A report commissioned by

TANZANIA: MARKET INTELLIGENCE

December 2013

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ABBREVIATIONS & ACRONYMS

AfDB	African Development Bank
BOP	Bottom of the Pyramid
BOT	Bank of Tanzania
BRELA	Business Registration & Licensing Agency
CBO	Community Based Organization
COSTECH	Commission for Science &Technology
CRDB	Cooperative Rural Development Bank
DANIDA	Danish International Development Agency
ESRF	Economic &Social Research Foundation
EWURA	Energy Water Utilities Regulatory Authority
FIT	Feed-in Tariff
GoT	Government of Tanzania
GWh	Gigawatt-hour
HBS	Household Budget Survey
IFC	International Finance Corporation
IPPs	Independent Power Producers
KWh	Kilowatt-hour
kWp	Kilowatt-peak
LA	Lighting Africa Program
LAMIM	Lighting Africa Market Intelligence Materials
LCC	Life Cycle Cost
LED	Light Emitting Diode
LV-Tariff	Low-Voltage Tariff
MEM	Ministry of Energy and Minerals
M&E	Monitoring and Evaluation
MFIs	Micro financing Institutions
MITM	Ministry of Industry Trade & Marketing
MOF	Ministry of Finance
MSME	Micro, Small and Medium Enterprises
MW	Megawatt
NBS	National Bureau of Statistics
NEM	National Environmental Management Council
NGOs	Non-Governmental Organizations
NSGRP	National Strategy for Growth and Reduction Poverty
PPPs	Public Private Partnerships
PV	Photovoltaic
REA	Rural Electrification Agency
REB	Rural Energy Board
REPOA	Research on Poverty Alleviation
SACCOS	Savings & Credit Cooperative Organization
SIDA	Swedish International Development Cooperation Agency
SHS	Solar Home System
SPP	Small Power Producers
SME	Small& Medium Size Enterprise
TANESCO	Tanzania Electricity Supply Company
TAREA	Tanzania Renewable Energy Association
TaTEDO	Tanzania Traditional Energy Development and Environment Organization
TBS	Tanzania Bureau of Standards
TIC	Tanzania Investment Center

TIRDO	Tanzania Industrial Research and Development Organization
TRA	Tanzania Revenue Authority
TSD	Tanzania Socioeconomic Database
TSHs	Tanzania Shillings
USD	United States Dollar
UDSM	University of Dar es salaam
UNFCCC	United Nations Framework Convention on Climate Change
UNDP	United Nations Development Programme
URT	United Republic of Tanzania

CURRENCY EQUIVALENTS

Currency Unit = Tanzanian Shilling (TSh)

USD 1 = TSh 1,600[1]

[1] In 2008, following the financial crisis the exchange rate fell to TSh 1162 = USD1. It has been fluctuating around TSh 1600 = USD1 for the past 3 -4 years, and this is the rate that is used in the report

[2]An economic analysis of energy sources showing affordability and expenditure patterns for electricity and kerosene, when considering the various lighting options available to BOP (Maliti & Mnenwa, 2011)

EXECUTIVE SUMMARY

A Market Intelligence study was carried out in Tanzania on behalf of the Lighting Africa program. The purpose of the study is to provide detailed information on the utilization and cost of current forms of lighting found amongst the "Bottom of the Pyramid (BOP)" population in Tanzania, the off-grid sustainable lighting products that have been introduced into the Tanzanian market, consumer attitudes towards these products and the supply and distribution chains that deliver them to the rural and peri-urban areas where the vast majority of the BOP consumers live and work. The goal is to inform stakeholders of key market issues and recommend how program interventions can support viable distribution models that will significantly increase the use of off-grid sustainable lighting products in Tanzania.

Key Findings of the Tanzania Market Intelligence Study Include:

State of Electrification and Lighting Access

- Only 21% of the Tanzanian population currently has access to electricity. There is a significant rural-urban gap as only 7% of the total electrification reaches rural areas, while 70% percent of the total population lives in these areas. Of the 25 mainland regions in Tanzania, the Dar es Salaam region has the greatest access to electricity at 59% of all households in the region with grid connection. Some regions however lag far behind, with Kagera, Kigoma, Lindi, Manyara, Mtwara, Mwanza, Rukwa and Shunyanga all registering less than 5% access to electricity.
- Access to electricity correlates with the rate of literacy, for example Dar es Salaam, which has the highest access rate of 59% has a literacy rate of approximately 91%. Arusha, which follows with the next highest access rate of 11%, has a literacy rate of 73%. The Lindi region, which has the lowest electricity access rate of 5%, also has the lowest rate of literacy, which is 60%.
- Over the last decade the demand for electricity has grown at a considerable rate due to population growth and the growth tendency of household social status in general. However, lighting provision has been inadequate to meet the need. The total units of electricity generated currently add up to around 5,700 GWh but due to losses, the actual amount of electricity distributed, is only around 4,200 GWh.
- The Government through the Ministry of Energy and Minerals, the Rural Energy Agency, TANESCO, and various development partners, is undertaking several electrification projects in the provinces to increase generation capacity by 3262 MW by the year 2020. However, this will only supply about 37% of the national demand, mainly in urban areas.
- The lack of sustainable energy sources and lighting services reduces national productivity; for example, if children from rural households do not have enough light to study at night, they are losing opportunities to improve their education, and consequently their living standards. Likewise, micro enterprises in peri-urban areas spend more on meeting energy costs than on investments to expand their business activities.

Profile of Bottom of Pyramid (BOP) Consumers

- The average per capita income for a BOP household is less than USD150 or TSh 245,550. Urban areas have a higher income per capita with earnings from both public and a wide range of private sector institutions, while the rural area earnings are dominated by the public sector and agricultural activities. The BOP consumer in Tanzania includes rural and peri-urban households.

- A large portion of the rural and peri-urban household budget goes to energy fuels like kerosene (discussed further in this report — economics of lighting section). After food expenses, the next highest portion of the household budget is allocated for lighting and water expenses, followed by spending on education and healthcare services.

- Most peri-urban dwellers do have some monthly surplus disposable income. The average revealed from the focus group respondents is TSh 90,000 (roughly USD55). The analysis indicates, however, that rural households on average have no surplus disposable income.

Existing Lighting Solutions

- The existing lighting options for off-grid BOP households are mostly tin lamps (commonly known as "koroboi"), used by 27% of respondents; kerosene hurricane lamps ("chemli"), used by 37.2% of respondents; dry cell battery powered LED torches, used by 19.3% of respondents; candles, used by 17.9% of respondents; and to a smaller extent, solar lighting, used by 4% of respondents. However, the latter is becoming popularized in many areas at increasing rates due to promotion efforts made by NGOs and private solar dealers. These regions include Mwanza, Mara, Geita, Arusha, Kigoma, Tanga, Dares Salaam, and Mbeya. A few households that are relatively well off, use generators or solar home lighting systems as alternatives.

- The focus groups also revealed that people in rural areas typically utilize firelight as a natural lighting source especially in kitchens. This includes the "Urumoli" used by Kigoma rural residents. Uromoli is a shrub of grass that provides temporary light when lit, bright enough to facilitate a small task. The Maasai in the Arusha rural area often use burning strips of motor vehicle tires for lighting.

- For SMEs, the lighting solutions are similar at the lower end, but due to some having greater lighting needs, they use somewhat more costly lighting solutions such as generators. For example, 12.3% of the SMEs use generators in comparison to only 4.8% of households, and for SHS 7.6% of SMEs use these compared to only 1.6% of households.

- The lighting solutions used by the BOP consumers, especially kerosene lamps, are expensive and hazardous to the health and the well being of the users, and are also costly to operate in the long run. Currently, the dry cell battery powered torches offer better light, but have short life spans and pose an environmental hazard relating to their disposal.

- For urban dwellers, electricity is the primary source of lighting energy but they also use kerosene lanterns, torches and candles for back up since the supply of grid electricity is erratic.

Attitudes Towards Alternative Lighting Products

- Most consumers are still not very aware of the availability of portable solar lanterns, in terms of their suitability for substitute usage, prices and performance characteristics.

- However, BOP focus group participants were highly aware of the limitations of the current devices they are using and revealed that it is only financial concerns that are the barrier for them to extricate themselves from the harmful kerosene dependent devices.

- However, BOP participants in Focus Groups conducted during this study, who sampled the solar lighting products showed great willingness to purchase the lanterns if provided with an affordable micro-financing scheme.

- Many Focus Group participants categorized the solar devices using a combination of two criteria. The most popular criterion for segmentation was usage purpose. This was indicated in seven of the twelve Focus Groups. The next most popular criterion for segmentation was the quality of light in terms of brightness; this was selected as most important in five of the Focus Groups.

- When considering alternative lighting solutions, BOP consumers want more than just a lighting device, and seek multipurpose products that can also charge mobile phones. As BOP households may be able to afford only one or two alternative lighting devices, portability is also a key concern, likewise they also want to be able to power their TVs, radios and other entertainment devices.

- BOP energy consumers buy their lighting products from Small and Medium Enterprise (SME) retail shops and local street vendors. Street vendors do not specialize in lighting, some don't offer product warranty, and a number of them sell a mixture of low quality products. Though, they offer what most SMEs can't: "informal" credit in the form of extended payment arrangements.

Lighting Economics

- Analysis of electricity affordability based on income level shows that for the upfront cost of electricity, there's a TSh 66,750 (~USD41) difference between the cheapest and the most expensive electricity options, which is a very significant spread. Regardless of the subsidies for households located far from power lines (mostly rural or peri-urban) intending to install connections, the amount is still very high to be affordable for most BOP consumers.

- Given the high electricity prices, even in the cheapest electricity scenario the cost of kerosene is only 13% of the price of electricity. With this analysis, grid connected electricity is in fact not an attractive option for BOP consumers — even if it is available, the customer will opt for kerosene because it's the cheaper option.

- Therefore, the BOP consumer will fare better economically with off-grid lighting alternatives, making them a suitable target market segment even in areas targeted for grid connections.

- Even with the high up-front cost for alternative products, the life cycle cost (LCC) for kerosene products are in fact much higher due to the recurring cost of fuels and devices. The economic argument for alternative lighting products is compelling.

- Awareness needs to be raised regarding the LCC advantages of alternative lighting products although information dissemination may not necessarily be all that is required to bring an overall impact. Financing will need to be offered to a majority of BOP consumers to allow them to cover the purchase costs, as the high up-front prices of solar lighting products put them out of reach of many of the targeted population. In fact, the study determined that this is the biggest barrier.

- Household incomes of BOP consumers clearly indicate that coming up with sufficient funds all at once to purchase an alternative lighting device would be problematic for rural BOP consumers. However, when consumers in the household survey were asked about how likely they are to be willing to purchase solar lighting products when financing is offered, ***72 percent across both rural and peri-urban households said they will either definitely buy or perhaps might buy***.

- Of the responding SMEs, ***54 percent said they are definitely willing to purchase alternative lighting products*** when credit is offered.

- These attitudes provide a striking endorsement of how important offering credit solutions should be in any large-scale marketing effort for alternative lighting products.

- Households and SMEs prefer to take loans either through Savings and Credit Cooperative Societies (SACCOS) or local banks, according to FGDs and survey responses.

Market Size and Potential

- The "technical potential" of the market for alternative lighting products may be considered to be as large as the number of households and SMEs that are today not connected to the grid. The Government estimates that the number of households without grid connection today remains over 7.8 million. One estimate of the total number of SME's is approximately 3.1 million. There is no reliable data on how many of these SMEs are not grid connected, but if the rate of electrification is taken at the overall country average, then one may assume that roughly 2.45 million SME's are without grid supplied power.

- The price range of all alternative lighting products on the market was estimated in a very wide range between USD 5.00-250.00, owing to significant differences in type, features and quality. Since many of the products are concentrated at the lower end, the median price range can reasonably be assumed to be at USD 50.00.

- Using this median pricing and information culled from supply chain interviews the study team estimates the current demand value for 2014 to be USD 9,150,000 and the projected national demand five years from now to be USD 21,250,000. This would imply that the market is expected to grow 2.3 times according to the surveyed dealers.

- The study team's estimate of total sales across five years is approximately USD 82,000,000. This may be a conservative estimate but it at least indicates the trends of sales in terms of growth rate.

Supply and Distribution of Alternative Lighting Products

- The supply chain for off-grid lighting products to BOP populations has until recently involved mostly the government and NGOs; today, however, several private solar distributors have become engaged in targeting this market segment and some have managed to systematically deliver off-grid lighting alternatives in some rural and peri-urban areas;
- The general supply chain for alternative lighting products consists of three or four levels, with importers and national distributors at the top end of the chain and retailers and street hawkers interfacing with customers at the end;
- Four or five significant private national players have emerged, and they handle the largest portion of product turnover. Their characteristics are as follows:
    - Operate both as national and regional distributors
    - Service high and middle-income customers, and only recently began to engage with BOP market segments
    - Evaluate product performance and some offer warranties
    - Expand distribution network to other neighboring countries in East Africa
- Vendors and street hawkers have received a particularly low amount of attention to date, however, they play an important role in delivering electronic devices of all sorts to BOP consumers and provide important informal credits in the form of extended payments offered on a “hand-shake” basis.
- Major solar system markets are located in Dar es Salaam, Arusha and Mwanza, these are also the areas where of a majority of the solar lighting suppliers are located, and where BOP energy consumers have access to modern lighting technologies. Markets in those three regions have evolved based on needs and opportunities. For example, Dar es salaam is a commercial center where solar technologies are marketed and all business operations are governed, while Arusha is the tourism region where education is highly valued and technology adoption is linked to access through neighboring countries like Kenya. In Mwanza, however, solar market penetration has been mainly through government sponsored projects in partnership with NGO development partners;
- NGOs continue to play a critical role in planning and delivering off grid lighting to BOP consumers using a more programmatic approach;
- Several distribution models have emerged which systematically target different market sub-segments. These are mostly delivered by NGOs, but some of the large private distributors are now also bringing novel ideas. While all of the models have some shortcomings, in totality they represent a variety of innovative approaches which may be improved upon and expanded. Some of these models are:
    - Using middle schools as marketing centers; selling first to school headmasters with follow-on promotions to students, who in turn convince their parents to make the purchase; the school serves as the local stocking, distribution and sales center.
    - Well organized campaigns that feature music and entertainment targeted for youth and women — using mobile shops inside trucks that travel to remote areas while carrying many diverse products

- Using community based organizations such as Savings and Credit Cooperative Organizations (SACCOS), Care International, and JUKULIA (a district association in Ilala district, Dar es Salaam) to reach each member of the association. The dealer supplies the products and the promotion materials to the SACCOS, or village/community agents who supply to their members.
- Use of mobile payment systems such as MPESA which are already used in the banking system to pay for services such as water and food, for lighting products as well,
- NGO awareness campaigns, through mass media
- Business networking, skills training, and building capacity for solar entrepreneurs

- While some of these organizations have partnered with Microfinance Institutions (MFIs), most dealers and distributors indicated that lack of a simple and affordable financing plan was one of several key obstacles to rapid expansion;
- A large number of distributors cite poor product quality and shipments of defective merchandise as a second key obstacle. The problem seems to lie at three distinct levels – poor product designs offered by manufacturers, insufficient technical expertise at the distribution level to select quality devices, and manufacturers dumping the defective units on the Tanzanian market with insufficient enforcement and control at importation by the Tanzania Bureau of Standards (TBS).
- High costs of establishing proper logistics and poor transport infrastructure were cited as additional key obstacles by distributors;
- Provision of after sales service is uneven amongst distributors and along with poor product quality is a major source of concern. NGOs are often the biggest culprit of lack of follow-up and product servicing due to poor technical capabilities and the transient nature of many NGO distribution efforts, which provide a flurry of promotion and distribution without any permanent presence in the community.

Government Actions:

- The Rural Electrification Agency (REA) has been the main government catalyst for alternative lighting solutions mainly through the Tanzania Energy Development Access Project (TEDAP), which focuses on improving rural electrification through supporting diverse off grid initiatives by fostering PPP arrangements. TEDAP receives funding from the REA administered Rural Energy Fund (REF) and donor contributions.
- TEDAP has administered Tanzania's major off-grid lighting initiative, the Lighting Rural Tanzania Competition (LRTC), supported by Lighting Africa, which channeled grants to distribution agents, mainly to fund start-up costs for launching or expanding delivery to rural and peri-urban areas.
- Financing to TEDAP for off grid lighting through the REF accounts for a minimal portion (only USD1 million of the USD22.6 million) of the total program budget. Private distributors fault TEDAP and the LRTC for providing the majority of their support to NGO development partners with limited private sector participation — eligibility criteria for renewable project developers offer little incentives for investors and on-line applications in English make it difficult for SME retailers to access. Initial focus has also been mainly towards supplying off-grid lighting only to institutional facilities with little or no outreach to individuals and businesses.

- TEDAP has pointed to a lack of sufficient national and local government support leading to questions whether it will leave a sustainable framework in place when the donor funding expires in 2015.
- Regulations have not yet been put in place specifically for alternative lighting products. EWURA (Energy Water Utilities Regulatory Authority) has not been able to develop regulations governing the application of efficient lighting because the Ministry of Energy has not yet developed the Renewable Energy Policy.

- There are 11 standards for regulating the influx of solar equipment products, including specifications on Solar photovoltaic power systems test procedures for main components, Photovoltaic modules, Installation, maintenance, testing and replacement of batteries, Charge regulators, Inverters, Luminaires, Solar photovoltaic (PV) power systems-design, installation, operation, monitoring and maintenance-code of practice, Design of solar PV systems, Installation of power PV power systems, Operation of solar PV power system, and Monitoring and maintenance of solar systems.

- However, the study team found that these standards have little or no relevance to the quality assurance of lighting products. Only one of the standards mentions the application of lighting systems.

- Import duties and value added taxes are exempted for all solar products according to the government officials interviewed for this study. However, the concerns of the supply chain survey respondents were that, although tax exemptions for solar products are well structured, the implementation is poorly managed by the Tanzania Revenue Authority and by the TBS. The survey respondents indicated that the system lacks technical capacity and knowledge at all levels from import, to storage, to the product inspection, to the clearance process.

- TAREA (the Tanzania Renewable Energy Association), an NGO involved in solar suppliers' accreditation is spearheading the prevention of counterfeit products entry, which is prohibited by the law.

Financing Mechanisms:

- Some amount of financing for lighting supplies in rural and peri-urban areas is provided in form of credits and microloans through Village community Banks (VIKOBAs); Savings and Credit Societies (SACCOS); and Trust Funds ("Mfuko wa HISA").
- Only a few MFI's offer specific loan products for household or business sustainable energy purchases.

- The BOP's income base, especially in rural areas, often does not enable borrowing from MFIs. In peri-urban areas, incomes are higher but there is often no asset base to support lending since many peri-urban BOP consumers live in rented homes and have no agricultural assets. MFIs prefer lending to SMEs since the enterprise cash flows and assets can serve as collateral.

- Across the full range of potential expenditure levels for solar lighting products, BOP participants in the study Focus Groups indicated the need for some form of financing to cover up front costs.

- If, for example, financing terms of up to a year were made available, a wide majority of Focus Group participants felt they would be able to handle expenditures in acquiring alternative lighting devices considerably better then in the absence of such financing or if credit terms are short.

- Financing was also cited as the main challenge among supply chain survey respondents. A common challege established for all levels of private dealers is that they have no access to loans for importation and distribution of goods. Based on the interviews held with the dealers almost all of them (97%) had no access to loans to support their business. According to the financial institutions interviewed most of the dealers were being denied provision of loans due to lack of collateral, lack of expertise in finance, the high cost involved in small transactions, and risk aversion.

Recommendations:

In order to enhance delivery of high-quality solar lighting products to the market, key actors like the Rural Electificatin Agency (REA) should strengthen their role in rural lighting provision, and encourage increased and more organized private sector partcipation. In effect, three keys aspects for effective market entry of solar lighting products should be focused upon; (i) limited knowledge on the use and benefits of solar lighting products (ii) lack of product standards leading to market saturation with low quality products; and (iii) limited financing for solar lighting products.

The following recommendations are made for stakeholders and government institutions responsible for off grid lighting programs:

- Offering information and training particularly in these areas: understanding of the entire product Life Cycle Costs, comparative product durability, maintenance and disposal costs;
- Work with the Ministry of Energy and Mineral Resource (MEM) to ensure that Solar VAT/Duty exemptions are allowed only for high quality products;
- Work with REA to establish a quality certification program for lighting products in which manufacturers will compete and receive approval for their brands so that they gather greater appeal in the market place;
- Assist REA in working with the Tanzania Bureau of Standards (TBS) on developing minimum quality standards specifically for lighting products, which TBS should enforce in the usual manner under their jurisdiction;
- Conduct a more intensified campaign for awareness of private dealers in the supply chain and disseminate information on successful distribution models and provide training for implementation of these models;
- Provide TA to MFIs to encourage and assist them in establishing special financing programs to support off grid lighting product purchases. Help make connections between distributor/dealers and MFIs to set up joint programs and provide TA to both on workable models for collaboration;
- Develop closer relations with the Government of Tanzania through MEM to help government take an even greater role in promoting off grid lighting solutions as a cornerstone of national energy policy;

- Use the mass media institutions to disseminate publicity about off grid lighting products and the efforts of various stakeholders to ensure that better quality products are being delivered to the market. This can be through joint press conferences, sponsored programs in broadcast media, and advertisements.

1.0. INTRODUCTION

For the majority of Tanzanians living in rural and peri-urban areas, access to grid power has been slow, and in most cases unaffordable. Off-grid alternatives for lighting such as kerosene lamps or paraffin candles produce polluting fossil fuels, and come with long-term health and environmental repercussions, besides being very expensive. For those with access to electricity, the majority is under-served and they also turn to similar unsustainable lighting solutions. Inadequate access to electricity has traditionally left rural and peri-urban households and Small and Medium Sized Enterprises (SMEs) with a poor choice of lighting options. Energy efficient products have slowly started to enter the market with the availability of lighting alternatives such as LED lamps and solar lanterns providing more options, though the market penetration and awareness about these modern lighting technologies remains limited.

The lack of sustainable energy sources and lighting services reduces national productivity; for example, if children from rural households do not have enough light to study at night, they are losing opportunities to improve their education, and consequently their living standards. Likewise micro enterprises in peri- urban areas spend more on meeting energy costs than on investments to expand their business activities. [2]

It is in this context that the Lighting Africa (LA) program was launched in 2007 as a joint program of the World Bank (WB) and International Finance Corporation (IFC). The LA program is part of a global movement towards an Energy Access Policy[3] framework, which sets goals for investing in energy transformation providing education and healthcare services to marginalized communities. The LA program works to provide sustainable lighting options for populations without access to the electricity grid. Through market development and mobilization, the program offers modern lighting options for Bottom of the Pyramid (BOP) energy consumers in Africa. Lighting Africa seeks to eliminate market barriers for the private sector to reach the 250 million people in Africa currently without electricity and to those using fuel-based lighting by 2030, which responds to the Sustainable Energy For All initiative. The program has completed pilot projects in Kenya and Ghana and is in the early stages of a large-scale rollout across the continent, with activities already initiated in Tanzania, Ethiopia, Malawi, the Democratic Republic of Congo, Zambia, Burkina Faso, Mali and Senegal.

The activities of Lighting Africa in Tanzania started in 2008, with an initial market assessment report[4], followed by the partnering up with the Tanzania Rural Energy Agency (REA) to undertake a competitive solicitation in 2010 aimed at selecting suppliers of alternative lighting products that would receive funding for targeted distribution campaigns. The implementation of these campaigns was followed by a Policy Report Note that was agreed upon by Lighting Africa sponsors and the Government of Tanzania in 2012.

