevant institution such as MFI, NGO, MNC etc. to market the product to that institution’s customer base or membership network. | • Rapid implementation of high volume orders.  
• Leverages an existing customer network.  
• Product financing opportunity.  
• Ensures social impact to customers. | • A monopolistic market may be created.  
• High likelihood of distribution depending on a finite funding level.  
• Often partnerships with large organizations subject small SPL organizations to limited bargaining power.  
• Frequent disputes over cost sharing and responsibilities. |
| Franchise Model             | • The company offers franchising packages such as income opportunities, training, marketing, and support, financing to micro-entrepreneurs who wish to be formalized retailers of exclusive company products. | • Outsourcing to a potential micro-entrepreneur.  
• Share in marketing and logistics expense.  
• Quick market penetration. | • Sharing of gross margin.  
• Branding risks in case the entrepreneur fails.  
• Less practical for solar PV products with low profitability. |
| Rental/Leasing Model        | • Company contracts or franchises to micro-entrepreneurs who set up solar charging kiosks.  
• The micro-entrepreneurs either (1) rent products out to consumers on hourly/daily basis or (2) sell the lanterns without a power source and offer a fixed fee for charging. | • Rapid market awareness and penetration.  
• Customer affordability.  
• Customer convenience.  
• Opportunity for adjacent enterprises | • High capital investment by local entrepreneurs.  
• Restricts end user choice.  
• Maintenance of quality control is challenging.  
• Low adaptability to latest innovation. |
The most preferred advertisement mode is a door to door distribution and word of mouth advertisement, however, the evolvement of e-platform is generating more interest with most of the retails posting their products on social media such as WhatsApp, Facebook, Jumia and OLX. Radio advertisement has also been used and major distributors use print media and television to advertise their products. Most user adoption of solar PV is due to its cost saving on fuel. The common distribution channels are represented in table 4 below:

Table 4. Solar PV distribution channels

6.1 Structural illustration of Basic Models

6.1.1 Commercial led approach

Multiple retail networks can be used by SPL suppliers. The first case is whereby a distributor/dealer distributes SPL products to a community based group or retail shops which then sell typically on cash basis to end users (Figure 8).

6.1.2 Credit distribution approach

Similarly, a distributor may opt to liaise or form a partnership with institutions such as NGO and MFI which then sell SPL products to community-based groups on credit basis. Most of the village savings and loan associations and MFIs give non-secure loan repayable in 3 – 6 months. Such groups then sell to end users, consumers (Figure 9). Trusted distribution networks are developed and supplier ensures availability of sufficient stock of solar lighting products. Profit is re-invested in market research to understand the market needs.

6.1.3 Mobile money aided PAYG system

Distributor dealer relationship is a type of relationship that is common with PAYG distributors. Under a contractual agreement, the distributer builds a relationship with a dealer with a nationwide spread to distribute their products (figure 10). The dealer is paid on commission per unit sold as the product payment is done via mobile money transfer to the distributer e.g. M-Kopa Limited.

6.1.4 Direct Channel

As opposed to using other networks, a distributor decides to hold direct business transactions with the end user, customer. Therefore, the marketing and logistics expense is wholly experienced by the distributor/manufacturer. This is common with distributors who also employ sales agents to sell their products. The sales agents are employees of the distributer who are paid on commission basis. This is effective for consumers who rely on word of mouth or door – to – door promotions.
6.2 Selected Case Examples and Achievements

6.2.1 The SNV Distribution Model

Business description

Founded in the Netherlands in 1965, SNV has built a long-term local presence in many of the countries in Asia, Africa and Latin America. The organization’s global team of local and international advisors work with local partners to equip communities, businesses and organisations with the tools, knowledge, and connections they need to increase their incomes and gain access to basic services – empowering them to break the cycle of poverty and guide their own development. Unlike many other development actors, SNV does not offer funding, but specialises in supporting the resourcefulness of development actors.