Climate change has negatively impacted Tanzania's over-reliance on hydropower for supplying electricity. Frequent droughts in the past have caused severe depletion of water supply to dams thereby leading to a reduction in power

[2] An economic analysis of energy sources showing affordability and expenditure patterns for electricity and kerosene, when considering the various lighting options available to BOP (Maliti & Mnenwa, 2011)
[3] Energy Access Policy — An analysis that examines energy policies and market trends that will provide insight on an enabling ecosystem, which is geared towards meeting pro-poor energy access goals. This is based on the 'Energy Access Ecosystem Index', which focuses on nine indicators, three each in the areas of energy policy, financing and capacity (Practical Action, 2013)
[4] The 2008 market assessment in Tanzania established a set of research objectives, which are incorporated in the Tanzania Market Intelligence study. Unlike previous market assessment that focus more on ascertaining the existing lighting options in the market, the current study focuses on determining the characteristics and needs of the BOP consumer, and maps the supply-chain of actors involved in distributing modern lighting products in Tanzania.

generation and consequently a disruption in socioeconomic activities.[5] These climatic changes are projected to increase in the near future[6] with intensified droughts, heat waves and wildfires. Fortunately, the increased exploitation of the country's considerable natural gas deposits, and the early stage development of geothermal, wind, solar and biomass resources are offering optional power generation and providing Tanzania an opportunity for socioeconomic growth, and environmental sustainability. Of specific significance to this Lighting Africa study, is that Tanzania's location near the equator, which allows for a large amount of solar radiation and comparatively high sunshine hours[7] during the day, provides an environment conducive to the use of solar powered lighting technologies.

The energy sector in Tanzania is undertaking deliberate efforts to introduce renewable energy strategies, and expand efforts to bring energy services to both on and off-grid segments of the population. Under the National Strategy for Growth and Poverty Reduction (NSGRP)[8], development goals focus on rural transformation through investment in environmental infrastructure and market opportunities for SMEs (URT, 2005). In particular, the national plan addresses energy policy reforms through enabling environments for renewable energy access and investments in Public-Private Partnerships (PPPs). This Market Intelligence study therefore coincides with positive steps taken by the Government of Tanzania towards energy sector reform, rural electrification, and introduction of renewable energy projects. Among these efforts is the implementation of the Tanzania Energy Development and Access Project (TEDAP) which, among its activities, utilizes of PPPs to deliver off-grid lighting solutions to BOP populations. TEDAP has helped create opportunities for the entry of energy efficient technologies in local markets. A variety of household level appropriate modern technologies have been explored in Tanzania as a result. These include solar photovoltaic (PV), solar thermal, biogas for cooking, bio-waste for small-scale power generation, micro-wind turbines for water pumping and a plethora of solar lighting products.

The Tanzania Market Intelligence study focuses on the BOP energy consumer and renewable energy actors, along with secondary information on the energy sector trade, and investment and policy trends in the country. Similar to previously piloted Lighting Africa programs, 'Market Intelligence' is a critical part of the project planning that will provide market information for designing suitable products for local markets, in addition to determining the market demand and supply chain mapping for modern lighting products.

Terms of Reference for this Study

The terms of reference for this assignment were to conduct market research which involved reviewing existing demand information on the lighting sources in off-grid rural areas, consumption and expenditures for kerosene/candles and other prevalent lighting alternatives, willingness to pay, consumer preferences, etc. and complement it with socio-economic surveys and focus groups in representative target rural and peri-urban areas Specifically the goals of the assignment covered the following:

- Evaluation of the State of Electrification (% of population with access to electricity, those connected to the grid, off-grid connections, etc.);
- Characterization of the existing lighting solutions, their challenges and their costs (financial and environmental);
- Summarizing the market potential and its key characteristics for the purpose of distributing information to potential manufacturers and distributors of off-grid lighting products;

[5]The Economics of Climate Adaptation Working Group Report shows climatic changes affected power provision and result in unsustainable livelihoods and national underproduction **(**ECA, 2009)
[6]Studies published by the Intergovernmental Panel on Climate Change show that the amount of freshwater resources have been depleting over the last 50 years, and projections for this trend are expected to increase in the future primarily due to natural and anthropogenic factors — natural seasonal changes and ecological impacts from population growth (IPCC, 2011)
[7]Daily solar radiation is 4-8 kWh/m2, with 2800-3500 hours of sunshine per year (Kimambo, 2009).
[8]NSGRP **—** Tanzania's long-term development plans aimed at poverty reduction and moving the country into middle-income status. Policy reforms within the energy sector aim to ensure availability of reliable and affordable energy services and their use in a sustainable manner to support national transformation (URT, 2005).

- Screening the market for Solar Home Systems (SHS), solar lanterns, and other similar products, including PPPs (e.g. concessions, private sector-driven initiatives and informal market.);
- Analysis of the most promising distribution models;
- Analysis of the competiveness (direct and indirect) of the market for prices, types, functions, performance, quality, etc.;
- Mapping out the key stakeholders to engage in the country's off-grid lighting market (commercial sector, NGOs, and national/local government);
- Mapping out areas for collaboration with key stakeholders, the best institutional arrangements and engagements;
- Defining the key implementation areas for the program;
- Defining the monitoring and evaluation framework;
- Defining the consumer needs and analyzing the cost and growth of the current options.

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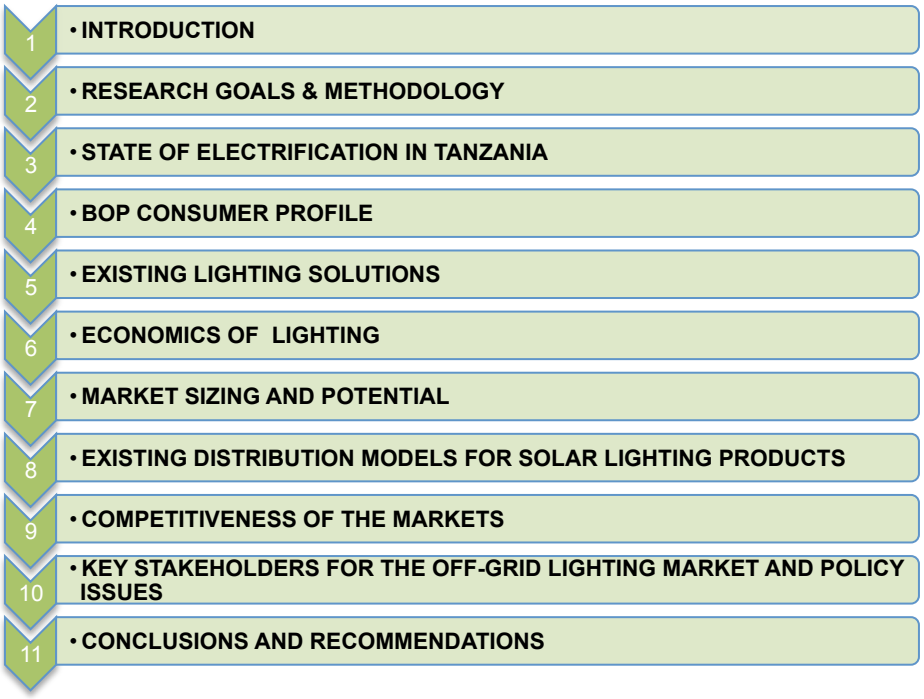


2.0. RESEARCH GOALS & METHODOLOGY

Purpose of the Study

The primary objective of the study is to collect information that will provide manufacturers/distributors with market insights and data that would inform/facilitate their entry, growth and scale up in the country.

Market Assessment Methodology

The specific research activities undertaken, involved:

a) A desk review of relevant documents on energy and lighting in Tanzania, including Government and Development partners.

b) In-person interviews with relevant stakeholders, including businesses with operating supply and distribution channels for alternative lighting products, and representatives from the Government of Tanzania and Non-Governmental Organizations. Interviews were conducted with 163 private dealers at various levels of the supply chain, 6 interviews with government agencies and 16 interviews with NGOs, development partners, research and micro-financing institutions. Also, interviews were conducted with 40 supply chain distributors of general electronic goods across the country.

c) Twelve focus groups were selected from 6 representative regions, one from a peri-urban location and one from a rural location in each region. The groups comprised household heads who had been carefully selected to reflect the socio-economic profile of the BOP population in that cluster. A total of 185 household members participated in these discussions.

d) A consumer survey in six geographical zones of Tanzania, involving 374 households and 236 owners of micro and small enterprises (SMEs) was conducted to determine the characteristics related to energy access for the provision of lighting solutions and lighting usage behaviors.

e) Compilation of the market research materials into a report with program monitoring and evaluation recommendations, to be shared with manufacturers and distributors of modern lighting products.

3.0. STATE OF ELECTRIFICATION IN TANZANIA

3.1. Access to Electricity

The total population of Tanzania is 43.9 million with an average household size of 4.5 persons according to the most recent census conducted in 2012 (NBS 2013). The rate of electrification in the country stands at 21% with only 7% coverage in rural areas and about 50% in the urban areas. Of the 25 mainland regions in Tanzania, the Dar es Salaam region has the greatest access to electricity with 39% of all households in the region having a grid connection. The Government is targeting 30 per cent connectivity by 2015, involving connection of 250,000 new customers per annum starting in 2013, to 2017. So far the Rural Energy Agency (REA) has been actively participating in rural electrification initiatives mainly in either grid extension or isolated mini-grids. For example, electrification of villages that will be affected by the 400kV Backbone transmission line, the Millennium Challenge Corporation (MCC) funded electrification projects in seven mainland regions (Morogoro, Iringa, Mwanza, Kigoma, Mbeya, Tanga and Dodoma), and the electrification expansion program in Mpanda, Ngara and Biharamulo.

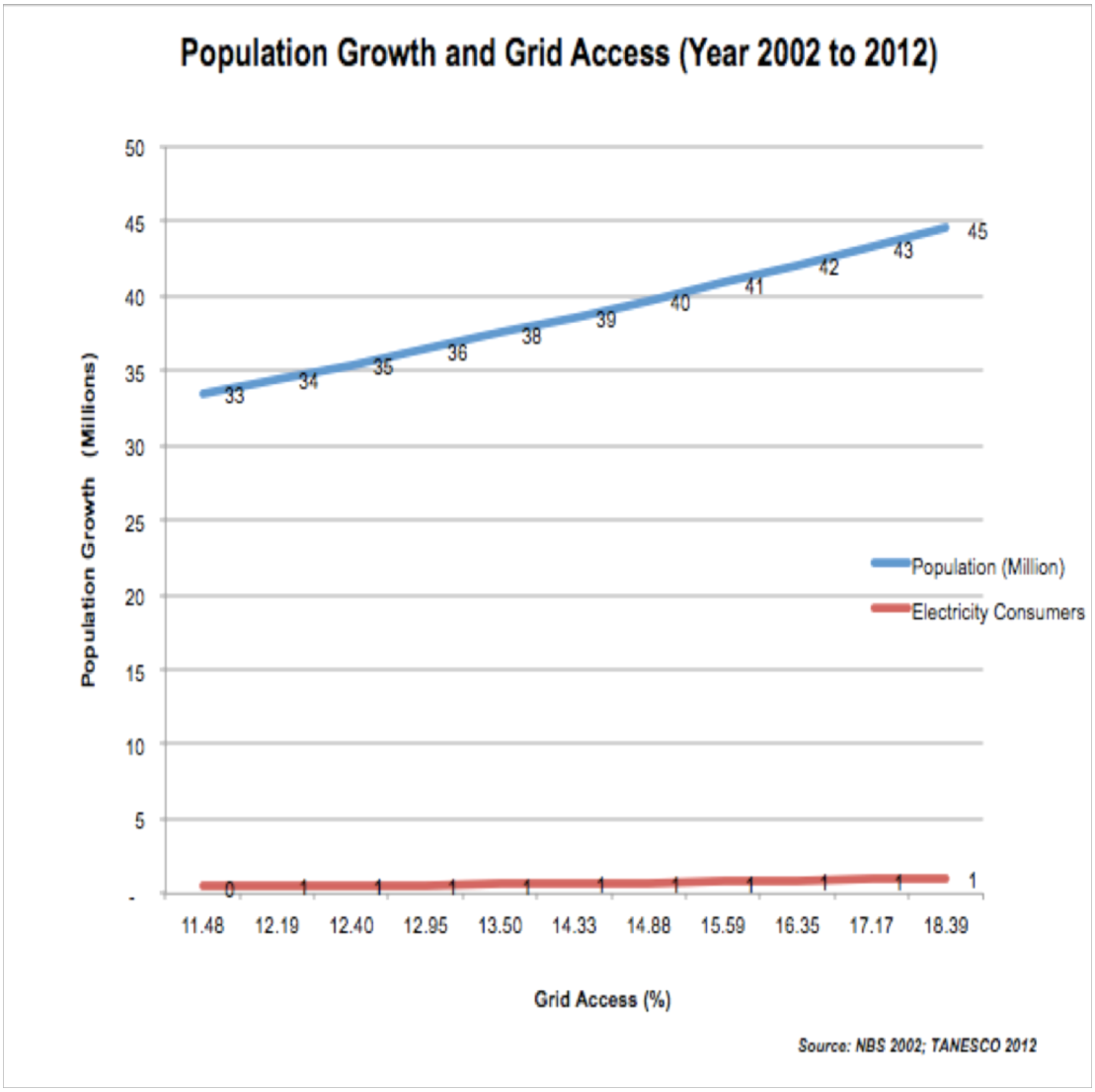
According to recent figures published by the Tanzania Power System Master Plan, Tanzania Electricity Supply Company (TANESCO) connection rates are as shown in Table 1. These rates are broken down by regions in Mainland Tanzania. Figure 1 indicates the relationship between population growth in the country and access to grid electricity.

Table 1: The number of TANESCO customers by region and the degree of electrification for the year 2010

Region	% Access	Population
Arusha	17	231,331
Dar es Salaam	39	2,090,429
Dodoma	7	92,011
Iringa	9	94,742
Kagera	4	45,937
Kigoma	4	12,432
Kilimanjaro	21	137,939
Lindi	3	14,903
Manyara	3	23,501
Mara	5	53,339
Morogoro	10	132,161
Mbeya	9	144,023
Mtwara	3	29,136
Mwanza	3	217,321
Pwani	13	111,391
Rukwa	3	17,057
Ruvuma	5	21,293
Singida	6	30,293
Shinyanga	3	235,901
Tabora	5	34,363
Tanga	10	197,035

Source: Power System Master Plan 2013 (MEM)

Figure 1: Population Growth and Grid Access in Tanzania



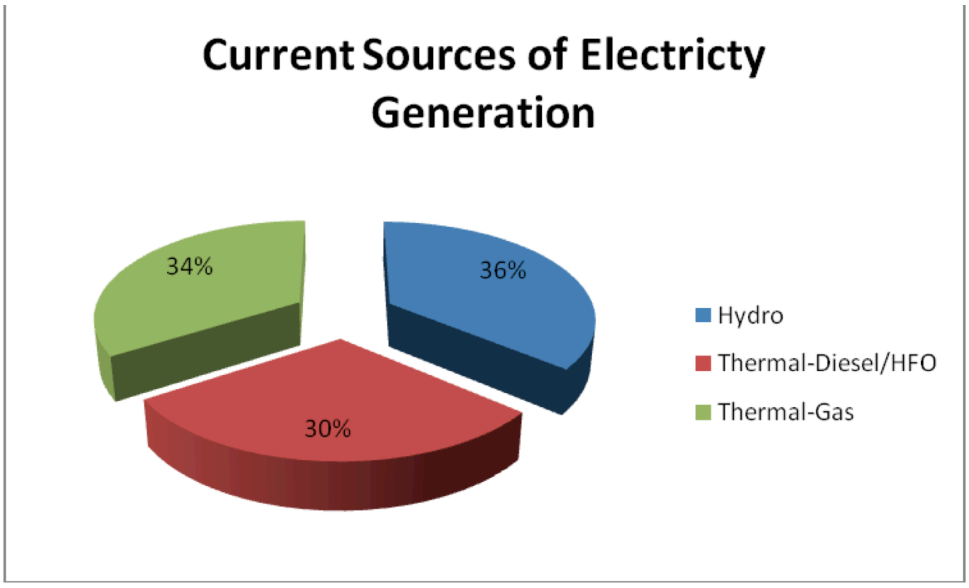
The approximately 5,700 GWh of electricity generated annually supplied through the grid is for both industrial and house hold consumption. The proportion which goes to households and institutions is about 37 percent while the rest goes to industries (38%) or is lost in the process of transmission (25%) (PSMP 2011). Those who do have access to the grid, however, experience frequent power outages and supply is generally erratic. For the past decade, the undersupply of electricity has been prominent with the increase in domestic energy demand due to population growth, and the high consumption of biomass fuels at 85% of the total energy consumption in the nation.[9]

[9](URT, 2012b)

3.2. Electricity Generation

Electricity generation has fluctuated tremendously due to recurring drought periods[10] in 2003/2004, 2005/2006, 2009/2010, 2010/2011 and 2011/2012, which have forced the country to pursue development of other indigenous sources of energy supply including natural gas, coal and all forms of renewable energy. As a result, a larger portion of electricity is now derived from thermal generation. However thermal generation has not been able to cover the deficit caused by the low levels of supply from installed hydropower. Figure 2 illustrates the proportional contribution of the different sources of electricity generation to the grid.

Figure 2: Current Source of Electricity Generation



Source: Tanesco 2013

Tanzania's power industry remains centralized, with one vertically integrated, public corporation, Tanzania Electricity Supply Company (TANESCO), which is in charge of electricity generation, transmission and distribution. TANESCO has an installed generation capacity of 1545 MW[11]; of which 36% is derived from hydropower[12] and 64% is derived from thermal energy. About 13MW of the generated electricity is imported from Uganda and Zambia[13]. TANESCO's monopoly position was ended in June 1992 to allow private sector participation in power trading. The sector is however undergoing major transformation with liberalization being at the forefront.

Table 2 shows the country's generation capacities and primary sources.

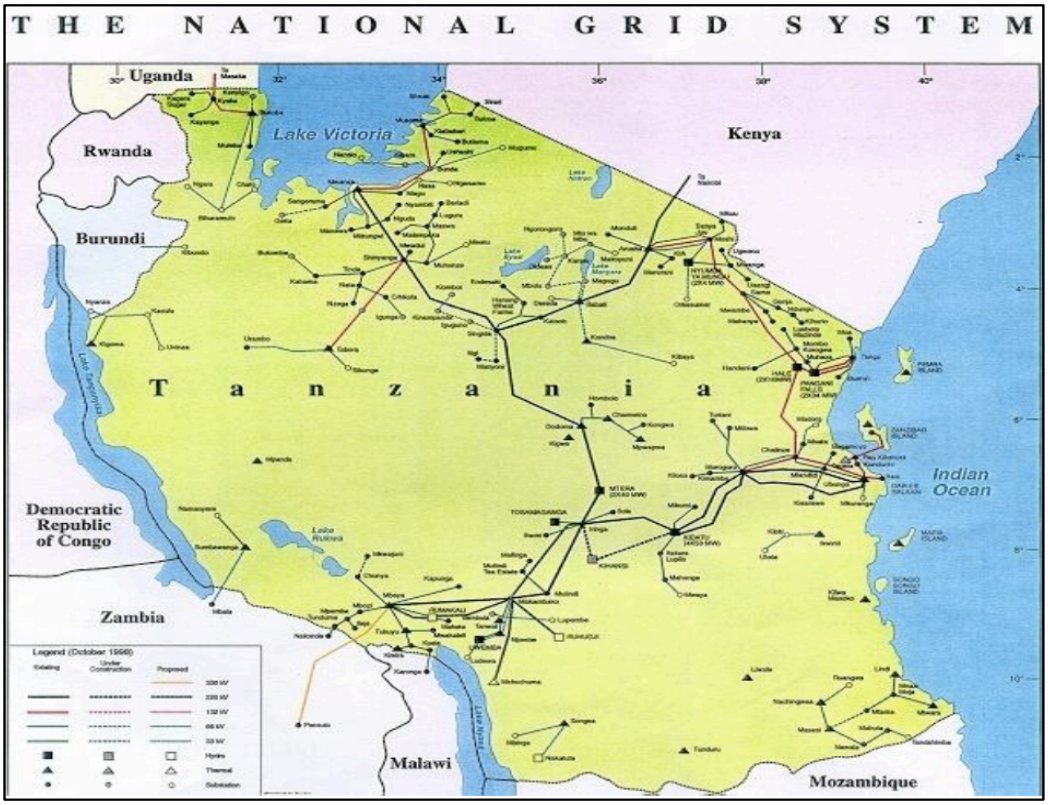
[10] (Eberhard&Kapitak, 2010; MEM, 2013)
[11] (Msyani, 2013)
[12] Hydropower— Hydropower accounts for 55% of Tanzania's power generation this is a reduction in reliance on hydropower compared to the past, where in 2002 97% of the country's grid-based electricity came from hydropower, but also because in 2006 there were severe droughts, which affected the hydropower generation (Malley, 2011)
[13] (Nganga et al., 2013)

Table 2: Generation Capacities and Primary Sources

Ownership	Plant	Installed capacity (MW)	Type
Tanesco	Kidatu Kihansi	204.0 180.0	Hydro Hydro
	Mtera	80.0	Hydro
	N/Pangani Hale	68.0 21.0	Hydro Hydro
	Nyumba ya Mungu	8.0	Hydro
	Uwemba	0.8	Hydro
	Subtotal	**561.8**	**Hydro (36.3%)**
IPPs	Ubungo gas 1 Ubungo gas 2	102 105	Gas Gas
	Tegeta	45	Gas
	Mtwara Gas Plant Somanga Gas Plant	17.75 7.5	Gas Gas
	Subtotal	**277.25**	**Gas (17.95%)**
	Small diesel Generator	89.076	Diesel (5.77%)
	Subtotal	**89.076**	**Diesel (5.77%)**
	Songas SYM UB GP	189 60	Gas Gas
	Subtotal	**249**	**Gas (16.12%)**
	IPTL	103	Diesel
	AGR (UB) AGR (TG)	50 50	Diesel Diesel
	SYMB UB JET A	60	Diesel
	SYMB (ARU) SYMB (DOM)	50 55	Diesel Diesel
	Subtotal	**368**	**Diesel (23.82%)**
	Grand Total	**1545.13 MW**	

Tanzania's power generation facilities are located primarily in the south of the country, while the demand is concentrated in the north, northwest and east (see Figure 3), where a majority of the commercial centers and industries are located. The transmission system infrastructure is inadequate and prone to system interruptions.

Figure 3: National Grid System



The capacity for generation of electricity by different suppliers who feed the national grid, and the sources of this energy is given in Appendix 4.

The administrative regions of TANESCO, generally follow the political administrative regions in Tanzania. The Dar es Salaam region however, due to its high population is composed of four TANESCO Regions. There are two areas that are not part of the national grid, the western regions of Kagera, Kigoma and Rukwa and the Southern-Eastern regions of Lindi, Mtwara and Ruvuma. The current power system development plan is to ensure that these regions are connected to the grid by the year 2019. These regions offer a comparatively larger potential market for solar lighting products.

3.3. Power System Development Plans

The Ministry of Energy and Minerals (MEM) has a Power System Master plan, which has outlined the development plans for electrification in the country. It works together with the public utility company TANESCO, the Rural Energy Agency, and a number of other stakeholders including MFI's, donors, and NGO development partners. The short-term power generation plans include developing 1120 MW in the period 2013 to 2017. The mid to long-term power development strategies (2018 – 2035) include developing additional sites for renewable power generation, accelerating coal usage for power generation, and exploiting additional natural gas deposits. Appendix 4 further displays some of the target power system development plans of the Tanzanian government.

These power system development plans will take a long time to satisfy current energy needs, including those for lighting. That means that in the interim the demand for alternative lighting will still be high.

3.4. Rural Renewable Energy Projects

Potential energy resources for off-grid electrification available for investment include Geothermal Energy, Biomass Energy, Solar Energy, Wind Energy and Small Hydropower. For rural electrification the development of the projects in Tanzania is coordinated through the REA.

Through the Tanzania Energy Development Access Project (TEDAP), five small hydropower projects have been provided with matching grants for pre-investment studies. The REA has identified small hydropower projects that are eligible for carbon financing through the Clean Development Mechanism (CDM), implemented capacity building for prospective developers of CDM projects, and implemented a Program of Activities (PoA) to aggregate small projects in one application. The Government of Tanzania has signed an agreement with the World Bank to advance up to 5% of capital investment to developers, which will be recovered from revenues accrued from the selling of Certified Emission Reductions (CER). This is a positive development towards increased access rate for the BOP consumers.

Assessments for small hydropower for off-grid rural electrification have been conducted since 2005 by the Ministry of Energy in collaboration with TANESCO. The magnitude of small hydropower potential has increased from 390MW to 475MW (sites assessed so far). Some sites have very attractive potentials with simple lay-outs to develop. But so far, only 15MW have been developed and mostly by religious missions.

Table 3 presents a summary, obtained from the REA, of small hydropower potential projects that are available for investments through partnership and co-financing with local or other foreign investors. The potential small hydropower plants with estimated capacity of 190 MW will provide more than 100,000 off-grid connections. A more detailed list is included in Appendix 4.

Table 3: Rural electrification projects for investment

Number of projects	Total Potential capacity (MW)	Status	Potential new connections
33	145	Pre-feasibility /Feasibility Study	46,234
8	6.34	Under Construction/Construction to start	30,729
14	5.9	Needs Rehabilitation/Expansion (Some closed down, some operating)	4,340
13	32.4	Potential identified	20,200
68	**189.64**		**101,503**

As for solar projects, TEDAP is financing 100% of public solar facilities, while REA provides a 2.5USD/Wp performance grant for the private projects. Under this scheme, the Sustainable Solar Market Package (SSMP-Phase I) with a pilot project in 81 villages in the Sumbawanga District, Rukwa Regionn has been facilitated. Currently this facility (SSMP-Phase II) is now being extended to eight additional districts across the country. The districts involved include: Bukombe, Sikonge, Chato, Biharamulo, Kasulu, Kibondo, Tunduru, and Namtumbo. The program is involved in installation, provision of maintenance and spare parts, and conducting training of end users and off-takers for public facility solar photovoltaic (PV) systems and street lights. The program also includes commercially marketing, selling, installing and enabling access to after sales service for a number of PV systems and products for private customers. A solar lighting component being implemented by TEDAP is funded at USD 1 million and officials from REA have confirmed that TEDAP has achieved its objectives. The TEDAP project as a whole, which amounts to a total of USD 22.6 million, is scheduled to terminate in March 2015. TEDAP projects are considered to be “participatory” since most of the projects were proposed by local communities from the area where the project was to be implemented.

Other projects that target rural and peri-urban households mentioned by the respondents include:

(a) The proposed SNV Tanzania project supporting lighting entrepreneurs–independent project for Pico solar in Mwanza, result-based financing to promote the solar market in the country;
(b) SNV supports TEDAP's biogas sector awareness program;
(c) SNV supports TAREA in expanding and implementing its mandate; e.g. in promoting awareness of quality energy efficient/services and renewable energy programs among the population. The support is mainly in the technical areas involving expert human resources in conducting awareness campaigns;
(d) Research for Poverty Alleviation (REPOA) is coming up with energy policy research to advise the MEM on an energy sector reform/plan since the current energy policy is 10 years old with few changes. The research will focus on infrastructure development and investment in renewable energy.

4.0. BOTTOM OF THE PYRAMID CONSUMER PROFILE

4.1. Rural and Peri-Urban Populations

A 2012 census report published by the National Bureau of Statistics (NBS)[14] shows that the Tanzanian population has tripled in the last 45 years, from 12.3 million to 44.9 million, with an annual growth rate of 2.9%, with a 1.05:1 ratio of women to men respectively.

Geographically, Tanzania is an expansive country, and its regions and residents vary greatly. The country covers an area of 945,203 square Kilometers, with a population density of 51.06 per square kilometer (July 2013 estimate). Urban centers have higher population growth rates, while the household size in rural areas is biggest — — Dar es Salaam has the highest annual population growth rate, which stood at 5.6 percent in the period 2002 – 2012 and currently has 4.4 million people, and Simiyu has the highest average household size at 7. There are 120 tribes in Tanzania, and the sizes of their populations vary (from 5.5 million of the "Sukuma" tribe to fewer than 50,000 for others). The BOP energy consumer resides mainly in rural and peri-urban areas. The majority of the people are Christians and Muslims, and a few have indigenous beliefs and some are Hindus. The annual average household size has remained constant compared to the population growth and the population for women slightly exceeds that for men).

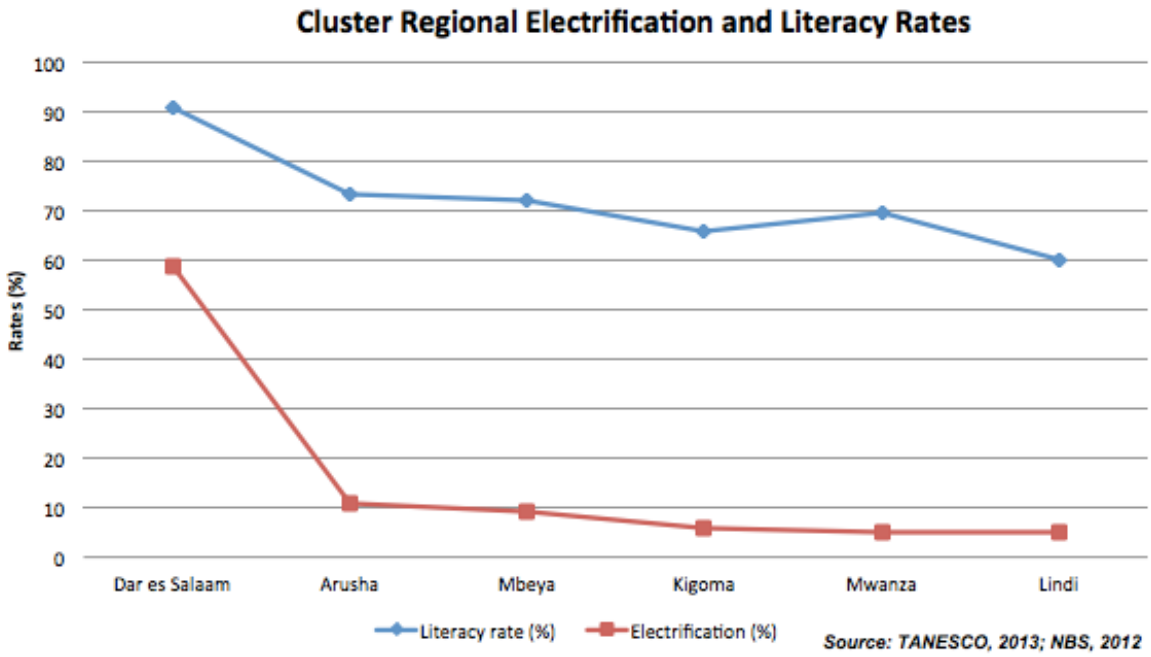
In 2002 women in Tanzania were twice as likely as men to have no education at all; over one third of women in rural areas had little or no education[15]. Fortunately this has changed over time. Due to universal education reform and women's participation in innovative microenterprises, women have become more empowered and are now occupying high-level ministerial positions. What has not changed is the male-dominated household, and the low literacy rates among young women, especially in rural areas, where access to electricity is also low (see Figure 4). A 2010 Health Demographic Study by NBS shows a 3:1 ratio for male to female heads of households, and 72% of women and 82% of men are literate — this is a slight change from the 67% and 80% women and men literacy rates in 2004. In terms of rural-urban disparities, the literacy rates for women and men in rural areas are lower compared to urban areas.[16]

[14]National Bureau of Statistics indicated a rapid population growth in the urban areas — Dar es Salaam has the highest growth rate at 5.6% in the entire country, however a large portion of the population of Tanzanians live in rural areas (NBS, 2012).

[15](NBS, 2002),

[16](NBS, 2011).

Figure 4: Cluster Regional Electrification & Literacy Rates



Looking at Figure 4, it can be observed that access to electricity correlates with the rate of literacy, for example Dar es Salaam, with the highest access rate of 59%, has approximately a 91% literacy rate. Arusha, which follows with an electricity access rate of 11%, has a literacy rate of 73%. The Linda region, which has the lowest access rate with 5% also has the lowest rate of literacy, which is 60%.

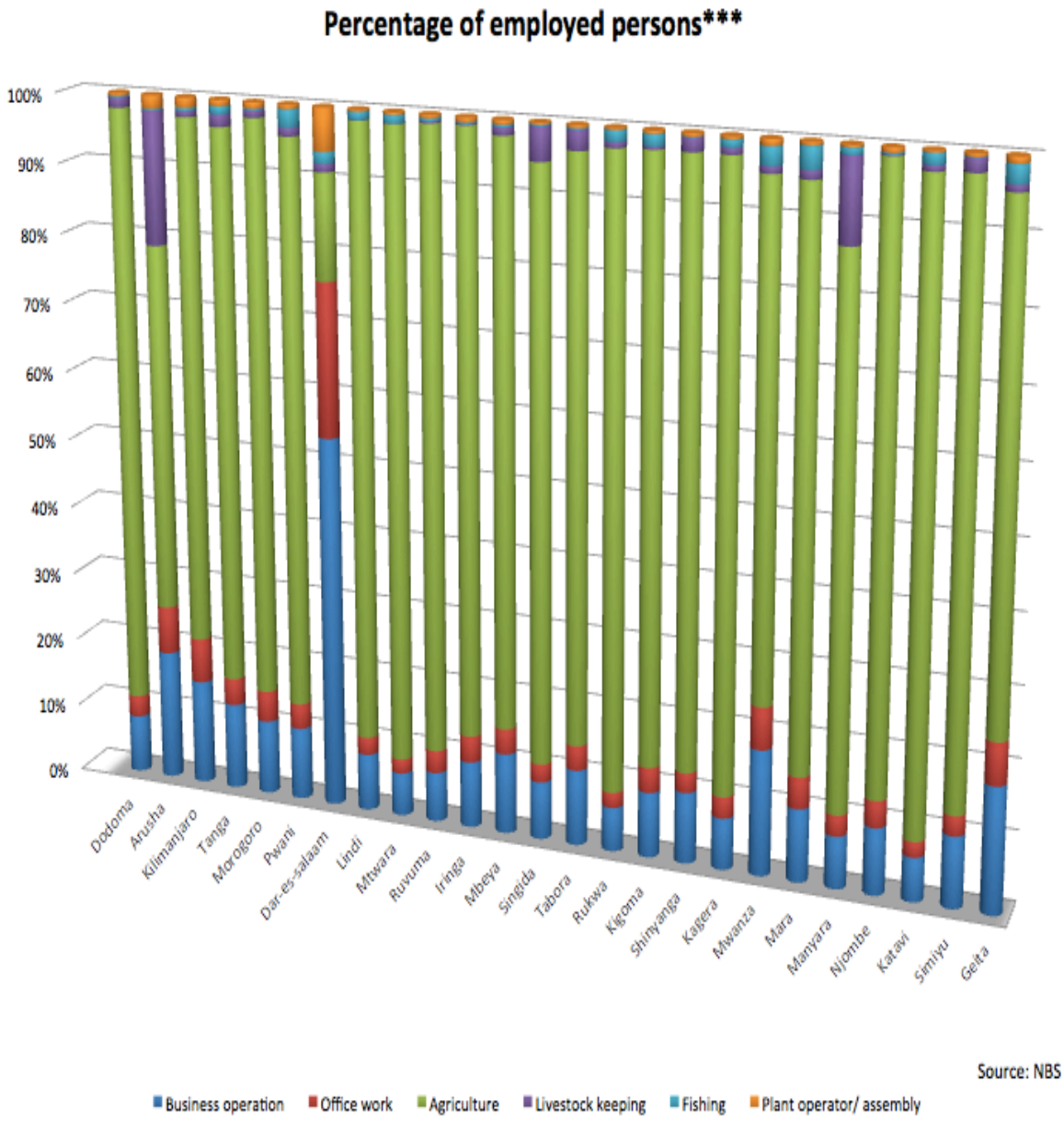
The majority of the rural and peri-urban participants in the Focus Groups conducted as part of this study indicated that the lack of energy services is part of an overall problem in the country of inadequate social and economic services, particularly reflected in the underdeveloped infrastructure for roads and water supply, schools and healthcare centers. Apart from looking for income generating opportunities, better access to electricity and water are the two primary contributors to rural-urban migration.

4.2. Income Generation among BOP

A considerable portion of Tanzania's population lives in the arid and semi-arid regions of the country, relying mostly on livestock and food production in order to generate income (see Figure 5**)**. Seasonal droughts and floods impact the country's agricultural-based occupation hence income generation is climate dependent. More than 74% of Tanzania's workforce is involved in agriculture, which contributes 25% of GDP.[17]

[17](Gicharu &Juma, 2011).

Figure 5: Percentage of Employment by Occupation and Region



Source: NBS (2012)

The average per capita income for a BOP household is less than USD150 or TSh 245,550[18]. Urban areas have a higher income per capita with earnings from both public and a wide range of private sector institutions while the rural area earnings are dominated by the public sector and agricultural activities. The BOP consumer in Tanzania includes

[18](NBS, 2012)

rural and peri-urban households. Many BOP families rely on income from small-to-medium size enterprises that earn less than the average per capita income for a household. Most of the BOP households in rural areas engage in the following income generation activities: farming, livestock, fishing, artisanship and micro-enterprises. The majority of peri-urban dwellers engage in the same activities with a minority finding employment in the formal sector such as teaching (elementary school) and nursing. The time spent on and concentration of earnings from these activities varies. For example, farming is seasonal and involves initial preparation of the land through clearing and tilling (manual), sowing, weeding and finally harvesting. What follows is storage and for maize crops, shelling, and finally sending some of it to the market to sell and earn money, while the rest is for family consumption. Farmers, therefore, obtain the bulk of their annual cash income during the harvest seasons. Most of the BOP income generating activities are part of a daily routine and involve working during most of the daytime hours.

Men dominate the formal employment sector, whereas most women earn their income as entrepreneurs in the informal sector, and this is more evident in the rural areas — most SMEs in Tanzania are owned by women. The male-female earnings disparity is noticeable, since women spend a large portion of their day on labor intensive, time consuming tasks at home or in the field (agriculture). This opportunity cost of time is linked to the over-reliance on biomass for lighting, cooking and heating in rural areas. From a very young age women spend an average of 6 hours per day collecting wood fuels for household usage, which takes away time that could be used for education and other self-improvement (productive engagement) activities that could lead to economic advancement for them and their families.

The incomes generated vary considerably depending on what activity is being undertaken, but it is generally low and provides only a subsistence living for most households. Certain regions have better agro-environments enabling those living there to obtain bigger incomes. For example, Mbeya rural families cultivate the cash crop coffee and are thus able to obtain higher revenues than other regions dependent on less marketable commodities. Both men and women collaborate to bring income into the house, even children participate in income generation when not in school, e.g. assist parents to sell fruits and vegetables in the market.

The population demographics broken down by regions are shown on the Table 4 below.

Table 4: Tanzania Population Broken Down By Regions

SN	REGION NAME	TOTAL	MALE	FEMALE	HOUSEHOLD SIZE	POPULATION GROWTH(2002-2012)
1	Dodoma	2,083,588	1,014,974	1,068,614	4.6	2.1
2	Arusha	1,694,310	821,282	873,028	4.5	2.7
3	Kilimanjaro	1,640,087	793,140	846,947	4.3	1.8
4	Tanga	2,045,205	992,347	1,052,858	4.7	2.2
5	Morogoro	2,218,492	1,093,302	1,125,190	4.4	2.4
6	Pwani	1,098,668	537,826	560,842	4.3	2.2
7	Dar-es-salaam	4,364,541	2,125,786	2,238,755	4.0	5.6
8	Lindi	864,652	414,507	450,145	3.8	0.9
9	Mtwara	1,270,854	599,648	671,206	3.7	1.2
10	Ruvuma	1,376,891	668,684	708,207	4.5	2.1
11	Iringa	941,238	452,052	489,186	4.2	1.1
12	Mbeya	2,707,410	1,297,738	1,409,672	4.3	2.7
13	Singida	1,370,637	677,995	692,642	5.3	2.3
14	Tabora	2,291,623	1,129,730	1,161,893	6.0	2.9
15	Rukwa	1,004,539	487,311	517,228	5.0	3.2
16	Kigoma	2,127,930	1,028,994	1,098,936	5.7	2.4
17	Shinyanga	1,534,808	750,841	783,967	5.9	2.1
18	Kagera	2,458,023	1,205,683	1,252,340	4.7	3.2
19	Mwanza	2,772,509	1,360,381	1,412,128	5.7	3.0
20	Mara	1,743,830	840,020	903,810	5.6	2.5
21	Manyara	1,425,131	717,085	708,046	5.2	3.2
22	Njombe	702,097	329,359	372,738	4.1	0.8
23	Katavi	564,604	279,682	284,922	5.5	3.2
24	Simiyu	1,584,157	759,891	824,266	6.9	1.8
25	Geita	1,739,530	861,055	878,475	6.1	2.6
26	Kaskazini Unguja	187,455	92,114	95,341	4.8	3.2
27	Kusini Unguja	115,588	57,880	57,708	4.4	2.0
28	Mjini Magharibi	593,678	283,590	310,088	5.2	4.2
29	Kaskazini Pemba	211,732	103,222	108,510	5.3	1.3
30	Kusini Pemba	195,116	93,871	101,245	5.4	1.1

Source: NBS Tanzania Population Census 2012

4.3. Household Budget

The following estimates are based on the market information collected during Focus Group discussions. The samples selected were of households representing the typical socio-economic clusters of mainland Tanzania. The figures presented are, however, indicative of the BOP rural and peri-urban households.

The average rural household has 4 to 6 family-members, while a peri-urban household usually consists of 2 to 4 family-members. Within the typical BOP household, men are viewed as the head of the household in the vast majority of cases and are expected to provide income (mainly in terms of monetary funds) for the family, while women manage the household activities (which in many cases could be worth more in monetary terms if their engagement in day-to-day household activities were paid). Ultimately, women decide on household budget spending, although in most cases the decision-making is a collaborative effort within the family and at times even involves children in an active role with a real voice. There is little financial planning and thus a lot of uncertainty about household budget spending, in part due to the seasonality of agricultural earnings. Due to the irregular amount of income earnings throughout the year, the market introduction of any new technologies should consider the period when the households' earning value is better compared to other regular times. The composition of family members also determines the household budget.

Typical daily expenses for food bought by cash for rural households total about USD1.25 (TSh 2,000) and about USD12.50 (TSh 20,000) for urban households for at least 2 main meals for a family of size seven. Part of the discrepancy in expenses is because rural households typically produce a major portion of their own food and therefore spend money only on additional items such as animal protein and sugar. BOP households normally buy most food items on a daily basis, and not in bulk. This is especially true for peri-urban families, while rural families tend to store part of the harvest for consumption for as long as it will last, before they start buying more. For example, maize is stored in its seed form and when the time comes the women go to the millers to grind it into flour. Daily food purchases may therefore be for cooking oil, vegetables, etc.[19]

Other normal daily expenses include energy for cooking and lighting, water, schooling, health, and transport. Apart from energy, the other expenses vary from place to place depending on factors such as individual school requirements, type of health institution and distance from school/work place. The main sources of energy are charcoal, firewood, and kerosene with rural families obtaining free firewood from forests, typically at considerable and increasing distances from their homes due to deforestation. The average daily expense for kerosene, which is mostly used for lighting devices is about USD0.50 (TSh 800). Peri-urban households mostly use charcoal for cooking and heating, which is purchased at between USD0.60 (TSh 1000) and USD1.25 (TSh 2000) for their daily needs. When it comes to water services, these are by far the most inadequately supplied in both rural and peri-urban areas. Most peri-urban households have limited access to the water pipeline, and even when connected, water is not supplied frequently. Many end up purchasing water from street vendors or from individual suppliers (carrying water usually pumped from deep wells). Vendors charge higher costs which often are about USD0.30 for a 20-liter container. This

[19] In this section an FX of USD 1= TSh 1600, was applied which, was the average exchange rate prevailing between the buying and selling of a USD (LAMIM) as of September 10, 2013.

also applies to rural areas where households have very little access to water services, though street vendors in rural areas are mainly located in villages.

As shown in Table 5 below, a large portion of the typical rural and peri-urban household budget goes to energy fuels like kerosene (discussed further in this report — economics of lighting section). After food expenses, the next highest portion of the household budget is allocated for lighting and water expenses, followed by spending on education and healthcare services. Unlike rural dwellers, which grow and store their own food, peri-urban dwellers have to buy food on a daily basis. Also unlike rural dwellers, who live on their own farmland property, peri-urban dwellers usually rent a home and have more expenses in proportion to their incomes. However, most peri-urban dwellers do have some monthly surplus disposable income, on average (as shown in the analysis in Table 5) is TSh 90,000 (roughly USD55). This is due to their having higher primary and supplementary incomes and more opportunities for engaging in micro-enterprise activities. The analysis in Table 5 indicates that rural households on average have no surplus disposable income.

In terms of lighting solutions, rural areas have limited options for lighting devices even compared to peri-urban areas. Urban dwellers find the most choices, as the highest influx of sustainable technology and environmental infrastructure services are found in Tanzania's cities.

Table 5: BOP Household Budget (Monthly in TSh)

Rural family					Peri-urban family				
Item	**Income**	**Item**	**Expenditure**	**% of Total budget**	**Item**	**Income**	**Item**	**Expenditure**	**% of Total budget**
Average sale of cash crops /micro enterprise e.g. tailoring, petty trading	65,000	lighting	25,000	23.8%	Micro enterprise (carpentry, tailoring, general trading, etc.	360,000	lighting	30,000	7.3%
Average sale of food crops/diary product	40,000	Food*	60,000	57.2%	Petty trading	50,000	Food	180,000	43.9%
		Water	N/A				Water	10,000	2.5%
		Rent	N/A				Rent	20,000	4.9%
		Energy for other uses (firewood, charcoal, LPG, etc.)	10,000	9.5%			Energy for other uses (firewood, charcoal, LPG, etc.)	60,000	14.6%
		Other expenses (transport, school, medical, etc.)	10,000	9.5%			Other expenses (transport, school, medical, etc.)	20,000	4.8%
Total	105,000		105,000	100%		410,000		320,000	78%
Surplus/deficit			0					90,000	22%

* The value of the self-grown food they consume has not been taken into account, only additional items (although most of the rural families stated their daily food requirements in monetary terms if they had to purchase it). .

Contrary to popular belief, rural and peri-urban populations are not necessarily 'poor' (per capita income of less than USD1 per day) and some in fact have valued assets (i.e. land and livestock depending on the region) and due to the frugality of rural life, they sometimes accumulate considerable savings. Their monthly earnings opportunities

however, might be limited and seasonal, which affects their disposable income. There is a growing number of SMEs engaged in a broader array of activities than ever before in these areas, which means that household budgets can be expected to expand in the coming years.

The amount spent on lighting fuel per month, by a typical BOP household (USD9 rural and USD18 peri-urban) is more than enough to purchase a solar lighting device if payments are apportioned over a reasonable period (i.e. with financing). For example, a lantern costing USD30 will require a monthly remittance of USD5 for six months. With rising amounts of disposable income already spent on existing, poor lighting options, the economics of new alternatives look attractive on a life cycle basis. Although the analysis in Table 5 indicates that peri urban households should have enough surplus disposable income to elect to purchase alternative lighting products without any financing, both peri-urban and rural household participants indicated a high willingness to purchase these products only when financing was offered. The willingness of consumers to pay for alternative lighting products, as well as the type of financing needed, are addressed in Sections 6 and 7 of this report.

5.0. EXISTING LIGHTING SOLUTIONS

5.1. Common Lighting Options

Households in Tanzania use various lighting devices as an alternative to conventional grid electricity. The existing lighting solutions for households and SMEs are summarized in Tables 6 and 7. The existing lighting options for off-grid BOP households are mostly tin lamps (commonly known as "koroboi"); kerosene hurricane lamps (chemli); dry battery powered LED torches; candles; and to a smaller extent, solar lighting. However, the latter is becoming popularized in many areas at increasing rates due to promotion efforts made by NGOs and private solar dealers. Such regions include Mwanza, Mara, Geita, Arusha, Kigoma, Tanga, Dares Salaam, and Mbeya. A few households that are relatively well off, also use generators or solar home lighting systems as alternatives.