The Model

SNV seeks to increase access to and use of modern lighting for households at BoP by establishing and strengthening sustainable and commercially viable supply and distribution models for quality Pico PV (1-10 W) products and services at the local level. The organization as a central distributor imports/distributes SPL products to rural distributor that provides financial services, ensures availability, and provides after-sale services to end users. This has stimulated high interest for the solar PV products among the rural people.

Lessons Learnt

Though SNV does not support funding to the distribution networks, but it plays a key role in the capacity development of chains of distribution and, therefore, rural entrepreneurs are capable of conducting their businesses efficiently.

6.2.2 The Kopernik Distribution Model

Business description

Kopernik is a non-profit organization headquartered in Indonesia that distributes low-cost technologies to recipients in less-developed countries using crowd funding. In Kenya, Kopernik operates via Action for Child Development Trust (ACDT) as its local partner. ACDT was established in Kenya’s western region in 2007 with a mission “to facilitate communities to enhance the life of children and families by increasing their capacity to protect, educate, and advocate for promotion of children’s rights through quality education, better health and sustainable livelihood.”

Business Model

In partnership with ACDT, kopernik engages in both direct and indirect distribution channels to end users. The company also uses different payment systems as dictated by the distribution channel. For instance, in distribution to schools and individual households in Busia and Kakamega Counties, d.light S250 solar lanterns were sold at Kshs 1800, whereas local groups were sold at Kshs 3000 (Kopernik, 2016). These ratings are all below Kshs 3500, which is the market price.

Lesson learnt

Accordingly, individual households have their specific prices different from the one charged to schools and local groups. Such a differentiation allows users to prefer the best plan and, thus, an excellent distribution model.

6.2.3 The M-KOPA Solar PV Distribution Model

Business Description

M-KOPA is a Kenyan solar energy company that was founded in 2011. The company sells home solar systems in Kenya, Tanzania, and Uganda. M-KOPA has connected more than 375,000 homes within East Africa to solar power with over 550 new homes being added every day. Each 8W battery powered-system comes with three lights, mobile phone-charging, and a solar powered radio (M-KOPA, 2016). Recently, customers can opt for a 20W system with digital TV. As of June 2016, M-KOPA has connected over 380,000
Business Model

Customers buy the solar home system on an affordable M-KOPA payment plan, with an initial deposit followed by daily payments for up to one year. In particular, customers pay a deposit of 3,500 KES (approx. $35), take the system home then pay 50 KES (approx. $0.50) a day for a period of one year, to own the solar system (M-KOPA, 2016). After completing payments, customers own the product outright. Daily payments are made through M-PESA, a mobile phone based money system, and in addition to getting solar power, customers also slowly off-set the cost of the device. M-KOPA Solar is available through hundreds of M-KOPA dealers in Kenya.

Lesson learnt

The PAYG model adopted by M-KOPA solar is proving to be successful especially in Kenya. This is because customers can get the package at the agreed price and the remaining cleared at a later date facilitating more sales. Moreover, end users can pay via M-PESA making the system to be convenient with flexible credit financing.

6.2.4 Solar Sisters

Business description

Solar Sister is a network of women in Uganda, Nigeria, and Tanzania who are reaching the most energy-poor by selling solar lamps, mobile phone chargers, and fuel-efficient stoves founded in 2010. These Solar Sister entrepreneurs turn to their networks of family friends, and neighbors into effective distribution channels to reach rural and hard-to-reach customers who benefit most from the affordable technology.

The business model

They use Avon - style of distribution model system, and creates vital access to clean energy technologies by building and extending a supply chain through women’s rural networks. They provide women with a “business in a bag” startup kit of inventory, training and marketing support. The majority of the partners and end customers are subsistence farmers who trade informally.
7.0 Solar PV system demand and the consumer perspective

Consumer acceptance of any technology is critical to its wide adaptability. Consumer awareness campaigns, capacity development for rural entrepreneurship, setup of decentralized after sales services and setup of payment models that match the BoP customers’ irregular cash-flow. The solar market has impinged with numerous bottlenecks including counterfeits, product quality, and upfront cost of solar products and lack of understanding on the limitation of solar products hence giving the wrong impression on the performance of solar.