Table 6: Existing Lighting Solutions and Costs

Lighting Device	Energy source	Proportion of households (%)	Cost of device (typical)	Average cost of operations per month	Annual operating costs
Grid electricity	TANESCO	21.0%	USD300.00 up front for installation	USD10.90	USD130.80
Generators	Fossil fuel	4.8%	USD150.00 – 1,250.00	USD56.25	USD675.00
Tin lamp without cover	kerosene	27.0%	USD0.30 – 0.60	USD1.50	USD18.00
Hurricane lamp	kerosene	37.2%	USD4.98	USD5.90	USD70.80
Torch (non solar)	Dry batteries	19.3%	USD1.20	USD3.90	USD46.80
Candles	wax	17.9%	USD0.20	USD1.10	USD13.20
Solar torch*	Solar	1.3%	USD6.00 – 15.00	Negligible	USD0.30
Solar lanterns*	Solar	1.1%	USD15.00 -40.00	Negligible	USD0.90
Solar home lighting systems	Solar	1.6%	USD50.00 – 250.00	Negligible	USD2.50 – 12.50

Source: Household and SMEs survey (GreenMax 2013); *Focus groups and household surveys

For SMEs, the lighting solutions are similar at the lower end, but due to some having greater lighting needs, they are more likely to use somewhat more costly lighting solutions such as generators. For example, 12.3% of the SMEs use generators in comparison to only 4.8% of households, and 7.6% of SMEs use SHSs compared to only 1.6% of households.

Table 7: Existing Lighting Solutions used by Micro and Small Enterprises and their Costs

Lighting Device	Energy source	Proportion of SMEs (%)	Cost of device (typical)	Average cost of operations per month	Annual operating costs
Grid electricity	TANESCO	66.8%	USD300.00 up front for installation	USD16.13	USD193.60
Generators	Fossil fuel	12.3%	USD150.00 – 1,250.00	USD56.25	USD675.00
Tin lamp without cover	kerosene	3.0%	USD0.30 – 0.60	USD2.40	USD28.80
Hurricane lamp	kerosene	18.2%	USD4.98	USD6.45	USD77.50
Torch (non solar)	Dry batteries	16.9%	USD1.20	USD2.60	USD30.90
Candles	wax	4.7%	USD0.20	USD1.10	USD13.20
Solar torch*	Solar	2.1%	USD6.00 – 15.00	Negligible	USD0.30
Solar lanterns*	Solar	2.5%	USD15.00 -40.00	Negligible	USD0.90
Solar home lighting systems	Solar	7.6%	USD50.00 – 250.00	Negligible	USD2.50 – 12.50
Other		0.4%			

Source: Household and SMEs survey (GreenMax 2013) *Focus group and MSME surveys

The extent of penetration of the different lighting alternatives as deduced from the consumer and SME surveys is provided in Table 8.

Table 8: Proportion of the Sample Using the Following Lighting Devices

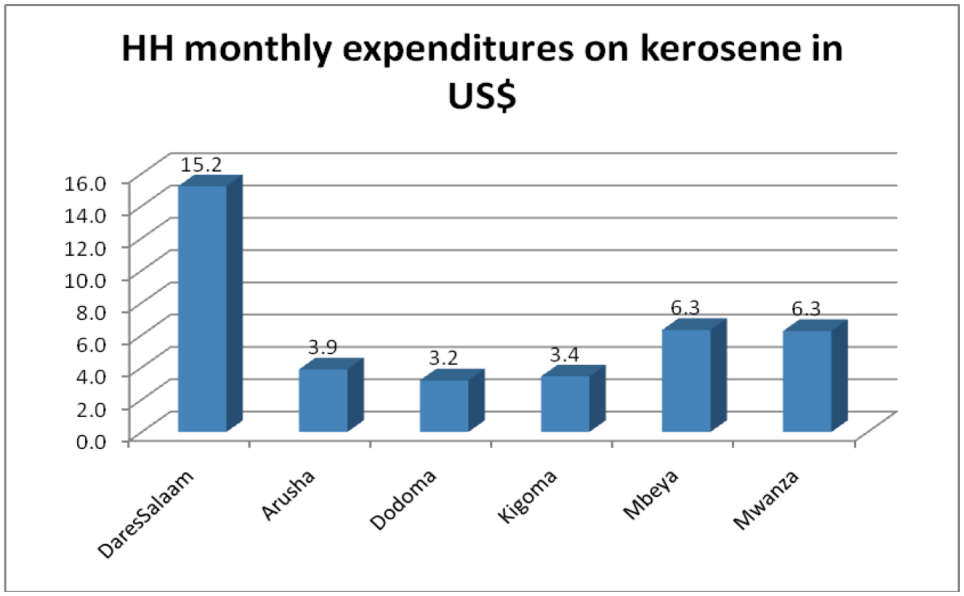
Households (374 total)									
Device used	Generator	Lanterns	Tin lamps with wick	Candles	Dry battery Torch	Solar Torch	Portable solar lanterns	Solar home system	Other
Number	18	139	101	67	72	5	4	6	0
Percent	4.8	37.2	27.0	17.9	19.3	1.3	1.1	1.6	0
Micro Enterprises (236 total)									
Device used	Generator	Lanterns	Tin lamps with wick	Candles	Dry battery Torch	Solar Torch	Portable solar lanterns	Solar home system	Other
Number	29	43	7	11	40	5	6	18	1
Percent	12.3	18.2	3.0	4.7	16.9	2.1	2.5	7.6	0.4

Source: Household and MSME survey (GreenMax 2013) Total sample size HH = 374.total sample size MSMEs = 236

Only one respondent in this sample, from the Dar es Salaam region, indicated using "other" devices. Previous studies however, indicate that the alternative devices used by a very small fraction of the Tanzanian population include gas lamps, car batteries, pressure lamps and lamps powered by biogas. The focus groups revealed that people in rural areas typically utilize firelight as a natural lighting source, especially in kitchens. This includes the "urumoli," which are used by Kigoma rural residents. The "urumoli" is a shrub of grass that, when lit, provides a temporary light that is bright enough to facilitate a small task. The Maasai in the Arusha rural area often use burning strips of motor vehicle tires for lighting, and scaring off wild animals, especially hyenas.

Figure 6 below shows the level of household kerosene expenditures differentiated by regions.

Figure 6: Mean Monthly Household Expenditure on Kerosene by Region



Source: Household and MSME survey (GreenMax 2013)

5.2. Characteristics of the Prevalent Lighting Options for the BOP

The focus group study revealed that lighting is used for the following tasks:

- Preparing dinner for the family
- Kitchen and dining room chores
- Caring for infants and small children, especially at night

- Caring for the sick
- Operating SMEs
- Self-care and personal hygiene
- Reading

The four types of devices that are most prevalent in the BOP households are shown in Figure 7**.** The tin lamp is used predominantly in the kitchen for BOP consumers, and are also used in the main building or rooms for most rural households. This is the cheapest of these four types of lighting devices, both in terms of up-front cost and in the use of kerosene fuels. The light quality is, however, considered very poor and it poses numerous health and fire hazards. From an environmental perspective, the tin lamp is an unsuitable device since it uses fossil fuels and pollutes the environment considerably.

Hurricane lamps are used to light the living rooms and bedrooms although economically better off families use them in the kitchen as well. The light quality is considered better than the tin lamp and presents less of a fire hazard, although participants said that these lamps can explode at times. The few families that have electricity (national grid) often use these when there are power shortages. Some families may have both a koroboi and a hurricane lamp, but the latter is used only on special occasions. As one participant put it:

> *"Even some of us who have hurricane lamps use them only on special occasions, such as when visited by guests, or during wedding ceremonies, or during funerals."* – ***elderly male participant Dar es Salaam rural***:

Figure 7: Current Common Lighting Devices in Rural and Peri-Urban Markets

Tin Lamps (Koroboi)	Hurricane Lamp	Dry cell powered LED Torch	Candle
			
Commonly known as 'Koroboi' or 'Kibatari' – the most popular and affordable lighting option, used primarily in the kitchen and by SMEs	Commonly known as 'Chemli' – not as affordable as tin lamps, used primarily in the living room/ dining area, used by SMEs and social institutions	Commonly known as 'Mchina' – a bit more expensive than the kerosene lamps, often used by young people and school children for reading, also preferred by SMEs	Commonly known as 'Mshumaa' – same price and sometimes cheaper than tin lamps, used primary in the bathroom and bedroom
Kerosene fuel	Kerosene fuel	LED batteries	No fuels or batteries

Candles made of wax are more costly and are often used as a backup when tin or kerosene lamps are out of fuel. Their light quality is slightly better than that of the tin lamp but they are the most dangerous in terms of fire hazards and also expire quickly, making them very expensive to use.

Dry cell powered LED torches are used primarily in living rooms and bedrooms; mostly by some relatively better off BOP consumers. The quality of light is considered to be the best among the four alternatives and they are relatively much more efficient in their energy usage. Specific applications for these torches have been described to include students who use them to do their studies and people who have small businesses that require lighting in the evening.

Some of these torches which are already in widespread use today in Tanzania are of poor quality and short duration. They do not pollute the environment like kerosene-fueled lamps, but battery and device disposal creates environmental challenges.

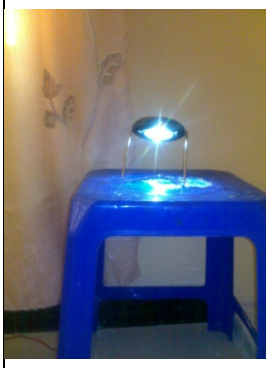
The BOP consumers surveyed in this study rely mostly on local retailers or vendors for purchasing their current lighting devices, while for torches are purchased mostly only from vendors. The sales terms are generally straight cash and in a few cases, these retailers or vendors offer short term credit on a familiarity basis. The interest charged on vendor credit is described by one energy consumer as follows:

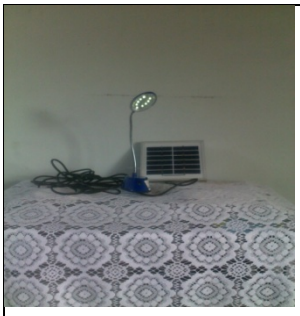
*"They offer to sell to you a product for 10,000 shillings (about USD6) if you pay straight away or 15,000 shillings (about USD9) if you pay it in three monthly instalments" – **Mwanza rural** (older cohort)*

5.3. Alternative Lighting Devices in the Tanzanian Market

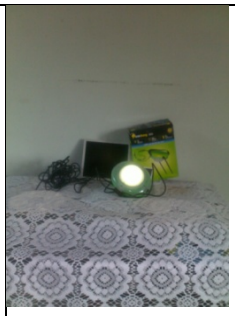
There are a variety of alternative lighting devices to be found in the market for lighting products in Tanzania. The focus group part of this study, however, focused only on those devices that have the potential to be adopted by the BOP population, due to their economic and other advantages to this section of the population. Lighting devices using solar energy were acquired and used for demonstrations in the focus groups in an approach typical of product sampling conducted by marketing researchers. The type and characteristics of the devices used in the study are illustrated in Figure 8.

Figure 8: Sample of Alternative Solar Lighting Products in the Tanzanian Market

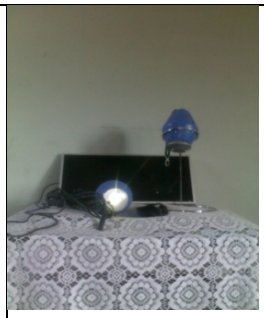
Lantern 1 *	**Lantern 2***	**Lantern 3**
		
Features: Built-in solar panel, portable, small desk stand, bright light (4 hours when fully charged)	Features: Built-in solar panel, portable, lightweight, two settings	Features: two state light intensity, mobile phone charger



Lantern 4*
Features**:** separate 1.5 W solar panel, 3 settings, mobile phone charger



Lantern 5*
Features**:** separate 700 mW solar panel, portable, lightweight, and multipurpose



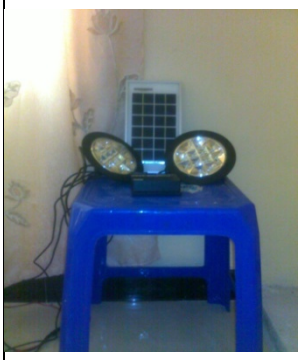
Lantern 6*
Features: desk lamp, wall lamp, ceiling lamp, hand torch; 2.5 W solar panel; 2 multi-lamp connection; charge indicator (green – fully charged); extra solar torch with remote switches to control the other lanterns; 4 brightness selections; mobile phone charging

Lantern 7
Features: flexible reading lantern, separate 500 mW solar panel

SHS 1*

Features: 3.2 V 12 SMD; 2.5 W solar panel; 3.3 Ah battery; 2 LED lamps; multifunctional mobile phone charger; two extension cables with switches; radio connection

SHS 2



Features: 18 working hours; 2 LED lamps; multifunctional mobile phone charger; two extension cables with switches; radio connection.

LED 2

Features: Analogue adjustable brightness; adapter for grid electricity

LED 1

Features: dual power source; built-in solar panels

LED 3

Features: AA batteries; adjustable brightness (analogue)

The Focus Groups examined the preferred model and criteria used by participants to categorize preference towards the alternative lighting samples. One or two of the following criteria emerged as salient for each group:

- Light quality – brightness, light intensity
- Usage purposes – kitchen versus living room, reading, etc.
- Multi-functionality - multiple tasks vs. single function
- Cost of the device – affordable vs. expensive
- Portability – portable versus fixed
- Quality of device – low or high (based on appearance)

Many Focus Group participants categorized the solar devices using a combination of two criteria. The most popular criterion for segmentation was usage purpose. This was indicated in seven of the Focus Groups. The next most popular criterion for segmentation was the quality of light in terms of brightness; this was selected as most important in five of the Focus Groups. The criteria used by each Focus Group according to their locations are summarized in Table 9.

Table 9: Criteria Used For Grouping the Solar Lighting Products

Cluster	Rural	Peri-urban
Kigoma	Usage purpose & light intensity	Quality of light & usage purpose
Mbeya	Multi-functionality and usage range	Light quality and multi-functionality
Lindi	Brightness and portability	Brightness and portability
Arusha	Usage purpose and light intensity	Usage purposes
Dar es Salaam	Light brightness and quality of device	External vs. built-in solar panel
Mwanza	Suitability of usage for particular tasks	Usage purpose and perceived cost of device

Grouping the products according to their utilization reflects an underlying motivation by these groups for selecting lighting products based on a task orientation -- the specific application(s) that the lighting device would be used for. The criterion of utilization purpose was closely linked with the multiple functions that a device could perform, which included phone charging and radio connections. This was highlighted as a group criterion in all regions except Lindi and Dar es Salaam where light brightness is seen as the major criterion.

The implication of these observations from a marketing stand point center mainly on (a) product preferences in relation to lighting product characteristics; and (b) marketing strategy formulation by the supply chain actors

(a) Product preferences

BOP consumers need lighting devices for clearly defined end uses, and therefore preferences for particular categories and/or models will be influenced by how well such devices help in accomplishing those tasks. For example, light quality and usage purposes are clearly prime attributes in selection. Suppliers should not expect to find customer satisfaction with products having poor light quality. Other important attributes include multi-functionality, affordability, portability and the quality of the device itself. Product appeal is enhanced considerably when the device can do other functions such as phone charging.

(b) Marketing strategy formulation

Product design is implied strongly here in terms of what should be produced in order to satisfy consumers' needs and expectations. Innovative designs such as those where devices can charge different types of phones give an extra competitive advantage. Market segmentation and targeting is also important as the different regions appeared to put more emphasis on particular attributes in comparison to others. Thus, depending on the location, suppliers should position particular models for specific usages. For example, a portable lantern that is not too bulky could be promoted as "suitable in the kitchen, for dining, and to rush to see the baby in the bedroom" for consumers in a Mwanza rural location. The affordability concern cuts across most BOP consumers and highlights the importance of providing financing in any large-scale marketing rollout of alternative lighting devices.

6.0. LIGHTING ECONOMICS

6.1. Comparative Life Cycle Costs of Lighting Solutions

In Tanzania, the cost of accessing grid-connected electricity is on average higher for BOP consumers than for middle to high-income households, although the differential varies. This is mainly due to the variable costs of bringing new connections to rural and peri-urban areas depending on proximity to the existing grid. The 2011 cost-analysis study on energy spending performed by Maliti and Mnenwa shows that when doing a comparison based on up-front costs, the cost of electricity is far higher than that for kerosene (see Table 10). The cost of using electricity (the expensive cost category) is 16 times higher than the costs for using kerosene (in a similar cost category), this is due to higher fixed costs which are associated with electricity transmission[20].

Table 10: Cost Comparison of Energy Sources

	Electricity		Kerosene	
Upfront Costs	**Cheapest Cost**	**Expensive Cost**	**Cheapest Cost**	**Expensive Cost**
Fixed Costs **(TSh)**	310, 295	377, 045	5,500	13,250
Recurring Cost **(TSh)**	79,411	79,411	14,840	14,840
Total (TSh)	**389, 706**	**456,456**	**20,340**	**28,090**
Annualized Costs	**Cheapest Cost**	**Expensive Cost**	**Cheapest Cost**	**Expensive Cost**
Fixed Costs **(TSh)**	37,816	43,933	637	1,660
Recurring Cost **(TSh)**	79,411	79,411	14,840	14,840
Total (TSh)	**117,227**	**123,404**	**15,477**	**16,500**

Source: Cost of Electricity, Kerosene and Liquefied petroleum Gas in Tanzania, Maliti and Mnenwa (2011)

A further analysis of electricity affordability based on income level shows that for the upfront cost of electricity, there's a TSh 66,750 (~USD41) difference between the cheapest and the most expensive electricity options, which is a very significant spread. Regardless of the subsidies for households located far from power lines (mostly rural or peri-urban) intending to install connections, the amount is still very high to be affordable for most BOP[21]. Given the high electricity prices, even in the cheapest scenario the cost of kerosene is only 13% of the cost of electricity. With this analysis, grid connected electricity is in fact not an attractive option for BOP consumers — even if it is available, the customer will opt for kerosene because it's the cheaper option. Therefore the BOP consumer will do better economically with off-grid lighting alternatives, making them a suitable target market segment even in areas targeted for grid connections.

A comparison of costs of lighting products from previous Lighting Africa demographic studies in Tanzania in 2008[22] with the current study is reflected in Table 11. As shown in this table, the expenditure on kerosene has not changed

[20](Maliti and Mnenwa, 2011)
[21] TANESCO subsidizes connection fees between 30 – 70% depending on the distance from the existing power lines. It also subsidizes consumption by charging a lower tariff to consumers who consume up to 50 KWh per month. Most of these are BOP and it is declared at the beginning during connection time. (Those who fraudulently consume more than the limit are penalized severely).
[22]2011 Lighting Africa Synthesis Report shows that many BOP consumers already allocate a substantial part of their household budget spending on lighting. Information on these products is scarce and there is limited access since many suppliers prefer conducting business in more lucrative cities like Dar es Salaam, Arusha and Mwanza, all of which have a growing solar market.

much — from TSh 400/day (USD 0.25/day) in 2008 to TSh 500/day (USD 0.31) in 2013, but the cost of the lighting devices has doubled — from TSh 150 to 6,000 (USD 0.09 – 3.75) in 2008 to TSh 400 to 12,000 (USD 0.25 -7.50) in 2013. There are of course the issues of exchange rate differences that might explain at least part of the rise in cost of the devices, but not the daily/monthly spending on kerosene. In the 2008 LA Tanzania Qualitative Study an exchange rate of 1 USD = TSh 1162 was used (see page 42), however the rate of devaluation of the TSh against the USD (now around 1600) does not move proportionally with local prices.

Table 11: Cost of Lighting Devices – Current vs. Previous Lighting Africa Studies

	Lighting Device	LA* 2008 Qualitative	LA 2008 quantitative	TMI * 2013
Cost (TSh)	Koroboi (tin lamp)	250	760	400
	Paraffin lamp/kerosene lantern (chemli)	6000	5870	4,500 - 11,000 (largest 8,000/-)
	Candle (mshumaa)	150	430	300
	Torch (mchina)	-	-	5,000 - 12,000
Kerosene Expenditure (TSh)	For koroboi	400 (daily) 12,000 (monthly)	200 (daily) 6,000 (monthly)	400 (daily) 12,000 (monthly)

* LA – Lighting Africa; TMI – Tanzania Market Intelligence **Sources (LAMIM 2013)**

An annualized cost-comparison between solar products and other lighting devices (see Table 12) reveals that even with the high up-front cost for alternative products, the life cycle cost (LCC)[23] for kerosene products are in fact much higher due to the recurring cost of fuels and devices. In this analysis, certain assumptions have been made concerning life-span, maintenance and repair, and disposal of alternative lighting products – taking manufacturer assertions at face value and adding some strictly anecdotal data. The study team cautions that the LCC of these products has still not been researched adequately. Arriving at statistically accurate estimates of replacement and maintenance costs based on usage patterns requires more data collection and analysis that would demand going beyond the scope of this study. On the other hand, there are some limited studies on this topic to draw on, and costs associated with the environmentally sound disposal of the devices after the end of their useful life are of particular concern. Still, even if maintenance and disposal costs proved to be considerably more than manufacturers' reports, the economic argument for solar lighting products as shown in Table 12 is compelling.

Clearly, awareness needs to be raised regarding the LCC advantages of solar lighting products, although information dissemination may not necessarily be all that is required to bring an overall impact. Financing will need to be offered to a majority of BOP consumers to allow them to cover the purchase costs, as the high prices of solar lighting products put them out of reach of many of the targeted population. In fact, the study determined that the up-front purchase cost is the biggest barrier. This is discussed further in the coming sections of the report.

[23] Life Cycle Costs — Theses are 'cradle-to-grave product costs'**, i.e.** production, distribution, installation, maintenance and disposal. The environmental impact of solar technology is associated with the use of natural resources during production and the disposal of technology materials after use. These include the use of fresh water (a depleting resource), habitat loss due to land-use and generation of e-waste from the hazardous substances used in solar technologies, which result in greenhouse gas emissions

Table 12: Annualized Cost Comparison of Solar Lighting Products vs. Currently Used Lighting Devices

	Solar Lighting Products			Other Lighting Devices		
	Lanterns	Task Light	Solar Torch	Koroboi	Hurricane lamp	Mchina
Intial Costs * (TSh)	29,000	52,000	10,000	400	7750	8,500
Fuel/Battery Costs (TSh)	5,000	15,000	5000	144,000	302,000	109, 500
Maintenance/Replace Costs (TSh) **	1,450	2,600	500	400	4,000	17,000 (replaced 2)
Total (TSh)	**35,450**	**69,600**	**15,500**	**144,800**	**313,750**	**135,000**

Source: Modified from LAMIM (2013)

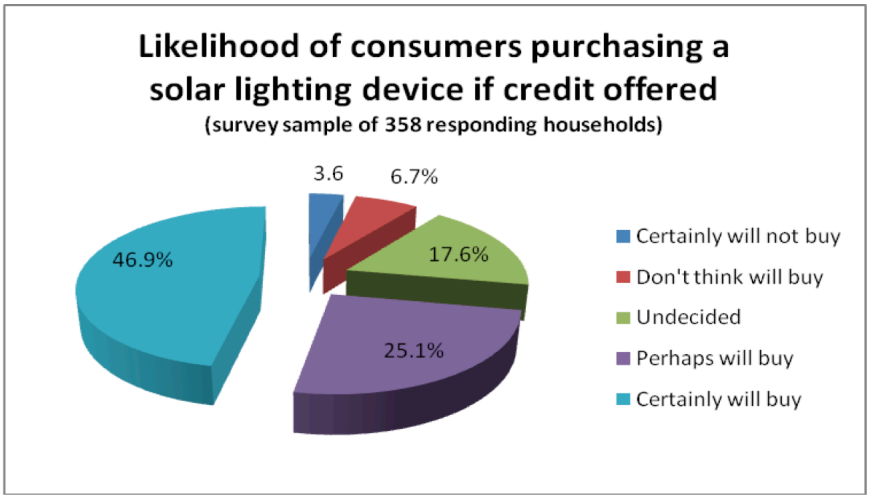
* prices for solar products based on taking the median price for mid-range products offered by five suppliers; prices for traditional products taken from Focus Group participant responses

** maintenance costs for solar products based on supplier assertions of 5% of first cost; maintenance costs for traditional products based on anecdotal data provided by Focus Group participants

6.2. Consumer Attitudes Toward Financing Alternatives

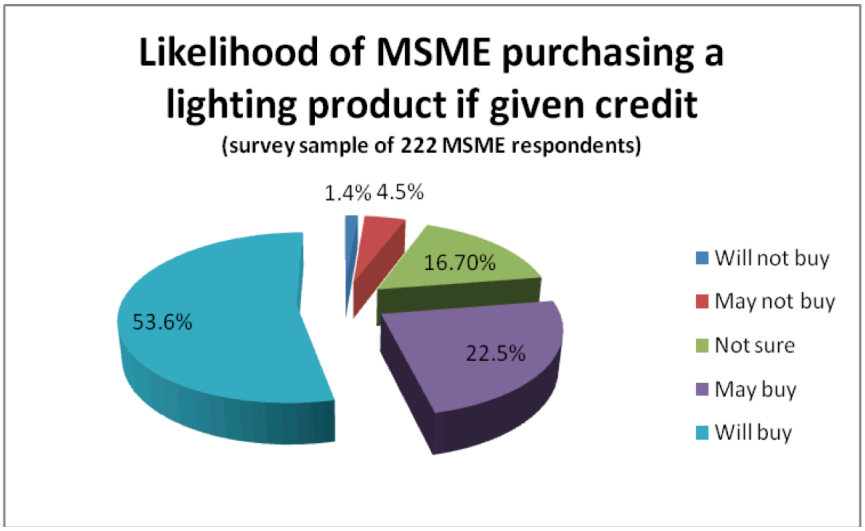
The data presented on household incomes in Section 4 clearly indicate that coming up with sufficient funds all at once to purchase an alternative lighting device would be problematic for rural BOP consumers. However, when consumers in the household survey were asked about how willing they would be to purchase solar lighting products, when financing is offered, ***72 percent across both rural and peri-urban households said they will either definitely buy or perhaps they might buy***, this is illustrated in Figure 9. These attitudes provide a striking endorsement of how important offering credit solutions should be in any large-scale marketing effort for alternative lighting products.

Figure 9: Consumers' Willingness to Purchase Solar Lighting Devices if Offered Credit.



The responses from the 222 MSMEs surveyed are illustrated in Figure 10. Of the responding MSMEs, 54 percent said they are definitely willing to purchase alternative lighting products.

Figure 10: MSME Willingness to Purchase Solar Lighting Devices if Offered Credit



Figures 11 and 12 provide household and MSME responses concerning their preferred sources of credit. The leading preferences for households are through Savings and Credit Cooperative Societies (SACCOS) with slightly more than a third of respondents preferring these sources. The second largest group preferred obtaining credit through a bank. Those who preferred other sources mentioned relatives, friends, associates, etc. as their preferred sources. MSMEs, however, prefer banks as their sources of credit, slightly favored over SACCOS. Together, banks and SACCOS constitute two thirds of the preferences of the MSME study sample.

Figure 11: Households' Preferred Sources of Credit for Purchasing Lighting Devices

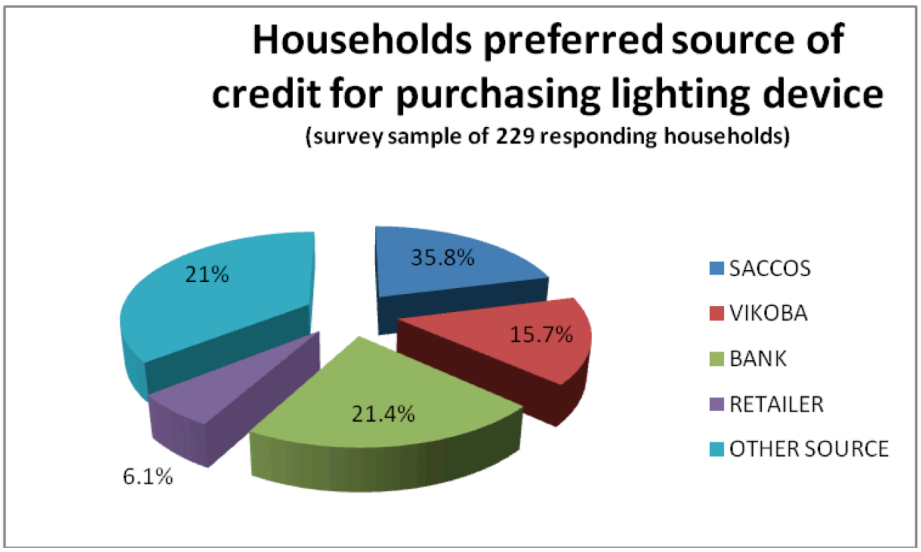
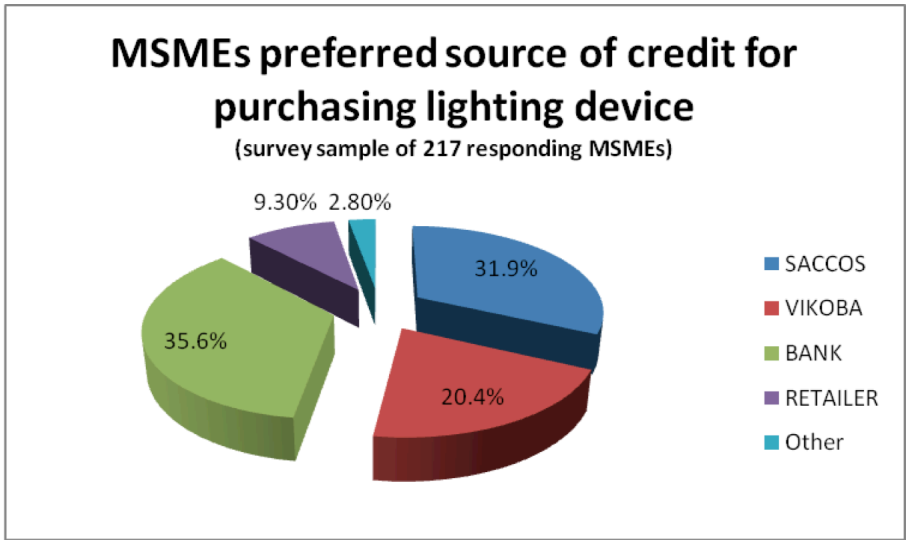


Figure 12. MSME's Preferred Sources of Credit for Purchasing Lighting Devices



Consumers' "willingness to pay" for alternative lighting devices is further discussed in Section 7.

7.0. MARKET SIZING AND POTENTIAL

7.1. Market Potential and its Key Characteristics

There is a strong market potential for off-grid lighting products in rural and peri-urban Tanzania since so many of Tanzania's BOP consumers are, as yet, not grid-connected. Moreover, grid connected electricity is expensive and supply is unreliable. This implies that even those households and SMEs located in areas that have been targeted for grid connection in the near future are most likely to adopt alternative lighting devices as a backup. Therefore, the "technical potential" of the market for alternative lighting products may be considered to be as large as the number of households and SMEs that are not yet connected to the grid. The Government estimates that the number of households without grid connection today remains over 7.8 million[24]. One estimate of the total number of SME's is approximately 3.1 million[25]. There is no reliable data on the number of these SMEs, which are not grid connected, but if the rate of electrification is taken at the overall country average, then we may assume that roughly 2.45 million SME's are without grid supplied power.

Hence, the market for off-grid lighting products has a huge potential and is at the moment growing at quite an impressive rate. This is based on several indicators:

- Sales trends and projections revealed by the distributors indicate a positive outlook for growth
- The survey of consumers indicates a growing interest in purchasing alternative lighting devices, specifically solar powered ones, due to their advantages over existing products
- The Focus Group study has revealed a number of basic motivators in consumers for doing away with traditional lighting devices which are harmful and costly
- The state of grid electrification in the country and current programs for expansion in the short and intermediate term still will not meet the national demands adequately, especially in the rural areas
- The population growth rate is quite high and expected to treble by the year 2050
- There are active and on-going efforts to promote solar energy usage by various stakeholders, including entrepreneurial firms, NGOs, and various national and international institutions.

Sales trends projections given by major distributors

The solar lighting dealers in the distribution chain expressed their views concerning the trend of sales as shown in Table 13. About 85 percent of the dealers perceive sales to be rising.

[24] NBS 2012 and TANESCO 2013

[25] Tanzania SME Policy Review Final 2012, UNIDO March 2013

Table 13: Supply Chain Members' Perspectives on Demand Rate for Solar Lighting Products

State of demand	Number of dealers who share such a perspective	Percent of dealers who share such a perspective
Demand is decreasing	4	2.5
Demand is static	20	12.7
Demand is steadily rising	91	58.0
Demand is rapidly rising	52	26.8
Total	157	100

Alternative Lighting product demand indicators from Focus Groups

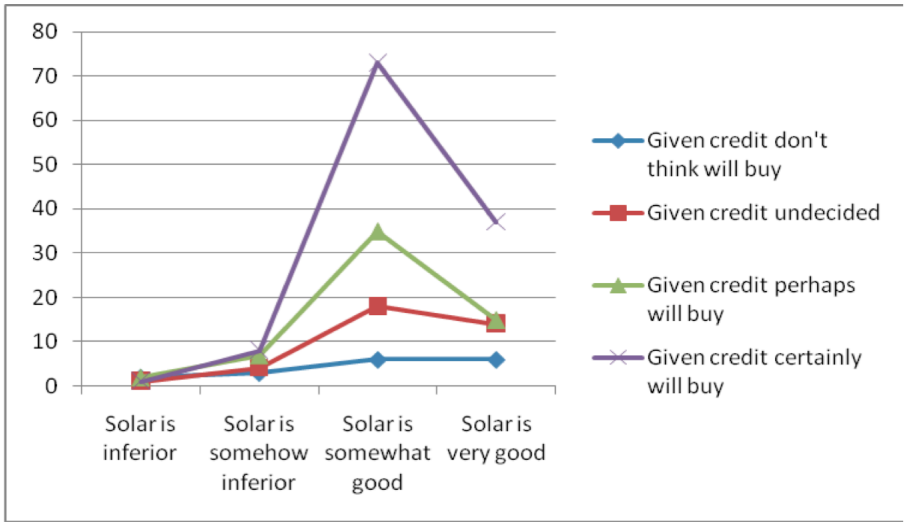
Initially a majority of the BOP participants involved in the study in most locations showed no or very little comprehension of solar lighting devices of the kind that may be suitable for low-income households. However, through the product sampling approach, almost all participants showed appreciation for at least two or three models that were on display and expressed their willingness to purchase them under the right conditions vis-à-vis availability of finance and quality guarantees. ***In particular, focus group participants were highly aware of the limitations of current devices they are using and revealed that it is only financial concerns that are the barrier for them to extricate themselves from the harmful kerosene dependent devices.*** Table 14 illustrates the Focus Group study results in relation to willingness to pay.

Table 14: Willingness to Pay for Solar Lighting Devices by the BOP Focus Group Participants

Product Size/Capacity	Price willing to spend	Clusters/location	Proportion of households (%)	Credit period	Installment payments	Recommended credit period
High Capacity	USD62.50 - 81.25	Lindi peri-urban	15	1 year	12	1 year (4 installments)
		Lindi rural	15			
		Kigoma peri-urban	40			
		Arusha rural	28			
		Mbeya peri-urban	80	2 months	2	
		Mbeya rural	60	1 year	2	
		Mwanza peri-urban	40	10 months	10	
		Kigoma rural	20	18 months	18	
Medium Capacity	USD31.25	Lindi peri-urban	50	6 months	6	6 months (3 installments)
		Lindi rural	35			
		Arusha rural	34			
		Kigoma peri-urban	45			
		Mwanza rural	55			
		Mbeya peri-urban	25	none	Purchase at once	
		Mbeya rural	20	6 months	1	
		Mwanza peri-urban	40	4 months	4	
		Kigoma rural	50	10 months	10	
Low-Capacity	USD12.50 - 19.00	Lindi peri-urban	35	3 – 4 months	3 – 4	3 months (2 Installments)
		Lindi rural	50			
		Kigoma peri-urban	15			
		Arusha rural	28			
		Mwanza peri-urban	20	2 months	2	
		Kigoma rural	30	1 month	1	
		Mbeya rural	15	1 month	1	
		Mwanza rural	45	3 months	3	

The survey of 374 households also inquired about perceptions of solar product devices' qualities, and, therefore, it is important to see whether there is a link between this and their willingness to purchase such a device. The results are illustrated in Figure 13.

Figure 13: Household perceptions of solar product quality and intention to buy given credit



There appears to be a definite link between the perception of quality and the willingness to purchase, given a suitable credit scheme. For example, a majority of the "certainly will buy" group rated the products as somewhat good or very good. The same applies for the "perhaps will buy group."

7.3. Estimation of market size for the next five years

Through the "demand projection by expert opinion" approach, supply chain dealers were interviewed to suggest the current and future projected demands for the alternative lighting products. A few reputable dealers who operate at the national level gave their demand projections, which may indicate the current and future trends of the alternative lighting products market as shown in Table 15. The stakeholders interviewed were asked to give estimates of demand for their enterprises and also for the nation (industry demand).

Table 15: Demand projections provided by a few national dealers

Company	Current Company Demand (units)	Estimated National demand (units)	Estimated Company demand five years from now (units)	Estimated National demand five years from now (units)
A	20,000	130,000	50,000	200,000
B	10,000	200,000	100,000	400,000
C	50,000	200,000	100,000	500,000
D	20,000	200,000	100,000	600,000
Median		**183,000**	**100,000**	**425,000**

The price range of all alternative lighting products on the market was estimated in a very wide range between USD 5.00-250.00, owing to significant differences in type, features and quality. Since many of the products are concentrated at the lower end, the median price range can reasonably be assumed to be USD 50.00. This would imply the current estimates for the national demand is USD 50.00 x 183,000 units = USD 9,150,000 and the projected national demand five years from now is USD 50.00 x 425,000 = USD 21,250,000. This would imply that the market is expected to grow 2.3 times according to these dealers.

It should be noted that these estimates are for now and five years from now. They are not cumulative and so it should be realized that in between these years product sales will also be taking place and, therefore, one may project that in the next five years estimates of total sales by extrapolation could be about USD 82,000,000. This may be a conservative estimate but it at least indicates the trends of sales in terms of growth rate.

Other factors that indicate a promising growth potential include:

(i) The population growth rate, which is about 2.9 percent, implying the population is expected to be over 50 million in 5 years' time, while the current supply of electricity from the grid is not expected to be able to satisfy demand, especially in the rural areas
(ii) The intensification of awareness and promotional campaigns is expected to capture new buyers
(iii) The technological improvements to solar lighting devices that produce better and more efficient devices and at the same time lowering the prices will attract new customers
(iv) For a number of devices the life span is around 2 – 5 years, meaning replacement demand will occur in the intermediate term
(v) The results of the consumer survey and the focus group studies have indicated a significant willingness of a sizeable portion of the BOP consumers to purchase solar lighting devices given that they understand the health, performance and longer term economic advantages of such devices in comparison to the traditional lighting devices in use.

The Tanzanian population has been growing for the past decade at a rate close to 2.9% per annum increasing by about a third in size based on the 2002 count. The population is expected to grow at a similar rate in the coming decades, therefore, resulting in a much greater demand for electricity and lighting products in the future. Chapter 4 provides details on the latest population size and growth rates, as well as socio-economic characteristics that are relevant for off-grid lighting products stakeholders.

An optimistic projection of demand for the next five years would, therefore, be a higher figure than USD 82 million, given the above considerations. When comparing rural versus peri-urban and urban demand, the willingness to purchase alternative lighting devices gives an indicator of relative market size. Projections from the consumer survey

reveal the following estimates shown in Table 16. The estimates are, however, contingent upon there being the offer of some kind of credit scheme.

Table 16: Estimates of National Household Demand for Solar Lighting Devices*

	Dar es Salaam	Arusha	Dodoma	Kigoma	Mbeya	Mwanza	Total
Sample size	69	80	12	40	81	92	374
No. of HHs represented by the sample (n)	1091135	376513	452954	373321	629630	486405	3409959
Percent of HHs certainly intending to buy (a)	36.5	80.3	46.9	74.4	44.3	12.2	46.9
Percent of HHs who perhaps may buy (b)	25.4	17.1	25	17.9	26.6	34.4	25.1
No. of HHs certainly intending to buy (a x n)	398264	302340	212435	277751	278926	59341	1599271
No. of HHs who perhaps may buy (b x n)	277148	64384	113238	66824	167482	167323	855900
Expected no. of HHs to purchase [(a + .5b)n]	536839	334532	269055	311163	362667	143003	2027221
Provincial zone represented by region	Eastern	Northern	Central	Western	Southern	Lake	Total
No. of HHs represented in the provincial zone (m)	2078382	1467143	1093502	676884	1674428	2095681	9086020
Projected no. of HHs in zone expected to purchase [(a + .5b)m]	1022564	1303557	649540	564183	964471	616130	**5401639**

* Willingness to pay given the offer of credit

As can be seen, the projections suggest that around 5 million households are willing to buy alternative lighting devices given the offer of suitable credit schemes. This demand estimate must, however, be considered in its proper context. First, there is no time frame attached to it. The analysis simply points out what is the current potential, but that could be spread over several years. Also, the figures represent units and not total sales in currency, implying the dollar amount of demand will depend on the average price an alternative lighting product is going to be sold at.

The demand estimates based on the willingness of owners of the micro and small enterprises interviewed to purchase solar lanterns, in particular if credit was offered is shown in Table 17.

Table 17: Estimates of National MSME Demand for Solar Lanterns

	Area that business is located			Total
	Urban	Peri-urban	Rural	
Sample size	72	94	70	236
No. of MSMEs represented by the sample	465,000	930,000	1,705,000	3,100,000
Percent of MSMEs certainly intending to buy	49.3%	56.6%	54.7%	53.7%
Percent of MSMEs who perhaps may buy	26.1%	20.5%	26.6%	24.1%
Total	75.4%	77.1%	81.3%	77.8%
No. of MSMEs certainly intending to buy (c)	229245	526380	932635	1664700
No. of MSMEs who perhaps may buy (d)	121365	190650	453530	747100
Expected no. of MSMEs to purchase (c + .5d)	289927.5	621705	1159400	**2038250**

The owners were also asked at what price they would recommend that such devices should be sold to them, and what should be the length of the installment period. The mean recommended price in TSh for urban, peri-urban and rural locations, as well as the mean installment duration in which to complete payments proposed by those who responded to these two questions are shown in Table 18.

Table 18: Mean recommended price for solar lanterns and mean installment payments duration by location

Area that business is located	Price of solar lantern recommended to sell to us (TSh)	Installment duration for us to complete payments (months)
Urban	119250 (n = 44)	4.57 (n = 44)
Peri-urban	153277 (n = 56)	4.97 (n = 36)
Rural	84600 (n = 50)	3.25 (n = 32)
Total	120403 (n = 150)	4.28 (n = 96)

It can be seen that rural MSMEs recommend a lower price (mean TSh 84,000 / USD52.50) but a shorter average installment payment duration of 3.25 months. The peri-urban enterprises have the highest average recommended price of TSh 153,277 (USD 95.50) and the longest average installment payment duration of about 5 months.

The Tanzania Revenue Authority has only recently been recording imports of solar goods and their accessories. However, the records are imperfect in the sense that import consignments are not broken down but lumped together with their accessories in terms of reporting their value for the purposes of tax exemption. For the year 2012, the CIF value for all imported solar products and their accessories, amounted to approximately USD 18,580,000. This figure compares well with the estimate of USD 9,150,000 derived from the supply chain national distributors since it includes accessories.

8.0. EXISTING DISTRIBUTION MODELS FOR SOLAR LIGHTING PRODUCTS

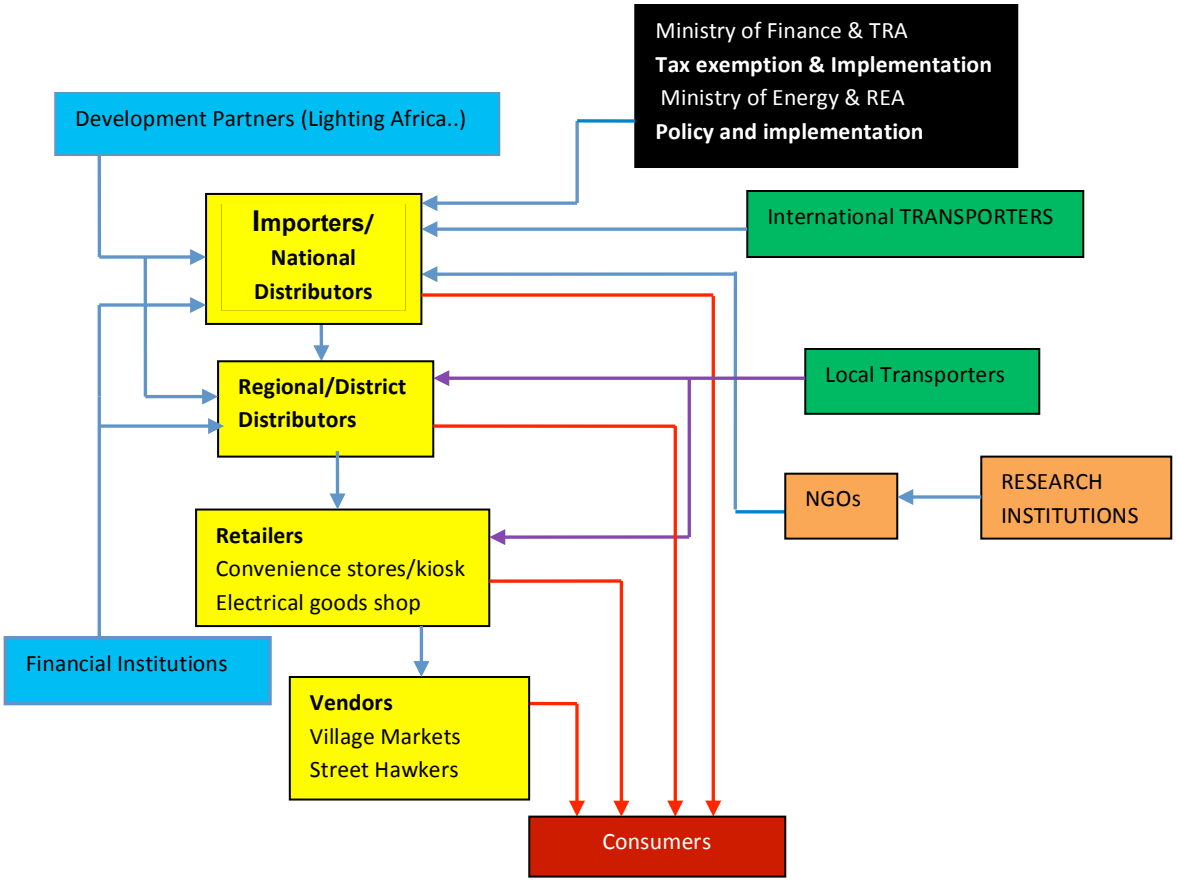
8.1. Supply Chain Configurations

A number of distribution models exist for solar lighting products. There is the general supply chain configuration similar to that found in the distribution of other lighting products; there are also community based models, school based models, and entrepreneur based distribution models. The general distribution channel has at most four levels, which are:

- **Level I**: Importers / National Distributors
- **Level II**: Regional / District Distributors
- **Level III**:Retailers (convenience stores/kiosks and electrical goods shops)
- **Level IV**: Vendors (village markets and street hawkers)

This type of model was found to be applied by major distributors. Figure 14 is a diagrammatic representation of the value chain for solar lighting products in Tanzania

Figure 14: Value - Chain for Solar Lighting Products in Tanzania



The model depicted in Figure 14 has the following key benefits and challenges:

Key benefits	Main challenges
1. Potential for wide geographical scope of operation 2. Carries multiple brands 3. Promotes free market model	1. Limited quality control 2. Limited technical support/advice 3. Logistical related losses/damages 4. Transactions are on cash basis 5. Limited promotional opportunities for individual brands

A description of the key players follows:

I. Importers or National Distributors are involved in ordering and purchasing goods in large quantities and selling them wholesale to the Regional/District Distributors. Most of these players import products from China and Germany and transport them by sea or air. Almost all of them are located in Dar es Salaam, with some a few of them in Arusha or Mwanza. Most deal with solar products only. Very few also deal with other electrical goods. The study team also observed that these Importers/National Distributors store product goods directly within their wholesale and retail trading facility.