7.1 Consumer survey demography

The survey focused on both rural and urban dwellers. The distribution of respondents was 8% casual labour, 21% employed, 62% were running own businesses, and another 8% were farmers. All the groups had diverse reasons for acquiring solar PV technology. About 34% had attained college or university education and 64% had attained secondary and primary education. Only 2% had a non-formal education.

7.2 Access to Solar PV product

From the survey, 52.5% of Kenyans had owned a solar product while 47.5% had never owned. And 50.7% still own solar PV products indicating that the level of breakages is 1.8%. Majorly people use solar PV for lighting at 93.6%, Phone charging at 2.9%, Reading - 1.9%, and other uses such as water heating, for lighting while cooking scored less than 1.0%. In the past one year, it was observed a rise in solar PV product ownership by 32%. About 38.7% learned about solar PV from friends, 7.0% from womens’ group as a result of the ongoing awareness programs and 15% from media. Word of mouth is hence a special tool and should never be disregarded in the dissemination process of the technology. Again the selling point of solar PV products is on the saving accrued due to the replacement of kerosene and other lighting technologies (Figure 12). Cash sales still dominate the market however credit facility through PAYG mobile technology is gaining root into the solar micro-SHS system. About 67.0% of the population who own solar PV paid cash for their solar PV, 24.4% paid for them using loans 6.7% got them as gifts.

The loans from women groups/VSLA were at 32.9%, whereas mobile PAYG model accounted for 63.0% and from friends - 4.1%. The fact that a bigger percentage were willing to take up loans to acquire the solar PV is an indicator that accesses to finance can enhance market growth and uptake of solar PV products. The survey sought to establish the various reasons why people would want to buy solar PV product and 58% of consumers eluded to product specific attribute of expected savings accrued that would otherwise be used on other alternative energy sources (figure 12).

Figure 12: Reasons why consumers buy solar lighting products

The various benefits accrued by the users that would make them continue using solar lighting products include, cost saving, quality lighting, ease of use, it is clean energy with no emission, most solar products are also used for mobile charging. In urban areas where over 90% of the household use electricity for lighting find it a better alternative during
blackouts and power outages. Solar energy has also been attributed to reliability and can be used to power other devices such as radios and televisions.

Most the respondents had an interest in purchasing solar products however the limiting factors included:

- The initial investment cost is too high.
- Awareness on how or who to help install within the vicinity and
- Others expressed that they had alternatives.

It was easy to capture the alternatives as including kerosene, grid electricity and rechargeable lamps. Various challenges were however pointed out to be working against rapid adoption of solar PV products in the market including:
1. Charging process and variable weather,
2. Short lifespan of some solar product yet high capital investment cost,
3. Tedious process of claiming warranty,
4. Inability to repair when damaged,
5. Product/system maintenance.

8.0 Conclusion and Recommendations

The study identified and classified solar PV actors in two main categories: state and non-state actors. Whereas the former is mainly involved in building an enabling environment, the later has a core responsibility to push solar products in the market. Non-state actors have been broadly divided into two

a) service level actors, providing education, financial facilities, business development services, consumer organization and public media,

b) market value chain actors – manufacturers, distributors/retails and consumers. On direct market value chain actors, the study pointed out that globally there are only 42 solar PV manufacturers with a portfolio of about 90-different products tested and approved by global lighting testing protocols. Some of them have built distribution networks in Kenya such as barefoot, M-KOPA and Solar-works. Other manufacturing companies have built distribution networks with local distributors through agreements.

About 52% of the actors run sole proprietor businesses and 60% of the solar lighting products have been sold through retail outlets. Although the majority of the distributors sale their products in cash basis, credit financing is gaining root in the Kenya market. About 23% of solar products in the market have been sold through credit schemes, commonly mobile phone supported PAYG system accounts for about 63% of total solar products sold on credit. Other credit systems include, village savings and loans associations (VSLA), micro-finance institutions (MFIs) and trusted networks such as schools. Focus in the rural areas forming 57% of the market share and peri-urban (35%) where there is widely lack of access to grid electricity, and it is in this market segment where the upfront purchase cost of the product is an issue to tackle as you access the market.

It was interesting to note that at least 50% of Kenyan have owned a solar product for lighting, mobile charging or other application. New applications of solar such as water pumping, irrigation and

From the survey, 52.5% of Kenyans had owned a solar product while 47.5% had never owned. And 50.7% still own solar PV products indicating that the level of breakages is 1.8%. Majorly people use solar PV for lighting at 93.6%, Phone charging at 2.9%, Reading – 1.9%, and other uses such as water heating, for lighting while cooking.
sterilisation are promoted majorly through NGOs. There penetration in the market however remains low. The consumers cited battery maintenance as the major challenge experienced in the solar market, and although they are aware of the warranty, very few use it to get replacement of their faulty products. At least 90% of Kenyans would prefer solar PV systems to other technology due to cost saving potential. The market is growing and with great opportunity, however, more effort is needed in the regulators side to enhance quality, regulate supply and protect consumer interest against the increasing counterfeit products in the market. Key policy recommendations are presented below.

8.1 Policy recommendations

I. For sustainable and efficient solar PV market, the government should promote credit financing of solar products and other renewable energy technologies including in the commercial banks by issuing guarantee fund.

II. Enact policy that provides incentives such as favourable tax holidays on investment on solar products across the level of engagement and with appropriate measures to ensure sustainability and negative causal impacts of the incentives.

III. Heighten capacity building of actors in the value chain including consumers and a light hand implementation of solar PV regulations in the transition period.

IV. Build a strong quality control system to reduce on flooding of counterfeit solar products in the market.

V. Introduce off-grid policy that looks into mini-and micro-grids providing investor protection to political influence and adverse community mob actions.

VI. Establish a FiT for mini and micro grids below the 500kW cap through net metering to protect mini grids from grid tie connection in future.
Annex 1: Household Solar Questionnaire

Part One: Demographic Information

1. Name (Optional)________________________________ Tel: _____________________

2. Please indicate your gender
   a. Male { } b. Female { }

3. Marital status
   a. Married { } d. Separated { }
   b. Single { } e. Widower { }
   c. Divorced { }

4. Age
   a. 18-24yrs { } d. 36-40yrs { }
   b. 25-30yrs { } e. 41-45yrs { }
   c. 31-35yrs { } f. 46-50yrs { }
   h. Over 60 years { }

5. Which of the following best describes your occupation?
   a. Casual labor { } e. Self-employed { }
   b. Employed { } f. Other (Please specify) __________________
   c. Business person { }
   d. Farmer { }

6. What is your level of education?
   a. University { } d. Primary { }
   b. College { } e. Not gone to school at all { }
   c. Secondary { }

Part Two: Access and Adoption

7. Have you ever own solar PV product?
   a. Yes { } b. No { }

8. Do you currently, have a solar product in your home?
   a. Yes { } b. No { }

   (If no, skip to Question 26, 27, 28)

9. What are you currently using your solar product for?
   a. Lighting [ ]
   b. For reading [ ]
   c. For cooking [ ]
   d. While cooking [ ]
   e. For water heating [ ]
   f. Charging phone [ ]
   g. Water purification [ ]
   h. Other uses (specify) _____________________________________________

10. When did you learn about the Solar PV Products?
    a. Less than 1 year ago { }
    b. 1-2 years ago { }
    c. 3-5 years ago { }
    d. More than 6 years ago { }
11. From whom did you learn about solar power?
   a. Friends {  }
   b. Women group {  }
   c. Men group {  }
   d. Just saw in the market {  }
   e. My son/daughter/relative introduced me {  }
   f. Media (e.g. billboard, radio, TV, papers, sms)