Challenges that face this level of the supply chain include:

(a) Delay in clearing of the goods at the ports or airports due to bureaucracy and corruption
(b) High cost involved in transportation of goods to reach their regional and district agents due to poor transport infrastructure.
(c) Damaged products due to improper handling of the goods during transportation, loading and off-loading
(d) Lack of large warehouses for the storage of goods
(e) Downsizing the importation of branded products, due to inferior and cheaper products in the local market

II. Regional or District Distributors are located in the capitols of the regions or districts. These players are responsible for ordering the products from importers and selling them to the retailers. Some act as agents of the national distributors but others operate independently. In most cases they themselves travel from their regions to Dar es Salaam, Arusha or Mwanza to purchase their goods. Most use road or rail transport for transportation of purchased goods depending on the cost and location of the region. Regional distributors deal also with other goods, mainly electrical products. No regional distributor was found to have its own separate warehouse or storage facility. Most were found to have stored and displayed different types of products mixed in their trading/retail shop.

Challenges also face this category of intermediaries:

(a) High cost involved in transportation of goods purchased from the national distributor to their destination. Poor road infrastructure results in delays in the products reaching their destination.
(b) Lack of space for the storage of goods. They cannot stock goods in large quantities which increases the operating costs
(c) Damaged products due to improper handling of the goods during transportation

(d) Shifted from focusing only on solar products due to market competition, low sales and inferior products

III. Retailers (including convenience stores / kiosks and electrical good shops) are located in the regions, districts or in economic centers. They either sell their products to vendors or directly to end customers. There are two types of retailers dealing with solar lighting products: those who exclusively deal with solar products and those who supply both solar and electrical goods. The retailers buy the products from the regional/district distributors and they use hired trucks for transportation of their purchases. These players have no separate storage facility outside of

their main retail shops. The retailers are closer to customers compared to the other levels in the supply chain. However, they are static, in the sense that they are in fixed locations. This means buyers have to seek out the retailers for buying goods. The disadvantage for the retailers who deal with both electrical and modern technologies categories is the lack of specialization in alternative lighting products. They are not able to vigorously promote these products or even engage customers in dialogue at potential points of sale. The retailers are generally faced with the following challenges:

(a) General low awareness of customers on solar products. Many customers returned damaged products due to poor handling of the devices
(b) Complaints from customers due to inferior products sold to them
(b) There are no trained artisans/technicians in off-grid locations to maintain, repair and service of the products
(c) Complaints from customers due to price fluctuations
(d) Absence of regional/district wholesalers in their local areas. The retailers are forced to travel to Dar es Salaam, Mwanza, or Arusha to buy goods
(e) Not focusing only on solar products due to market competition and low sales on solar products due to little awareness of the consumers
(f) Length of time between ordering and delivery of products

IV. Vendors (Village Markets or Street Hawkers) are split in two categories; those who sells their goods at the village markets, and street hawkers who move with few items along the road. They all keep their goods at their home, or at other retail shops, as they normally don't have an established place of business. Some of them buy a few items to sell while the rest enter into an agreement with a retailer for a commission. These are informal operators and normally pay only city taxes. They do not specialize in solar lighting products, but sell a wide range of electrical products and modern technologies. Their advantage is that they know the consumers well in terms of location, purchase habits and purchase abilities; many of their customers are also neighborhoods, relatives, etc. They are often skilled at persuading their customers to purchase their goods based on reference to regular customers who are often their neighbors or friends who have perhaps purchased the same product.

8.2. Other Important Players in the Value Chain

Other players involved in this distribution channel are:

NGOs who play a prominent role in solar lighting products distribution, through dissemination of information by conducting continuous workshops/seminars, training SMES in business skill development and financing, and training technicians/artisans in the installation and maintenance of solar lighting products. NGOs also link SMEs to micro financing institutions after appropriate training and vetting. A few of the NGOs participate in wholesale delivery of solar lighting products to regional distributors. Table 19 shows some of the major NGO's that were interviewed, their roles in the energy sector, and some of their programs and locations.

Table 19: Roles and Programs of Major NGOs in the Energy Sector

NGO	Role in Energy sector	Programs	Location
GVEP	Support SMEs who sell lighting products through training (business development skills, and technology), and awareness building Linking SMEs and suppliers to financial institutions such as banks, SACCOS etc.	Development of Energy Entrepreneurship Project (DEEP). This 5-year project has dealt with almost all renewable energy technologies: solar, briquetting, ICS, biogas etc. The project has assisted more than 350 entrepreneurs by linking them with financial institutions Capital Access for Renewable Energy Entrepreneurship project. GVEP supports people by linking them to financial institutions for funding a solar system that can charge a mobile telephone, with two lights, so that the entrepreneur can continue to conduct business at night.	Mwanza
SNV	Facilitates/advises on system change by assisting the public and private sector to adapt inclusive development strategies – building partnerships networks on various levels Improve the value chain for solar products – through participatory approach and capacity building, informing people on means to access lighting and expand RE financial opportunities	Supports TEDAP projects through awareness building Supports TAREA in expanding and implementing its mandate, e.g. support of quality energy efficient products/services and RE programs.	Dar es Salaam
ECUSINI	To create awareness on the importance of adopting renewable energies including solar at the community level	Water pumping project using solar energy for drip irrigation	Kigoma
Southern Highland Energy and Environment Centre	Dissemination of information on access to modern energy to the community in villages Feasibility studies of renewable energy technologies	Gasification: changing municipal waste to electricity, fabrication of briquettes, and design and manufacturing of gas fire for electricity	Mbeya

Research Institutions engage in researching and developing affordable lighting products in conjunction with NGOs and SMEs. Once the technologies are proven successful the products are passed over to the distributors. The Tanzania Institute for Research and Development Organization (TIRDO) in conjunction with Kakute Projects Ltd, an NGO based in Arusha, developed a lantern that uses jatropha oil. The research was successful, but needed more financial support for refining the technology and commercialization.

Transport and Logistics Operators: These include international companies, which transport the goods from their origin to their intended destinations -- usually to or through Dar es Salaam. Clearing and forwarding agencies handle the importation formalities such as customs duties and bonded warehousing management. Local transporters enter into agreement with regional distributors and retailers to transport goods to the regions and districts from the national distributors.

The logistics in the supply channel mainly suffer due to the high cost of transportation as a result of poor infrastructure, products damaged during transportation, and absence of big warehouses for storage of goods. This would be addressed through:

(a) Use of specialized trucks for transportation; and
(b) Big importers should create bonded warehouses for storage of imported solar products and create distribution mechanisms to retailers and final delivery to consumers

The creation of specialized warehouses to handle alternative lighting products would also assist TBS to easily inspect and conduct control quality assurances of solar lighting products.

Policy Formulation and Regulation: The Ministry of Energy and Minerals (MEM) and the Rural Energy Agency (REA) are key players in the overall country supervision of energy activities. They develop the relevant policies and perform supervision of the legal and regulatory framework governing solar lighting products. REA oversees the implementation of the plans and programs in partnership with development partners, private dealers, NGOs, and other stakeholders, for the purpose of increasing lighting access in the rural and peri-urban areas.

From the interviews with the stakeholders it was revealed that there is no regulation in place for alternative lighting products because of the absence of a renewable energy policy that would accelerate the enactment of appropriate rules. An official from EWURA confirmed that the Authority has not been able to develop regulations governing the application of efficient lighting because the Ministry of Energy has not developed the Renewable Energy Policy. The official further confirmed that EWURA was in the process of developing a tariff structure that encourages efficient lighting since the present structure does not. Likewise, REA is also piloting low cost design standards for rural electrification.

There are 11 standards for regulating the influx of solar equipment products as stated by the officer from the Tanzania Bureau of Standards. The specifications for these standards are on the following subjects:

- Solar photovoltaic power systems test procedures for main components,
- Photovoltaic modules,
- Installation, maintenance, testing and replacement of batteries,
- Charge regulators,
- Inverters,
- Luminaires,
- Solar photovoltaic (PV) power systems-design, installation, operation, monitoring and maintenance-code of practice,
- Design of solar PV systems,
- Installation of power PV power systems,
- Operation of solar PV power system, and
- Monitoring and maintenance of solar systems.

These standards were examined and found that they had no relevance to the quality assurance of lighting products. Only one of the standards mentions the application of lighting systems. Import duties and value added taxes are exempted for all solar products according to the government officials interviewed for this study. However, the

concerns of the supply chain survey respondents were that, although tax exemptions for solar products are well structured, the implementation is poorly managed by the Tanzania Revenue Authority and by TBS. The survey respondents indicated that the system lacks technical capacity and knowledge at all levels from the import, including storage, product inspection, and the clearance process. TAREA, an NGO involved in solar suppliers' accreditation is spearheading the prevention of counterfeit products entry, which is prohibited by the law.

Financing Institutions: There are various public and private institutions, which play a role at different levels of the supply chain, in facilitating access to finance for BOP consumers. These include government ministries and agencies, international development partners, MFIs, and CBOs. Through various schemes private dealers and consumers can access grants and loans. For example the Ministry of Finance (MOF) and the Tanzania Revenue Authority (TRA) develop the budgetary policies governing energy and rural electrification funding. In this case the tax exemptions governing solar lighting products are developed by the MOF, and enforced by the TRA. MFIs and CBOs provide microloans to BOP consumers and traders.

Financing schemes available to BOP

Micro-financing institutions that serve the BOP give loans to members for healthcare services, school fees, funerals, and for small projects such as soap making and tie-dye businesses. There are three basic types of microfinance associations:

(i) village community banks (VIKOBA)
(ii) savings and credit societies (SACCOS)
(iii) trust funds (Mfuko wa HISA)
(iv) Village Savings and Lending Associations – CARE International model (VSLA)

Village community banks are microfinance schemes or associations operated on a self-help basis mostly by women, and aim at offering micro-credit with the main objective being poverty alleviation by helping the members engage in some beneficial economic activity. The projects are sometimes supervised by an NGO or a national MFI but generally they are formalized with an elected secretariat and an operating bank account. This might be a viable option for BOP consumers wishing to purchase alternative lighting products.

Savings and credit societies are associations created by a group of people who could be employed in the same organization, living in the same locality, or who have practically any kind of informal or formal relationship and decide to cooperate in a savings and loan microfinance scheme. The associations are officially registered and monitored by government authorities to avoid possible breaches. SACCOSs normally provide loans on a rotational basis, and for the bigger ones, funds are borrowed from banks but then the interest rates become higher. This is another possible financing scheme option for BOP consumer purchases of alternative lighting devices.

Micro trust funds are associations that operate in a similar manner to VIKOBAs, and some of them are registered while others are not (usually in the process of being registered). They may offer a reasonable financing option for purchasing alternative lighting devices, depending on their state of establishment (assets and liquidity) and formalization.

Village Savings and Lending Associations (VLSAs) pioneered by CARE International are similar to the VIKOBA model, but limit their memberships to only village residents while VIKOBAs accept outside members. VLSAs are well supervised by CARE and are very widespread in the country.

Financing for the Supply Chain

Most of the lighting product dealers that were interviewed, still lack access to micro financing services for a variety of reasons although they claim to need it. The reasons that financial Institutions deny the dealers loans are due to: perceived high risks, high cost involved in small transactions, and the dealers' inability to provide credible collateral. There is need to create a micro financing-friendly environment to encourage rural banks and cooperatives to lend to these dealers. Efforts in this regard could be:

(a) Government to identify bona fide alternative lighting product dealers and provide guarantees so that they can access loans from financing Institutions.
(b) Financing Institutions should be encouraged to charge moderate interest rates on the dealers, with possible use of grant schemes to reduce borrowing costs.
(c) Donor and NGO intervention by providing grants for private dealers involved in trading and raising awareness of alternative lighting products.

The current list of MFIs that operate nationally or on a zonal basis is provided in Table 20

Table 20: MFI's in Tanzania

MFI	Report Date	986.2m Loans (USD)	376,483 Borrowers	194.1m Deposits (USD)	571,231 Depositors
AccessBank - TZA	2012	32,596,119	15,819	40,817,928	101,947
Akiba	2012	46,766,487	27,111	65,870,313	213,104
BRAC - TZA	2012	20,267,459	104,225	—	—
ECLOF - TZA	2010	1,467,041	5,051	283,244	5,051
Equity Tanzania	2013-09-30	39,140,578	4,995	56,792,965	54,985
FINCA - TZA	2011	5,023,311	25,209	895,895	25,209
IDYDC	2012	354,157	—	—	—
K - Finance	2011	194,029	572	30,414	912
MBF	2011	212,031	2,478	113,430	2,478
Mbinga CB	2008	908,172	6,053	1,208,884	8,063
Mtoni	2011	2,004,364	1,351	1,743,415	2,799
MUCOBA	2012	4,024,608	5,601	5,479,648	—
Mwanga Community Bank	2011	2,407,619	2,203	2,018,413	—
NMB	2012-06-30	773,508,940	—	—	—
Opportunity Tanzania	2013-06-30	6,206,129	8,959	825,919	—
PRIDE - TZA	2011	37,028,179	100,055	14,241,007	121,354
PTF	2011	1,147,468	6,108	825,587	—
SEF-TZA	2005	263,569	1,198	27,709	1,198
SELFINA	2007	4,002,088	7,746	877,092	7,746
Tujijenge	2008	775,268	8,265	32,599	8,265
VICTORIA Finance	2011	342,857	155	—	—
Vision Fund TZA	2011	5,023,311	25,209	895,895	—
YOSEFO	2011	2,521,617	18,120	1,121,144	18,120

Source: Tanzania Market Profile (http://www.mixmarket.org/mfi/country/Tanzania December 2013)

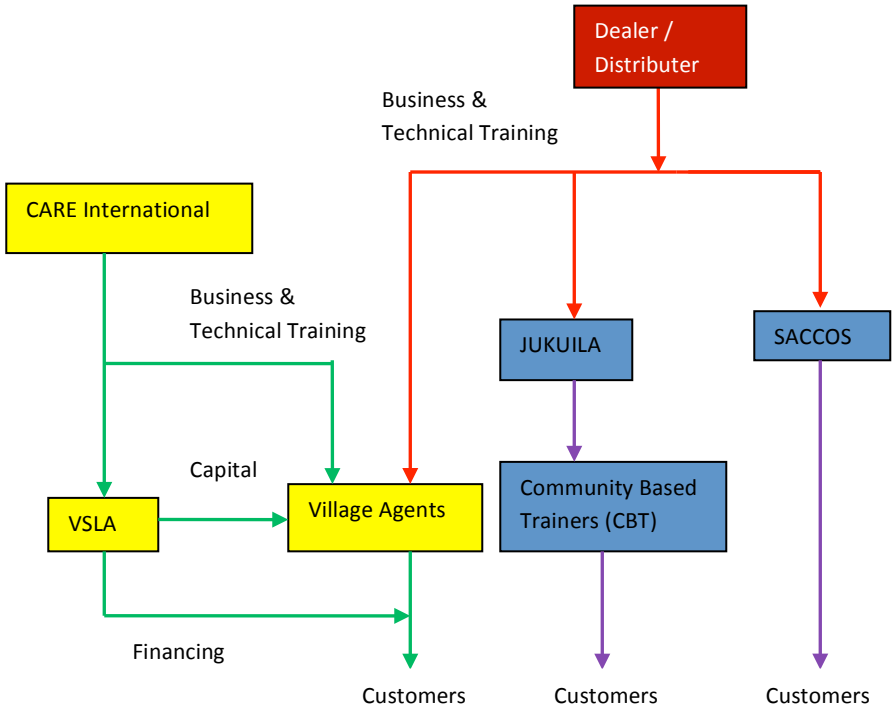
8.3. Commercial Distribution Models for Off-Grid Lighting and their Benefits

Community Based Distribution Models

Some enterprises are employing innovative distribution models that rely extensively on CBOs. This model is used by some of the private dealer/distributors. In this model, a dealer/distributor uses different community based organizations such as SACCOS, Care International, JUKULIA (a district association in Dar es Salaam) to reach each member of the association. The private dealer/distributor supplies the products and the promotion materials to the

SACCOS, or village/community agents who supply to their members or directly to households. Figure 15 illustrates the configuration of this model.

Figure 15: The CBO Distribution Model



The role of the NGO in this supply chain is to provide the village agents with business and technical skills in conjunction with the SMEs. In addition, the NGO assists in establishing a practical financing mechanism to the consumers like the village savings and loan association mechanism introduced by CARE international. In this specific model, the dealer also works with JUKUILA, SACCOSs and VSLAs (village savings and loans associations) which are different savings and loans groups that facilitate revolving fund schemes where members can contribute and borrow when need arises.

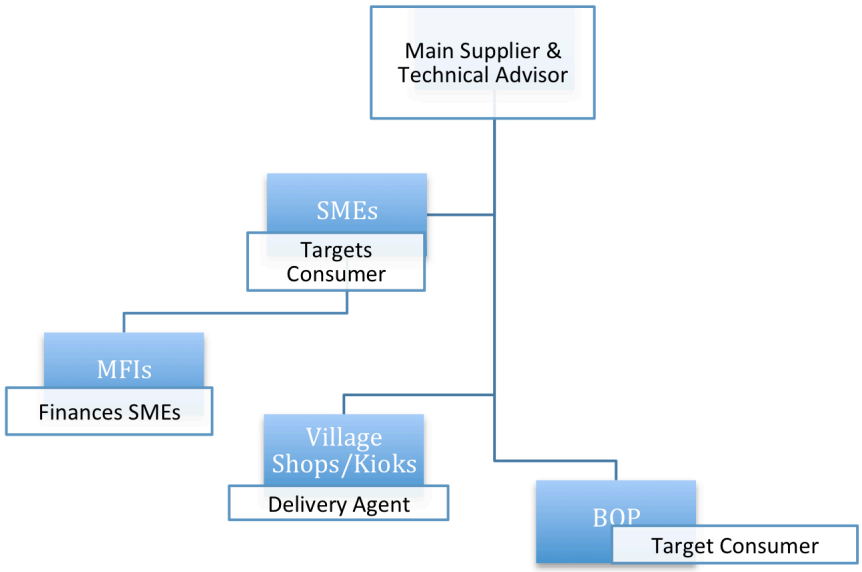
The key benefits and challenges of this model are:

Key benefits	Main challenges
1. Diverse channel configuration (to cater for different market segments) 2. Provides installation and troubleshooting services 3. Highly targeted market segments 4. Fast promotion and delivery mechanism – supply close to demand 5. Development of solar entrepreneurs – rural network 6. Investing in social institutions - VSLAs and SACCOSs 7. Gender empowerment (CARE collaboration) 8. Short channel so damage reduction and lower prices (overall margin low)	1. Limited product diversity 2. Limited customer reach (mostly members of VSLAs and SACCOSs) 3. Needs huge amount of resources for managing the channel and for promotional efforts

Enterprise Based Distribution model

The enterprise based distribution model has managed to penetrate the BOP market segment and improve access to clean energy in rural and peri-urban areas. Key features of this model include targeted consumers and suppliers, with social institutions utilized as delivery hubs. The enterprise works with SMEs that receive financing from MFIs, they also work with kiosks and small shops in village markets. They also support schools, health facilities, religious centers, etc.

Figure 16: The Entrepreneur Based Distribution Model



The key benefits and challenges of this model are summarized below.

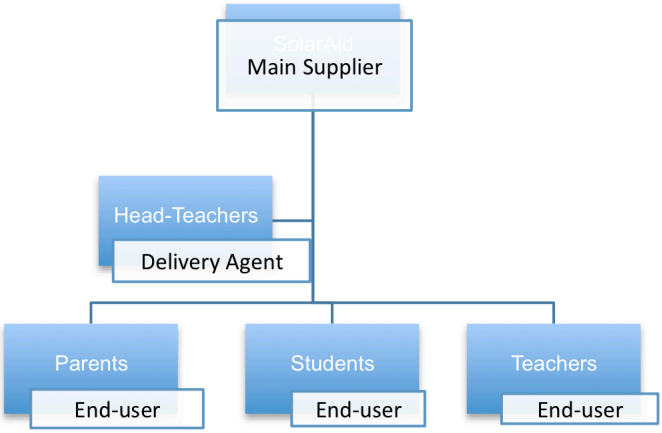
Key benefits	Main challenges
1. Support for micro and small solar and job creating within local region 2. Access to financing and business networks 3. Prioritize women in distribution mechanism through supplying to SMEs 4. Improvement in product quality over time and development of the value-chain 5. Supply close to demand and addresses other social issues like school performance 6. Investing in social institutions and improving access to social services – schools and healthcare centers 7. Support mobile-money management – used for sales communications and payments (MPESA)[26]	1. Limited to entrepreneurs within the network, with limited operating capacity 2. Doesn't address solar affordability/consumer financing because expanding distribution networks requires setting up payment options for BOP consumers

[26] MPESA is a system of money transfer through the mobile phone network operated by VODACOM Ltd. Any subscriber using this network can send or receive money from another person through kiosks franchised to entrepreneurs located in almost parts of the country. A fee is charged for each transfer. MPESA also doubles as a mobile banking system whereby customers can deposit money for later use (not savings). Three other mobile phone companies also operate similar systems.

The School Based Distribution Model

The School Based Distribution Model has also managed to penetrate the BOP market segment and improve access to clean energy in rural and peri-urban areas. Key features of this model are it targets school children and head teachers as delivery agents, by delivering products in secondary schools.

Figure 27: The School Based Distribution Model



The key challenges and benefits of this model are:

Key benefits	Main challenges
1. High promotional efficiencies as students are used to reach parents and can be more influential 2. Greatly reduces distribution costs by utilizing schools as distribution centers 3. Supply close to demand and addresses other social issues like school performance 4. Investing in social institutions and improving access to social services – schools and healthcare centers	1. Coverage may be limited 2. Products may be seen to be for academics 3. Feedback administration may be cumbersome

8.4. Most Promising Distribution Models

Some distribution models are very innovative and are proving to be very effective. This includes the models discussed in the previous section and illustrated in Figures 16 and 17, respectively. The main advantages of these distribution models have been explained as well as some of their shortcomings. Additional alternative distribution models are proposed mainly as modifications to the above and presented in Figures18 and 19 below.

Figure 38: Proposed General Model 1 for Value Chain of Solar Lighting Products

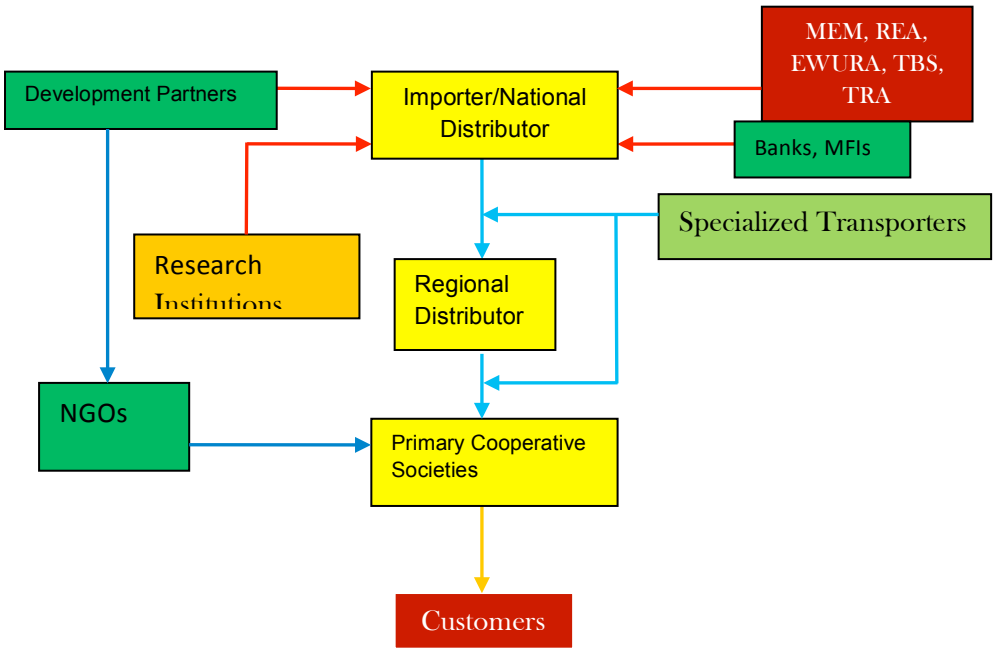
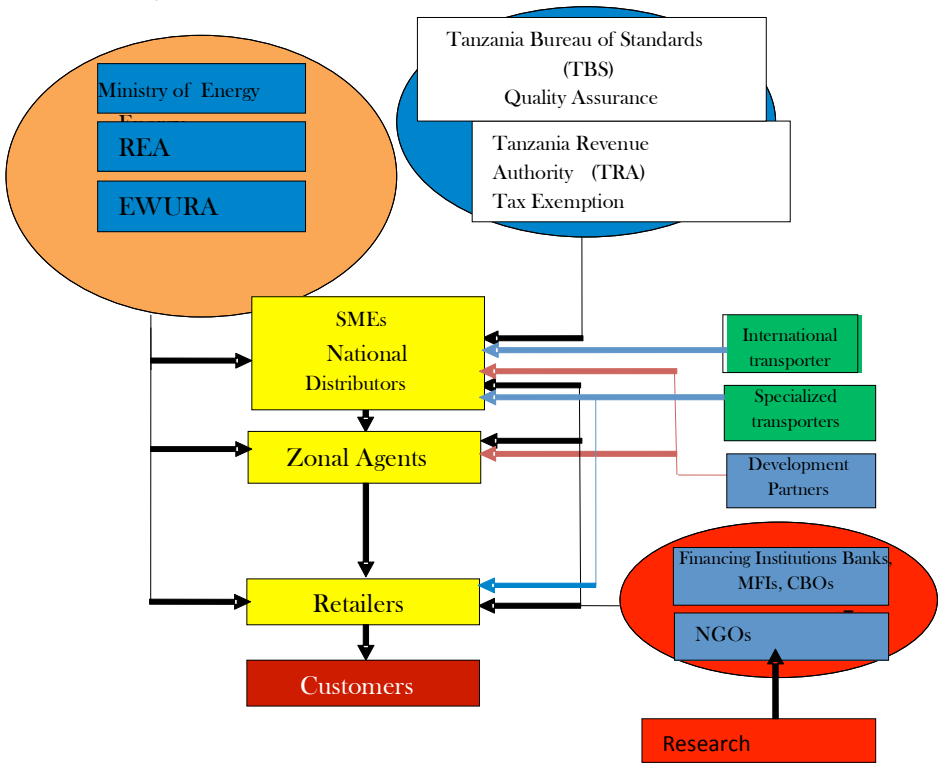


Figure 49: General Model 2 for Value Chain of Solar Lighting Products

Zonal Agents seek orders from major retailers in districts and connect them to SMEs who will use specialized transporters for direct delivery.