12. The enumerator shows the respondent a poster containing different types of Solar PV products in the market. Then asks which of those or others not in the poster the respondent has or has used? List below:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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<tbody>
<tr>
<td></td>
<td></td>
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</tbody>
</table>

13. What made you acquire these Solar PV products?
   a. Because I was told it saves on energy lost 100% since it uses the sun
   b. We bought it with other women/men in our group
   c. I was told it is not prone to accidents
   d. I was given free of charge /gift
   e. Other ______________________________________________________

14. How did you acquire your solar PV?
   a. Bought it on loan {  }
   b. Gift {  }
   c. Bought it cash {  }
   d. Other (specify)______________________________________________

15. If Loan, who is financing?
   a. Chama/women/youth group
   b. Friends
   c. MFI (please specify)_________________________________________

16. For how long have you been using the particular solar products in your home?
   a. Less than 1 year
   b. 1-2 years
   c. 3-5 years
   d. More than 6 years

17. How often you use it;
   a. Daily
   b. In case of a black out
   c. Other (Specify)____________________________________________________________________

18. Who installed the Solar PV for you?
   a. Self
   b. The distributor/retailer
   c. Technician referred by the distributor/retailer
   d. Other (specify)____________________________________________________________________
19. What is your experience with the solar product (*Fill positive and negative experiences*)

<table>
<thead>
<tr>
<th>Positive/Benefits</th>
<th>Negative/challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
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<tr>
<td>2</td>
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<td>3</td>
<td>3</td>
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<tr>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

20. Have you shared your experience with the Solar PV with friends/relatives and any networks you belong to (such as women groups’/youth/church)?
   a. Yes ( ) If so, How many how many have the solar PV since then?
      No. of men _____ No. of women ______ Not sure of the number _____
   b. No ( ) If not, Why have you not shared? ________________________________
      ___________________________________________________________________
      ___________________________________________________________________

21. Will you readily spend money to purchase/repair your current PV product in case it malfunctions? Please give reasons for your answer
   a. Yes ( )
   b. No ( )
   Reasons
   i. ___________________________________________________________________
   ii. ___________________________________________________________________
   iii. ___________________________________________________________________
   iv. ___________________________________________________________________

22. Does your solar PV have a warranty?
   a. Yes ( )
   b. No ( )
   If yes, for how long? ___________________________________________________________________

23. Do you know what the warranty entails?
   a. Yes ( )
   b. No [ ]

24. Have you ever used the warranty before?
   a. Yes ( )
   b. No ( )
   Please give reasons for your answer
   ___________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________

25. If yes, what was the problem with the solar PV? Please explain
   ___________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________

26. Would you like to own a solar PV product?
   a. Yes ( )
   b. No ( )
27. **If yes, when do you see this happening?**

__________________________________________________________________________

28. **If no, why don’t you want to own one?**
   a. It is expensive
   b. I don’t know who can install it for me
   c. I have an alternative (please name them)
   d. Other reasons (please explain)_________________________________________

__________________________________________________________________________

**Part Three: Availability of Substitute**

29. Are you connected to the electricity grid?
   a. Yes [ ]
   b. No [ ]
30. If no, what other lighting energy source other than solar do you use?
   a. Kerosene lamp { }
   b. Candle { }
   c. Firewood { }
   d. Rechargeable lamps { }
   e. Other (Specify) _______________________________________________________

31. If you are using any other energy than grid Electricity or Solar, How far is the vendor from your home?
   a. Less than 5 km away
   b. 5-10 km away
   c. 11-15 km away
   d. more than 15 km away
   e. Are you aware of any other alternative energy sources that can be available to you in the near future?
      a. Yes { }
      b. No { }
      c. Not sure { }

If yes please explain
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

Thank you for responding to the questionnaire. Your time is highly appreciated.

NOTE TO THE ENUMERATORS: We have three codes to help you remember who to ask what and when.

   a. Regular font - The questions are to be asked to only those who own solar PV product
   b. Bold font - This questions are to be asked all respondents with or without solar PV
   c. Bold italic - This set of questions are to be asked only the respondent who said they don't have solar PV product in question 7 and 8
Annex 2: Manufacturer and Distributors Interview guide
Section A: Business Information

1. What is the type of your business?
   a) Sole proprietorship
   b) Partnership
   c) Franchise
   d) NGO
   e) Limited company
   f) Other, please specify _______________________________________________________

2. How many years have you been trading in Solar PVs?

<table>
<thead>
<tr>
<th>Years</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 1 year</td>
<td></td>
</tr>
<tr>
<td>1 - 2 Years</td>
<td></td>
</tr>
<tr>
<td>3 to 5 years</td>
<td></td>
</tr>
<tr>
<td>More than 6 years</td>
<td></td>
</tr>
</tbody>
</table>

3. What is the nature of your business?
   a) Manufacturer [ ]
   b) Distributer [ ]
   c) Reseller [ ]
   d) Retail [ ]
   e) CBO [ ]
   f) MFI [ ]
   g) Other (Specify)___________________________________

4. Which of the following best describes your occupation?

<table>
<thead>
<tr>
<th>Occupation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employee of the business</td>
</tr>
<tr>
<td>Owner and employee of the business</td>
</tr>
<tr>
<td>Co-owner and employee of the business</td>
</tr>
<tr>
<td>Technician/Installer</td>
</tr>
</tbody>
</table>

5. What type of solar products do you deal with?
   a) Solar panels [ ]
   b) Solar batteries [ ]
   c) Charge controllers [ ]
   d) Inverters [ ]
   e) SHS kit [ ]
   f) Mkopa kit [ ]
   g) Barefoot kit [ ]
   h) Other specify ________________

6. How many customers have you installed/sold solar PVs for in the last 12 months?
   a. Less than 10[ ]
   b. 10 – 20[ ]
   c. Above 20[ ]

7. Do you offer training to your customers on Solar Installations and Equipment?
   a. Yes { }
   b. No { }
   If yes explain your answer above and indicate the amount/ Cost _________________________
________________________________________________________________________________
Section B: Product Quality

8. What instructions are delivered with the solar devises?
   a. User Manuals from the Manufacturer { }
   b. Verbal Instructions at the point of sale { }
   c. Demonstration at the household level upon sale or installation { }

9. Do you think your customers would like to read and keep the user manuals?
   a. Yes { }          b. No { }          c. Not Sure {

10. Do you have a Kenya Bureau of standards mark on your Solar PV Products?
    a. Yes { }          b. No { }

Give reasons for your answer__________________________________________________________
__________________________________________________________________________________

11. Do you have warranty for your Solar PV Products?
    a. Yes { }          b. No { }

Give reasons for your answer__________________________________________________________
__________________________________________________________________________________

12. What is the nature of the warranty?
    a) Money back { }
    b) Replacement { }
    c) Repair { }
    d) Other, please specify { }

13. How many of your customers have claimed warranty in the last one year?
    a) Less than 10 { }
    b) Between 11-20 { }
    c) More than 20 { }

14. Have you tested the performance of your Solar PV Products?
    a. Yes { }          b. No { }

If Yes, where and why did you test it?
__________________________________________________________________________________
__________________________________________________________________________________
If no, please explain________________________________________________________________
__________________________________________________________________________________

15. How often do you test your Solar PV Products? Please explain
__________________________________________________________________________________
__________________________________________________________________________________
__________________________________________________________________________________

16. If not, why are you not testing your Solar PV Products?
a) No testing facility  
b) High testing fees  
c) High cost of transport to testing facility  
d) Other, please specify  

17. What is the stated/estimated lifespan of your Solar PV Products?  
a) 1 - 2 years  
b) 3 - 5 years  
c) 6 - 10 years  
d) Over 10 years  

Section C: Distribution channels and Marketing Strategy  
18. What is your target market?  
a) Rural  
b) Peri-urban  
c) Urban  
d) Other (specify)  

19. Your Solar PV products are mostly sold to the following:  
a. Distributors ( )  
b. Supermarkets ( )  
c. Schools ( )  
d. Hospitals ( )  
e. Hotels ( )  
f. Religious Facilities ( )  
g. Individual orders ( )  
h. Others (specify) .................................................................  