8.5. Underlying Barriers to Scaling up Distribution of Solar Lanterns

There are a number of challenges that face the supply chain; financial, logistical and technological. Figures 20 and 21 outline the views of the private dealers on the issues of accessing finance and subsidies from financial institutions and the government respectively, whereas Figure 22 shows the logistical and technological challenges. A common challege established for all levels of private dealers is that they have no access to loans for importation and distribution of goods. Based on the interviews held with the dealers (Figure 20) about three quarters of them (77%) had no access to loans to support their business. According to the financial institutions interviewed most of the dealers were being denied provision of loans due to lack of collateral, lack of expertise in finance, the high cost involved in small transactions, and risk aversion. Similarly, only five supply chain respondents reported having received subsidies from the government, or any financial institution or NGO from inside or outside Tanzania (Figure 21). The training of technicians also presents a challenge, one respondent claims to be involved in training technicians in the villages through village agents but this is far from meeting demand. Actual numbers were not available. There is need for a concerted effort to create a microfinancing-friendly policy environment for formal institutions (rural banks and cooperatives), NGOs, and even informal sectors including money lenders and shopkeepers. The efforts could involve:

(d) The Government establishing bona fide solar lighting product dealers and provide guarantees so that they can access loans from financing Institutions;
(e) Financing Institutions should be inspired to charge moderate interest rates on dealers;
(f) Donor and NGO intervention through grant provision for private dealers involved in trading and raising awareness of solar lighting products

Figure 20: Access to loans by private dealers

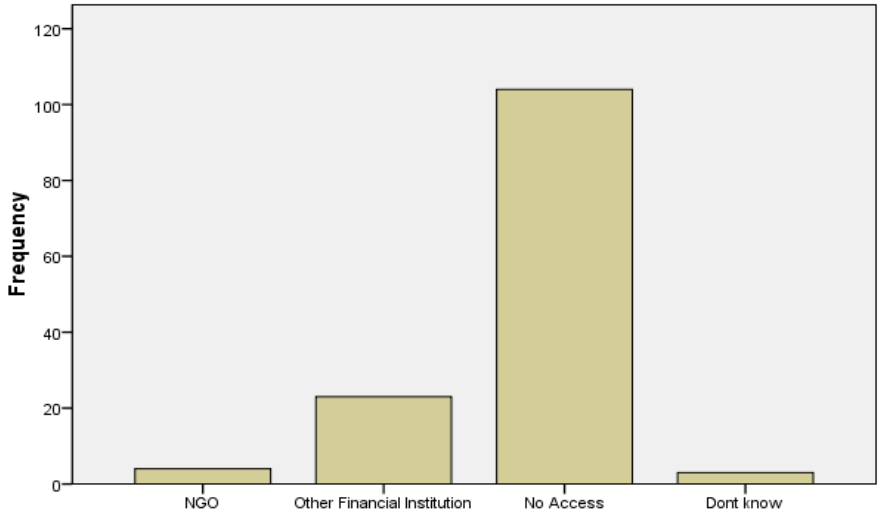


Figure 21: Subsidies for private dealers

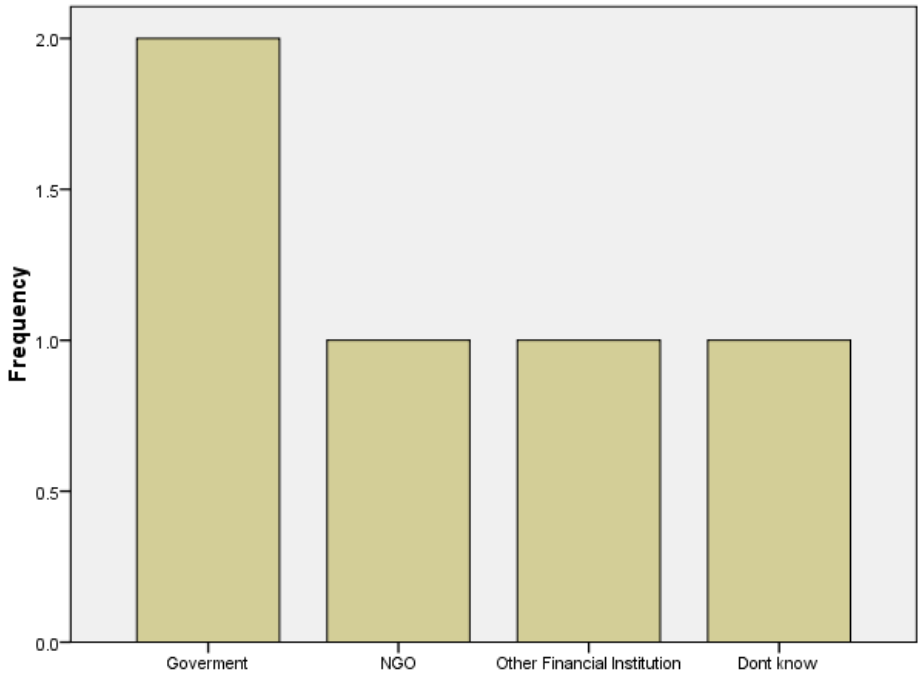
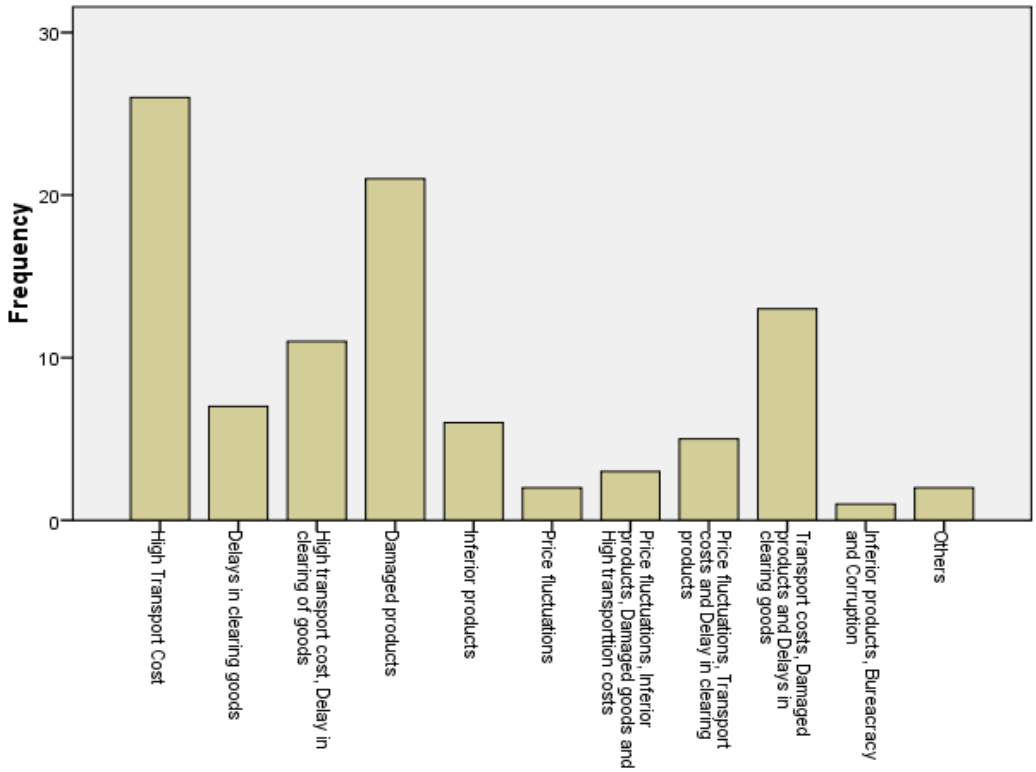


Figure 22: Logistical Challenges in the Supply Chain


Frequency
30
20
10
0
High Transport Cost
Delays in clearing goods
High transport cost, Delay in clearing of goods
Damaged products
Inferior products
Price fluctuations
Price fluctuations, Inferior products, Damagged goods and High transporttion costs
Price fluctuations, Transport costs and Delay in clearing products
Transport costs, Damaged products and Delays in clearing goods
Inferior products, Bureacracy and Corruption
Others

9.0. COMPETITIVENESS OF THE MARKETS

9.1. Distributors of Solar Lighting Products

Both private and NGO distributors are critical to the supply chain of modern lighting products. Prior to 2010, few companies were supplying and distributing solar products in Tanzania, but currently the number has grown to over 200, the majority of these being retailers. In the six regions where this study was conducted, more than 30 national and 40 regional distributors were interviewed. A comprehensive list of private dealers interviewed is found in Appendix 3.

When the dealers were asked where they get their products from, 75 out of 81 retailers said they obtain them from regional/district wholesalers, 2 said they obtain them from national distributors based in Dar es salaam and one retailer imports the goods directly. Of the 37 regional/district wholesalers interviewed, 16 obtain their products from other regional and district wholesalers, 15 of them obtain the products from national distributors and the remaining 6 import products directly. Of 37 national distributors/importers interviewed, 35 import their products directly, while 2 obtain them from other importers.

9.2. Key Commercial Distribution Partners in the Regions

Key commercial distribution partners in the regions are generally regional distributors who have premises in the regional capitals and they supply to retailers, vendors and often directly to customers. The major importers/national distributors and some regional distributors are shown in Table 21. A list of some of the existing potential commercial partners in the regions beyond those listed in Table 21 is provided in Appendix 3.

Table 21: Major Solar Lighting Goods Supply Chain Players in the Tanzania Market

Role in Value Chain	Company	Location
National Importers/Distributors	Helvetic Solar Contractors High edge solar (T) Ltd	Arusha
	Sunny Money Ltd Ensol (T) Ltd,Rex Investment Ltd ARTI Energy Ltd	Dar es Salaam
	Zara Solar Limited	Mwanza
Regional Wholesale Distributors	Green Leaf Technology Ltd RESCO (T) Ltd TACREEP Anverson Solar Power Aglex solar power	Dar es Salaam
	Kakute projects L's solutions Swift Holdings Bjarne Laustsen	Arusha
	Intra Profession East Africa Limited Mona-Mwanza Electricals	Mwanza

9.3. Common Products in the Market

Products and Brands

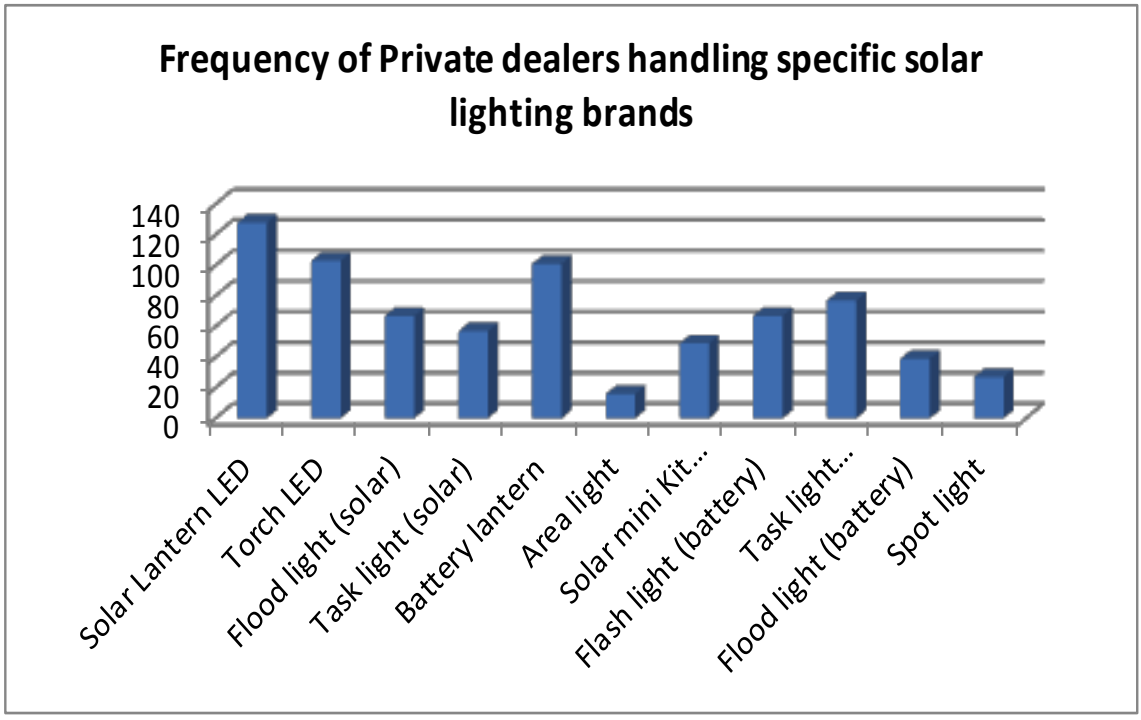
Figure 23 below shows eleven types of product that private dealers deal with. The dealer survey revealed that the leading type of products that many private enterprises deal with are the Solar Lantern LED (78.5%), Torch LED (63.2%) and Battery Lantern (62%) as also shown in Table 22 below. The results were obtained from interviewing 163 private dealers.

Types of products

Table 22: Solar lighting products in the Tanzanian market

Type of Product	Sampled Private dealers (PD) dealing with the product	Sampled PD dealing with the product in %
Solar lantern LED	128	78.5
Torch LED	103	63.2
Battery Lantern	101	62.0
Task light rechargeable	77	47.2
Flood light solar	67	41.4
Flash light battery	66	40.4
Task light solar	57	35.0
Solar Mini-Kit Generator	49	30.1
Flood light battery	39	23.9
Spot light	27	16.6
Area light	16	9.8

Figure 23: Frequency of private dealers dealing with specific solar lighting product types



From the discussions with the dealers, the reasons for the difference in the selling volumes are essentially on the usage purpose and the cost. For example, whereas the solar lantern is extensively used for reading, in the long run the cost for the solar torch is the least among all lighting products.

Brands

The distribution channel members were asked to mention the most popular selling brand among the solar lighting products in the market. In addition to naming a few best selling brands, a number of respondents also stated that their top selling products are German and Chinese products without specifying the brand names. This shows that dealers are not typically conversant with products that they buy and sell, or that the brands have not acquired distinctiveness. The likely reason for this is that there are always new brands in the market.

9.4. Direct and Indirect Competition

Direct competition is quite healthy at the moment but has not reached a level of equilibrium since demand is still not fully satisfied and is growing at a steady or high rate according to most distributors. As has been revealed by this study, there are many un-served or underserved markets, with very low awareness levels, and, in many cases, complete ignorance about the solar lighting products and the advantages they offer. For solar lighting products competition is mostly based on targeting of markets, prices, quality, promotion, and distribution.

Product quality was determined by responses from the dealers based on feedback they receive from their customers. The following aspects were assessed: durability, light quality, fragility, price of devices, cost of powering devices and light-on time. Except for the price of devices, the dealers claim that customers show complete satisfaction on all other remaining aspects of performance for the solar lighting products. As shown in Figure 24 close to 50% of the distributors indicated that the feedback from customers on the prices of the devices were average, while 32% and 9% of the dealers rated the prices to be good and very good respectively. Product performance was rated between good and very good for the rest of the aspects assessed. ***However this is from the point of view of the dealers. It does not necessarily reflect the view of the consumers.*** Nevertheless, on a relative basis one can discern that among the six attributes assessed, the prices of the devices received the lowest ratings. Figure 24 shows comparison between the prices, considered to be the worst rated aspect, and durability of the device, which is considered to be the best rated aspect according to the private dealers.

Figure 24: Product quality (n=157)

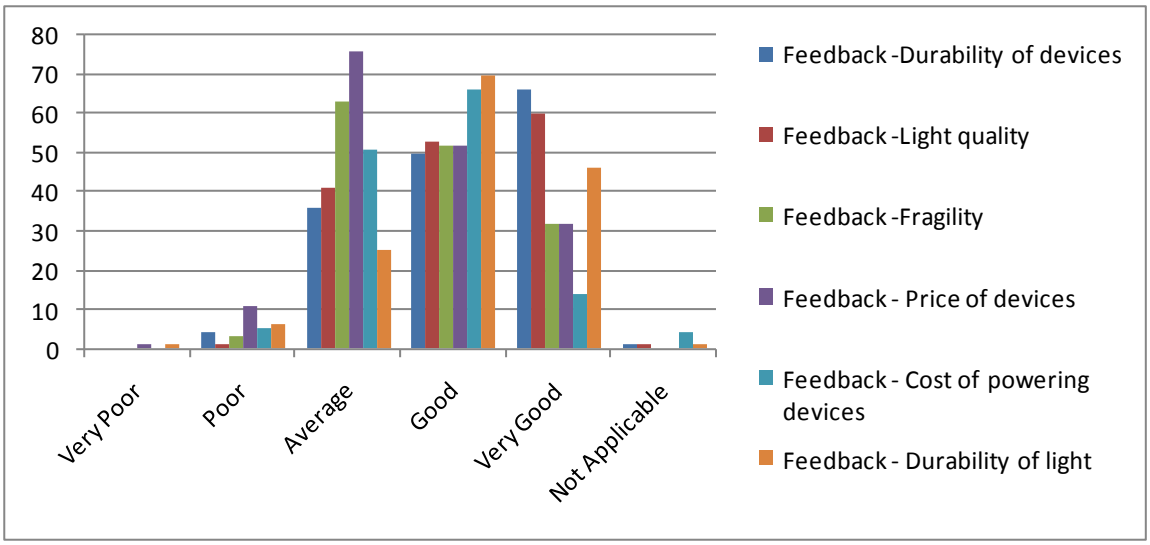
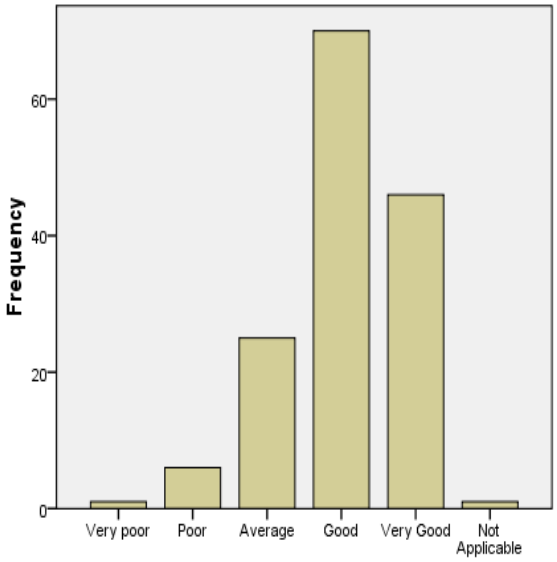
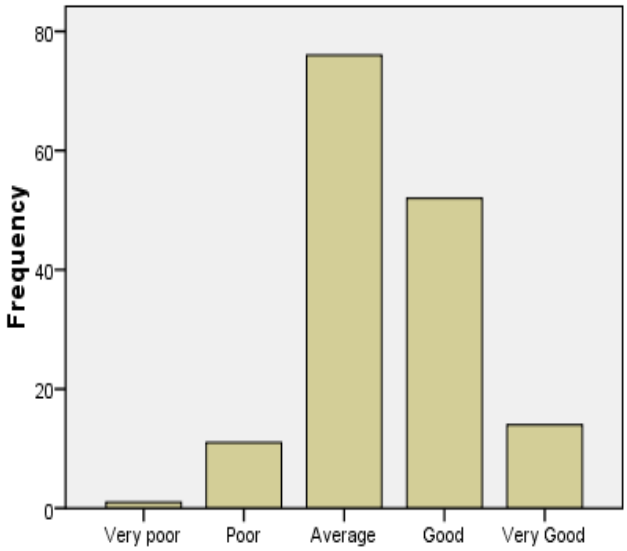


Figure 25: Comparison of Product suitability: Durability vs. Prices of Devices

Durability



Prices

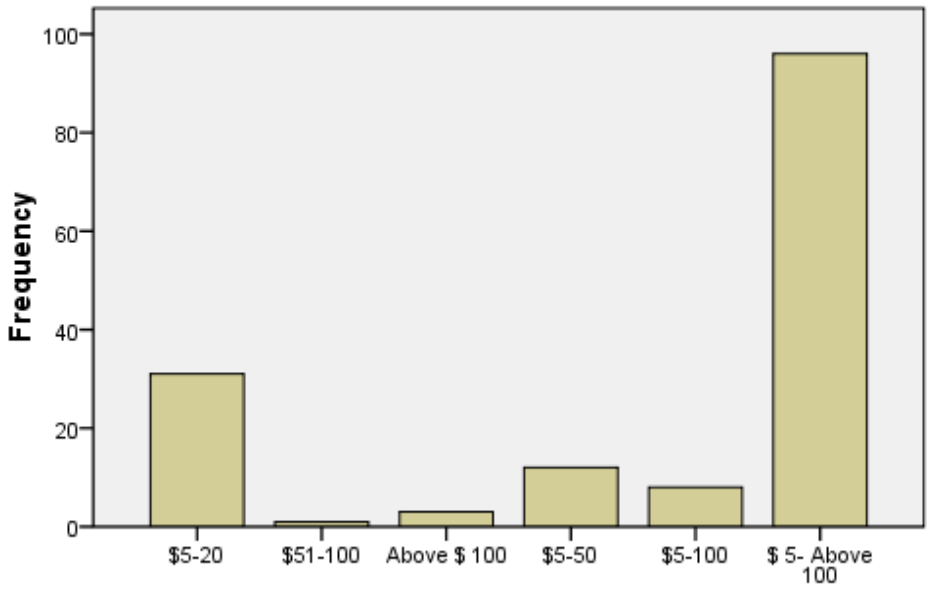


It can be seen that 74% of the dealers interviewed were of the opinion that the solar lighting products had good or very good durability, while when it came to prices only about 43% of dealiers believed that their customers felt that prices of these devices were good or very good.

Pricing

Most of the dealers sell solar products that range in price from USD 5 to more than USD 100, as shown in Figure 26. Dealers that sold such a wide range constituted more than 63% of the sampled interviewed dealers. This suggests that many dealers do not specialize in particular categories of solar lighting products to match specific customer groups; it is likely they do not practice market segmentation. Many also stock small amounts of a wide range of different solar products so that if sold out, it takes time to restock. On the other hand, about 20% of dealers sell products a price range of USD 5 -20 because these are affordable to most of their customers. Genuine, good products have high up-front costs and customers prefer to buy (seemingly) cheap unbranded products, which do not last long. Thus, in the long-term the inferior products do in fact become expensive, as they need to be repaired or replaced sooner than the higher end products.