20. How do you reach your target market?  
a) TV advertisements  
b) Word of mouth  
c) E-marketing  
d) Print media  
e) Radio stations  
f) Self  
g) Other (specify) .............................................................  

21. What nature of distributorship do you have?  
a) Manufacturer-distributor  
b) Wholesaler - retailer  
c) Retailer - end-user  
d) End-users  
e) Other (specify) .........................................................  

22. How many Solar PV Products do you sell per:  
a) Day  
b) Month  
c) Year  

Section D: Financing of the business  
23. What is the mode of payment by your customers?  
a) Cash (if by cash skip to 28)  
b) Credit  
c) Both
24. If on credit basis, do you work in collaboration with any financial institution to recover your money?
   a. Yes { }                          b. No { }

If Yes, Please list them________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

If no, explain why? ____________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

25. If yes, how many people have bought the Solar PVs in the last one year taking advantage of the financial help offered by the listed financial institutions?
   a. Less than 50{}
   b. 50 – 200{}
   c. Over 200{}

26. If no, to your knowledge, are there other funding methods or ways that the community uses to help them buy solar system/equipment? Please explain: 

27. If on credit, how long does it take you to recover your money?
   a) 1-3 months
   b) 4-6 months
   c) 7-12 months
   d) Over 12 months

Section E: Challenges and Opportunities in the Solar PV Products Sector

28. What are the main challenges you have experienced in the Solar PV Products sector?
   a) Access to finance
   b) Awareness
   c) Marketing
   d) Government policy
   e) Other, please specify

29. What are the main opportunities in the Solar PV Products sector? Please list them:

30. In your opinion, what should be done to improve development of the Solar PV Products sector?
   a. Financing of businesses in the sector (loans, grants)
   b. Improved regulatory and policy frameworks
   c. Labelling and standardization
   d. Proactive marketing of the local products e.g. Solar PV Products by the government
   e. Awareness creation
   f. Build capacity of local stakeholders
   g. Others (specify)........

31. Are there specific technical needs your company requires?
   Yes ( )   No ( )
   If yes, list them in order of priority

Thank you for your time
Annex 3: Semi structured Interview guide for Key Informants

GUIDE TO KEY INFORMANT INTERVIEWS FOR SOLAR PV

1. What is your take on the adoption Solar PV in Kenya?
2. What would you say about the Solar PV market in Kenya?
3. Which policies / regulations / standards are enhancing adoption / market growth in the Solar PV sector?
4. Are their gaps in policies / regulations / standards that you know of? Which ones are these?
5. What opportunities exist in the Solar PV sectors?
6. Describe to me any major challenges?
7. As a key player in this sector are there certain marketing models that work well in Kenya? Can you give examples?
8. Do you have any recommendations regarding the sector; Markets and Adoption?

Name..................
Organization ...........................................
Position in Organization: ..............................
# Annex 4: Stakeholder Validation Workshop Attendance List

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ephantus Wachire</td>
<td>Sunset Energy</td>
</tr>
<tr>
<td>Dennis Kariuki</td>
<td>Ecocare International Limited</td>
</tr>
<tr>
<td>Ngugi K M Festus</td>
<td>Kings Biofuels Ltd</td>
</tr>
<tr>
<td>Jesse Njoroge</td>
<td>Kings Biofuels Ltd</td>
</tr>
<tr>
<td>Mark Cannon</td>
<td>Burn Manufacturing</td>
</tr>
<tr>
<td>Dan Waithaka</td>
<td>Wisdom</td>
</tr>
<tr>
<td>Mbaari Kinya</td>
<td>WEET Enterprises</td>
</tr>
<tr>
<td>Beatrice Despioch</td>
<td>Eco-Charcoal Limited</td>
</tr>
<tr>
<td>Tim Rump</td>
<td>Envirofit</td>
</tr>
<tr>
<td>Luke Davey</td>
<td>Epven – Inspirafarms</td>
</tr>
<tr>
<td>Caroline Waithera</td>
<td>Epven</td>
</tr>
<tr>
<td>Myra Mukulu</td>
<td>CCAK</td>
</tr>
<tr>
<td>Francis Mugecha</td>
<td>Chaff Energy</td>
</tr>
<tr>
<td>Esther Were</td>
<td>ACEES Limited</td>
</tr>
<tr>
<td>Sarah Kibagendi</td>
<td>ACEES Limited</td>
</tr>
<tr>
<td>Gaston Adoyo</td>
<td>ACEES Limited</td>
</tr>
<tr>
<td>Margret Owino</td>
<td>ACEES Limited</td>
</tr>
</tbody>
</table>
## Annex 5: List of manufacturers with approved solar PV products by global lighting

<table>
<thead>
<tr>
<th>Solar PV manufacturer</th>
<th>Solar PV manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 AEG international (1)</td>
<td>23 JUA Energy (3)</td>
</tr>
<tr>
<td>2 All solar lights (1)</td>
<td>24 Little sun (1)</td>
</tr>
<tr>
<td>3 All weather solar Co (1)</td>
<td>25 M-KOPA Solar (1)</td>
</tr>
<tr>
<td>4 Brighter lite (1)</td>
<td>26 Mibawa Suppliers Ltd. (1)</td>
</tr>
<tr>
<td>5 Nadji.Bi Group (1)</td>
<td>27 Mobisol (1)</td>
</tr>
<tr>
<td>6 Off Grid Electric (3)</td>
<td>28 Niwa Next Energy Products Ltd (6)</td>
</tr>
<tr>
<td>7 Poly Solar Technologies Co. Ltd. (1)</td>
<td>29 Nokero International Ltd. (1)</td>
</tr>
<tr>
<td>8 Shamba Technologies (1)</td>
<td>30 Nuru Energy (2)</td>
</tr>
<tr>
<td>9 Speed tech Energy (1)</td>
<td>31 Off-Grid Solutions (1)</td>
</tr>
<tr>
<td>10 True Solar USA Inc. (1)</td>
<td>32 Omnivoltaic Power Co., Ltd (8)</td>
</tr>
<tr>
<td>11 Village boom GmbH (1)</td>
<td>33 Orb Energy (3)</td>
</tr>
<tr>
<td>12 Azuri Technologies Ltd (2)</td>
<td>34 Panasonic Corporation (1)</td>
</tr>
<tr>
<td>13 Anji DaSol Solar Energy Science &amp; Technology Co., Ltd. (1)</td>
<td>35 Philips (1)</td>
</tr>
<tr>
<td>14 Barefoot Power Ltd (5)</td>
<td>36 Renewit Solar Limited (3)</td>
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<tr>
<td>15 d. light design (7)</td>
<td>37 Schneider Electric (2)</td>
</tr>
<tr>
<td>16 ECCO Elecs Pvt Ltd (1)</td>
<td>38 Sinoware Technology Co., Ltd (2)</td>
</tr>
<tr>
<td>17 Fosera Group (4)</td>
<td>39 SolarWorks! (2)</td>
</tr>
<tr>
<td>18 Freeplay Energy (1)</td>
<td>40 Solarland (Wuxi) Electronic Power Technology Ltd. (1)</td>
</tr>
<tr>
<td>19 Futura (1)</td>
<td>41 Zimpertec (1)</td>
</tr>
<tr>
<td>20 Greenlight Planet (9)</td>
<td>42 Zhejiang Holley (1)</td>
</tr>
<tr>
<td>21 GS Yuasa International Ltd. (2)</td>
<td></td>
</tr>
<tr>
<td>22 India Impex (sunlite) (1)</td>
<td></td>
</tr>
</tbody>
</table>