Figure 26: Price ranges for alternative lighting products [27]



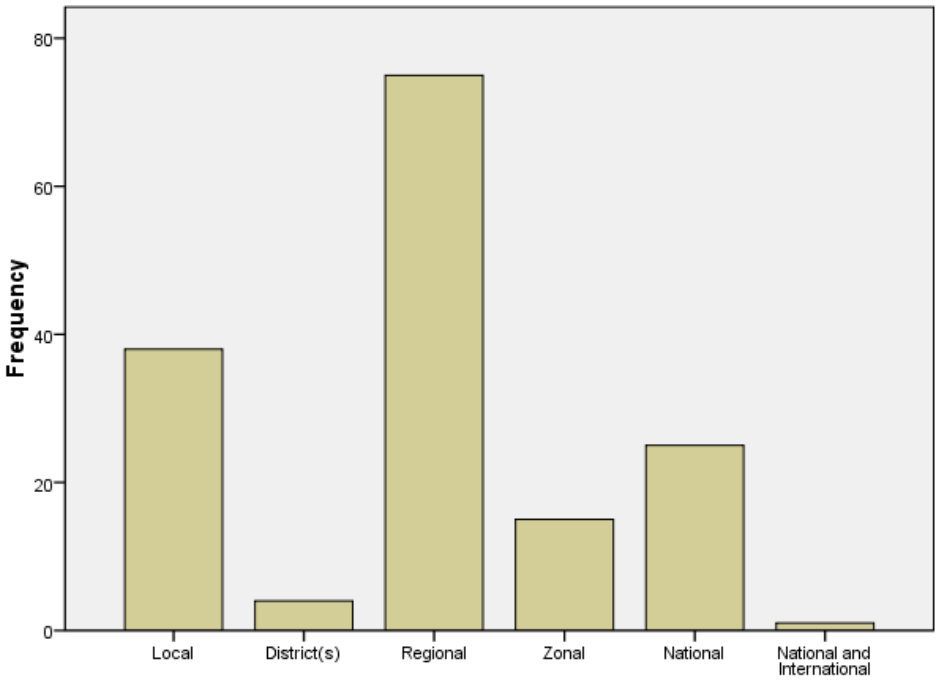
9.5. Demand trends

More than 80% of the responding dealers indicated that the market in Tanzania for solar lighting products was steadily or rapidly rising. Smaller numbers, 12.2% and 2.4%, indicated that the market is stalled and decreasing, respectively.

Regional markets were targeted more by national solar lighting products suppliers than local markets (see Figure 27). 46% of the dealers target regional wholesalers, 2.5% target district wholesalers, while 23% target retail markets. 15% sell to national distributors. A considerable number of regional wholesalers also double as retailers.

[27] Sample size = 152, non-responses are excluded

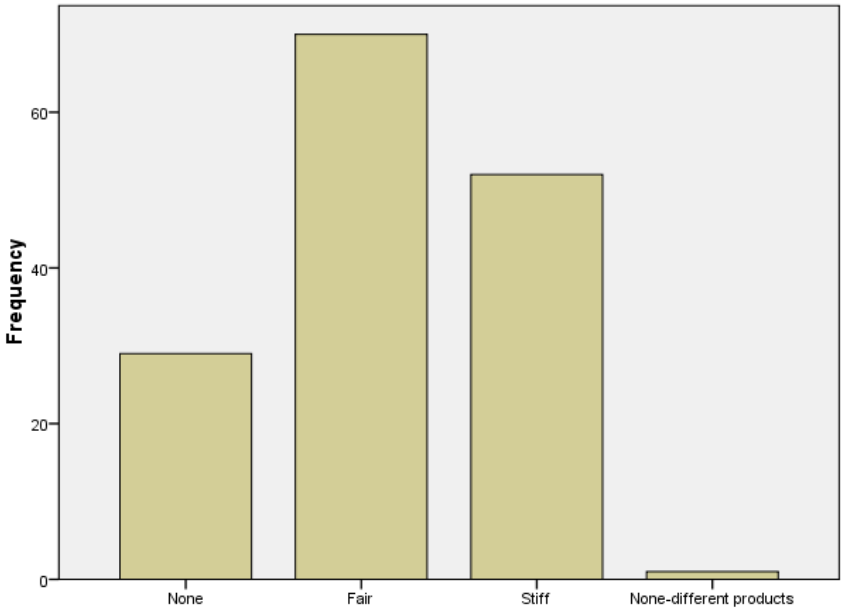
Figure 27: Specific Market Response



9.6. Competition from Alternative Lighting Products

Figure 28 shows the state of competition from other lighting products, especially those using kerosene. The survey of 152 private dealers that were interviewed revealed the following:

Figure 28: Competition with Alternative Lighting Products



Nearly half of the respondents stated that competition between solar lighting products and other products was fair. Solar lighting products are expensive, but are slowly becoming affordable and people are becoming increasingly aware of solar products. The trend in competition is increasingly favoring solar lighting products as general awareness among customers is increasing.

About 20% of respondents were of the view that there is no competition at all, mainly because most of the customers are fully aware of the advantages of using solar products and the disadvantages/impacts of using kerosene for lighting.

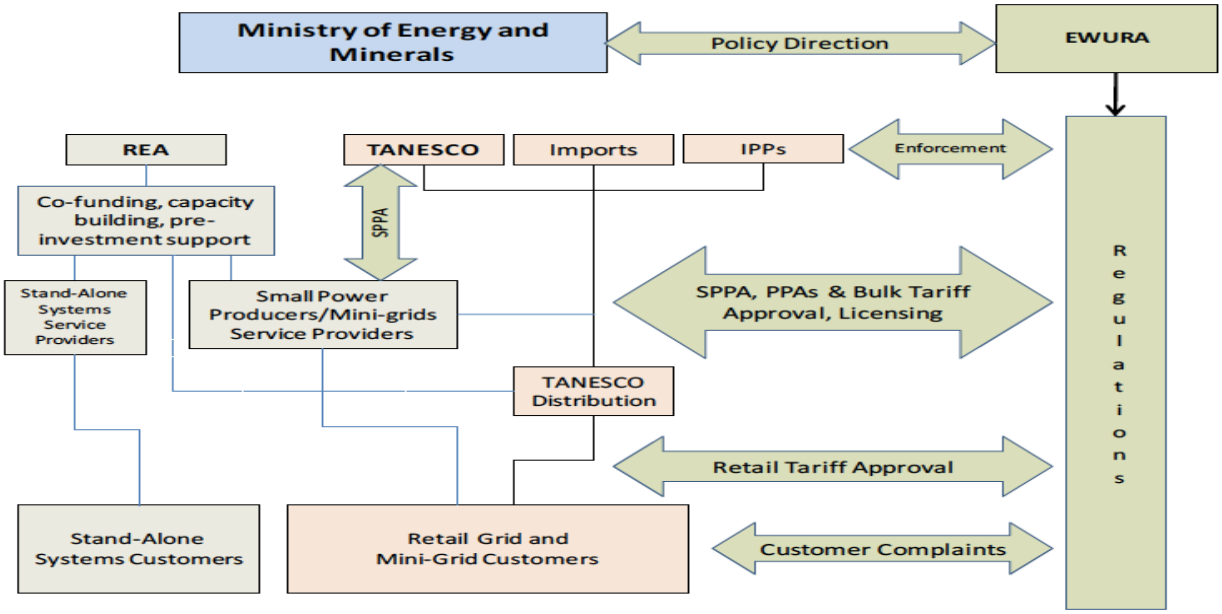
Close to 35% of the interviewed private dealers pointed out that competition between solar and non-solar lighting products was still high. This was attributed to the high up-front cost of solar products and the flooding of unreliable products into the market. There was a lot of concern about the supply of no-name, low quality, low priced products that sell faster than genuine branded products from known suppliers. Further, most of the customers are not able to distinguish between inferior and good products.

10.0. KEY STAKEHOLDERS FOR THE OFF-GRID LIGHTING MARKET AND POLICY ISSUES

10.1. Key Stakeholders for the Off-Grid Market

Major policy making and implementation of national programs in relation to the country's needs and development agenda is entrusted to a few ministries and agencies. These institutions regulate the structure and operations of the energy sector, including the energy financing structure and collecting information on energy demand demographics and market supply trends in Tanzania. Under the energy sector, the Ministry of Energy and Minerals (MEM) oversees the overall institutional, regulatory and legal framework for energy provision, with Energy and Water Utilities Regulatory Authority (EWURA) as regulatory agent. The Rural Energy Agency (REA) has been entrusted with development and implementation of programs for improving access to modern energy services in rural and peri-urban areas in Tanzania as part of the MKUKUTA and the national vision of 2025, and is governed by a public-private Rural Energy Board (REB). TANESCO functions as the utility in charge of electricity supply, with support from Independent Power Producers (IPPs) and Small Power Producers (SPPs)[28](see Figure 29). As part of broad-based privatization schemes, MEM allows private participation in electricity generation — private IPPs and SPPs sell electricity to TANESCO, which distributes this energy as well as that generated from TANESCO's own plants, through the grid to the population.

Figure 29: Electricity Stakeholders & Institutional Framework



Source: Scaling Up Renewable Energy Program, MEM 2013

As the agency responsible for off-grid electrification, REA is the most directly relevant government partner for promotion of alternative lighting products. REA receives its budget from a combination of levies on the sales of

[27]Small Power Producer — the SPP program was created by EWURA in fall 2009. SPP regulations enable cogenerated electricity and the expansion of renewable energy through standardized power purchase agreements (PPAs), standardized feed-in tariff (FiTs) payments, and streamlined interconnection and licensing requirements (Nganga et al., 2013).

utilities, plus donor funding. The agency has developed core competency and a pool of experts to support its activities. REA has implemented several programs that have significantly improved the state of electrification and 'rural lighting'[29] throughout Tanzania — the Rural Energy Fund (REF) has enabled off-grid lighting financing through renewable energy subsidies.

REA, together with partners, plans and implements programs aimed at increasing lighting access in rural areas. One of its main goals is the facilitation of PPPs. REA does not own projects, facilitation is given to public and private sector entities. One of the PPP projects that has been facilitated is the development of a new 10MW small hydropower plant in Momba District in Mbeya region, where a USA company in collaboration with Momba District Council are developing said project.

Much of REA's efforts to date have gone towards establishing favorable frameworks and programs for the development of small power projects (SPPs). These SPPs are primarily, but not exclusively, micro and mini-hydro, both connected to TANESCO's national grid, and built in tandem with an isolated mini-grid. REA has proven itself to be a dynamic proponent of such endeavors, providing sound technical and commercial guidance to private and community based project developers, as well as providing funding for technical feasibility studies and business plans. REA, by its own admission, has been less successful to date in organizing equity and debt financing for implementation of their pipeline of projects, and such financing remains a key obstacle to the many private and non-profit entrepreneurs active in this space. It has been challenging, but the financing options available could be good models for replication once there is closure to the current projects. With respect to off-grid lighting, REA has been the implementing partner for Lighting Africa in Tanzania. In this regard, the main accomplishment has been the management of the 2010 funding competition for off-grid solar lighting product distributors, through the Tanzania Energy Development Access Project.

There are other government agencies, which are important to the distribution of lighting solutions in Tanzania but are not directly involved in the energy sector. They include: the Ministry of Finance (MOF), responsible for economic planning and national budget mobilization (having a voice on the REB); the Tanzania Bureau of Standards (TBS), which governs lighting product standards and market quality assurance; the Tanzania Revenue Authority (TRA), responsible for the central government's tax administration and taxation policies for clearing lighting products at the ports of entry; the Ministry for Industry Trade and Marketing (MITM), which oversees lighting trade regulations and governs market operations; the Business Registration and Licensing Agency (BRELA), responsible for business registration and licensing of lighting companies; the Tanzania Investment Center (TIC), responsible for facilitating investments by enabling environments conducive to business and entrepreneurship growth; and the Bank of Tanzania (BOT), which finances all the budgets under the MEM. Additional stakeholders include the Tanzania Harbors Authority (THA), the Customs Inspection Company, and related forwarding agents in charge of clearing commercial goods from the ports of entry.

[28]Rural Lighting — Apart from focusing on rural energy access, REA is the main implementer of Lighting Africa, and sponsored the Lighting Rural Tanzania Competition. Overall, the MEM has been aggressively promoting grid expansion through REA, e.g. funding for rural electrification has increased from USD7.4 million in 2007/08 to USD27 million in 2009/10 (LAMIM, 2013).

Civil Society and Research Institutions

Nongovernmental organizations (NGOs), community-based organizations (CBOs) and research institutions create community awareness of off-grid lighting product use, and its benefits and effects, in addition to providing grants to solar dealers and transportation companies that distribute in rural areas. NGOs include both public and private think tanks that are leading policy research for socioeconomic development and environmental preservation. Research institutions like the Research on Poverty Alleviation (REPOA), the Tanzania Industrial Research and Development Organization (TIRDO), the University of Dar es Salaam (UDSM), the Tanzania Commission on Science and Technology (COSTECH), the Vocational Education Training Authority (VETA) and the Tanzania Renewable Energy Association (TAREA) all work on policy research in sustainable energy and socioeconomic development, along with providing expert advice on renewable energy investment and progress on lighting initiatives. Others like SNV Tanzania, Solar Aid, and GVEP International are directly involved with solar lighting awareness and distribution efforts, and have managed to influence the diffusion of Photovoltaic (PV) technologies and some solar lighting into Tanzania.

Financing Institutions

Major donor financing for solar lighting projects and infrastructure comes from multilateral development institutions like the World Bank and the African Development Bank (AfDB), which to one degree or another provide seed funds to private enterprises, advise on public-private policy strategies with MEM, and finance rural lighting projects in collaboration with REA.

Micro-financing Institutions (MFIs) like Savings and Credit Cooperative Organizations (SACCOS), Village community Banks (VIKOBA**),** and Trust Funds ("Mfukowa HISA") offer energy credits to BOP consumers through community arrangements. SACCOS are fragmented and work at the grassroots level offering services through social infrastructures like schools and hospitals, as well as financing for SMEs through the Small Industries Development Organization (SIDO). In fact, SIDO has been robustly supporting women's' initiatives and the promotion of entrepreneurship and works closely with REA on rural lighting projects.

10.2. Policies for Lighting Products

Regulatory arrangements pertaining to renewable energy generally, and off-grid lighting in particular, are set by EWURA and managed by REA. Currently no formal renewable energy policy is yet in place; however several policies and enacted laws affect the provision of lighting in Tanzania. The following regulations directly affect the delivery of modern off-grid lighting technologies:

- **National Energy Policy of 2003 —** promotes clean energy, cost-efficient energy pricing and facilitation of energy investments through research development, building gender-balanced capacity in energy planning and commercialization of sustainable energy distribution of energy.
- **Rural Energy Act of 2005** — created the REA and the Rural Energy Fund (REF**)** whose main tasks are to prioritize improved rural access to modern energy services by providing performance-based subsidies for renewable energy projects
- **Electricity Act of 2008** — adapted to privatize the monopolized power industry (by unbundling and restructuring TANESCO to allow IPPs/SPPs to supply directly to consumers). It also established a framework

for market penetration of renewable energy technologies.

- **Public-Private Partnership Act of 2010**[30]— provides frameworks for public and private sector collaboration, and procurement guidelines for implementing public-private partnerships (PPPs) in environmental infrastructure investment.

The government seems favorable to the adaptation of off-grid lighting solutions such as solar lighting, as an alternative to help meet the growing energy demands that are not being met through grid electrification. To encourage the diffusion and usage of solar lighting technologies, the GoT has done the following:

- Solar Product Exemption[31] — removed duty and VAT on imported solar lighting products. Exemption is provided for all categories of solar products, this includes pico-solar products, which a number of suppliers are distributing in the market. For example, thousands of lights in this category have been distributed to school children.
- Solar Research – through the Tanzania Renewable Energy Association (TAREA), an energy think-tank of diverse public and private sector energy experts who promote the renewable energy development, investment and energy sector reforms). They have also partnered with NGOs, who work on renewable energy awareness across the country.

The Ministry of Energy and Minerals through its renewable energy policy, which is currently under development, should include facilitation of affordable rural lighting initiatives. Once this is in place, then regulations and rules to enforce lighting product standards should also be established.

Challenges also face the tax exemption provision for solar products, which is provided for all categories. There is no clear categorization of which products fall into this category, as some importers seek exemption for products, which are accessories to solar devices. There is a clear lack of expertise amongst customs officials in being able to identify with certainty which products should be considered part of this category and thus merit the exemptions. This can be problematic when it comes to enforcement of quality standards.

Another weakness is in the limited ability of regulatory bodies to effectively enforce standards. Although regulations exist or may be put into place, enforcing standards that may have a positive impact on quality is a challenge, since experience shows that the practice of implementing such activities is unsystematic. The evidence is clear from the proliferation of sub-standard electronic products all over the country. In most incidences that are reported through the media the action taken is the “destruction” of the counterfeit or substandard products.

The Ministry of Trade and Industry should, through its Business Registration and Licensing Authority, make clear what enterprises can be registered to conduct business. This will avoid unqualified adventurers in entering the supply chain, and thereby importing/distributing sub-standard lighting products.

10.2.1 Bonded Warehousing Policy in relation to Lighting Products

Conditions for application of a license include the applicant already having or renting premises. The general regulations allow for an importer to have a bonded warehouse and pay an annual fee of USD1,500. Alternatively the importer may use the Customs warehouse, which charges USD 0.30 per cubic meter per day. At present however,

[30]Public-Private Partnerships — In attempts to improve public sector operations, Tanzania like other developing countries has been instituting broad privatization schemes, which have affected the regulatory and legal framework for energy at the national level, with expected implementation on the local level. PPPs have existed in Tanzania since its independence, though the *PPP policy* was only instituted in 2010, with exception of land, state-owned water, energy and transport utilities are partly privatized, or exist in one form of PPPs *(URT, 2009).*

[31]Solar Product Exemption — Solar products exempt from VAT/Duty charges at the port include solar: panels/modules, charge controllers, inverters, batteries, pumps, refrigerators, lights, vacuum tube solar collectors, plastic collector, linear actuators for tracking system, concentrating collectors, Fresnel lenses, cookers, water heaters, water distillation units, cooling system components and crop dryers.

there is no specific regulation regarding the importation of solar lighting products in relation to warehousing. More details of bonded warehousing policy are provided in Appendix 6.

11.0. CONCLUSIONS AND RECOMMENDATIONS

11.1 Conclusions

Implications of the Current State of Electrification on Demand for Alternative Lighting Products Demand

With the current state of electrification of only 21 percent nationally, and within it a significant urban-rural gap, there is big potential demand for off-grid alternative lighting products. Even with the current programs for expanding electrification in the intermediate and long term, not all BOP consumers will be satisfactorily served by electricity from the grid, especially households in rural areas

Satisfaction with Current Lighting Solutions of the BOP and Market Potential for Alternative Lighting Products

The current lighting solutions for most BOP consumers, who form the majority of the population, and who live mainly in rural and peri-urban locations, consist of fossil fuel powered devices such as hurricane and tin lanterns. A minority of all BOP consumers have access to grid electricity, but this is very unreliable as it is frequently subject to power outages. These solutions are expensive due to their high operational costs, and also pose serious health and environmental risks. Most BOP consumers are not satisfied with them as a result.

The study shows that a majority of these BOP consumers are willing to adopt alternatives which can provide good lighting, are cheaper, and do not pose health or other hazards, as do those using kerosene fuel. In particular, the study revealed that solar lighting devices are a viable alternative, once study participants were exposed to samples of relatively low cost devices with the suggestion of purchases through suitable micro-financing schemes.

Market size estimates put the current national demand value for solar lighting devices to be in excess of USD 9 million project that over the next five years it cumulatively will be in excess of USD 80 million. All findings from the study indicate that there is much larger potential given the execution of appropriate promotional campaigns, and particularly if **micro-credit schemes are put in place**.

A Summary of the Regulatory Obstacles from the Stakeholders' Perspective

The supply environment is hampered by numerous logistical challenges that are linked to inadequate regulation at the port of entry and on the lack of product standards. The majority of stakeholders who were interviewed highlighted the following as areas creating market entry barriers to off-grid lighting distribution:

- **No mandated framework for a renewable energy policy, and a mostly donor driven agenda** — from the government agencies interviewed (REA and EWURA), both seem to be waiting on a renewable energy policy mandate from the MEM;
- **Lack of energy sector representation at the district and local level** — MEM, EWURA, and REA staff are based mostly in Dar es salaam;

- **Limited availability of energy subsidies and financing for distribution** to solar companies;
- **Relatively slow rate of policy implementation that is relevant to rural off-grid lighting** —most work is done through the REA, although their influence is yet to be widely known both by the private sector and BOP;
- **Lack of access to diverse ports** — most import/exported goods go through Dar es Salaam;
- **Bureaucratic clearing process at the port** — slow the movement of lighting goods to the market and increase product cost;
- **Inadequate quality control of lighting products and technology modules** (**major issue**)[25] — presence of obsolete and low performing products due to low product standards;
- **Theft risk when goods are in storage, and other losses** incurred by entities importing solar products.

Finally, although tax exemptions for solar products are well structured, the implementation is poorly managed by the Tanzania Revenue Authority and the TBS. Interviews conducted with these institutions indicated that the system lacks technical capacity and knowledge at all levels from the import, to storage, to the product inspection, to the clearance process. TBS is trying to regulate product quality, but the change is slow because the market is saturated with inferior products. What is somewhat promising, however, is that TAREA, an NGO involved in solar suppliers' accreditation is spearheading the prevention of counterfeit products entry, which is prohibited by law. But it needs much greater support from other stakeholders.

11.2 Recommendations

In order to achieve better Lighting Africa program design in Tanzania, key actors like REA should strengthen their role in off-grid lighting provision, and encourage increased and more organized private sector partcipation. Three keys aspects for effective market entry of solar lighting products should be addressed; (i) limited knowledge on the use and benefits of solar lighting products (ii) lack of product standards leading to market saturation with low quality products; and (iii) limited financing for solar lighting products.The following framework is recommended:

General: Increasing knowledge of the BOP consumer

Awareness levels of the existence of alternative lighting products, especially solar powered ones at affordable prices, which have superior advantages, environmentally, economically, health wise etc., are very low in the general public and especially among the BOP. Out of 156 solar lighting products dealers who were interviewed, only 33 (21%) were aware of the Lighting Africa Program and most of these were actually the winners of the LRTC 2010 and 2012. Mass media institutions should be used to disseminate publicity about these products and the efforts of various stakeholders to ensure that better quality products are being made for the market. This can be done through joint press conferences, sponsored programs in broadcast media, and advertisements.

Offering information and training particularly in these areas: understanding of the entire product Life Cycle Costs, comparative product durability, maintenance and disposal costs.

Government:

1) **Improving lighting product standards in the supply-chain**

Work with the Ministry of Energy and Mineral Resource (MEM) to ensure that Solar VAT / duty exemptions are allowed only for high quality products;

2) Increase Government Role in Promoting Off-grid Lighting

The GOT through its Ministry of Energy and Minerals should take a greater role in promoting the LA program. Support by the Government even if just expressed verbally and if disseminated in the mass media, goes a long way to influence the public to accept the program.

The supply chain

The LA program is still unknown by a number of private dealers in the supply chain. This was observed during the stakeholders' interviews. A case in point was when a national dealer did not know that some brands were certified by LA. The recommendation is, therefore, a more intensive awareness campaign to private dealers in the supply chain. This will not only increase the uptake of the certified brands, but will also promote their uptake further down the chain.

Specifically, knowledge of LA certified products amongst the public should be increased; develop consumer awareness on quality products; encourage MFI/FIs to develop innovative financing products for both enterprise (dealers/retailers) and consumer financing (for BOP); and develop programs for targeted subsidy schemes to develop weak markets etc.

The Renewable Energy Association (TAREA)

Technical support should be provided to the Renewable Energy Association (TAREA); specifically, capacity building in conducting promotion campaigns for solar lighting products, as this association is very active and in the forefront of engaging in such activities nationwide. This will contribute to consumer awareness and stimulate more demand for solar lighting products.