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Marketing solar lights to the base of the pyramid:

The case of Tanzania

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The challenge of rural distribution and affordability

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Abstract

By means of a practical example, this thesis provides insights to the challenges faced when serving solar lights to rural markets at the base of the economic pyramid (BOP). On the basis of a co-authored working paper that features a literature review of articles about the various BOP market challenges, the case study identifies the most pressing difficulties in the market launch of OOLUX, a modern off-grid lighting solution, in Tanzania. For this purpose, the paper provides, after an introductory section and a presentation of OOLUX, an analysis on Tanzania's national energy market in general, and the solar off-grid market in particular. In the second part of this paper, the case study examines the question whether OOLUX is apt to overcome the challenges posed by the rural BOP market in Tanzania. The case study focuses on those difficulties, which are considered to be the most pressing ones at the present stage. These hurdles relate to the distribution of OOLUX and its affordability. Overall, the paper intends to contribute to the evaluation of the OOLUX business model and to provide the involved stakeholders with recommendations for the future development of OOLUX in general, and the distribution model in Tanzania in particular.

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List of Abbreviations

BOP	Base of the Pyramid
FMCG	Fast Moving Consumer Good
kW	Kilowatt
LED	Light-Emitting Diode
MEM	Ministry of Energy and Minerals
MWp	Megawatt peak
NBS	National Bureau of Statistics
NGO	Non-Governmental Organisation
REA	Rural Energy Agency
REF	Rural Energy Fund
SFIF	Sunjua Fundi Investment Fund
SHS	Solar Home Systems
SPV	Solar Photovoltaic
TANESCO	Tanzania Electric Supply Company Limited
TAREA	Tanzania Renewable Energy Association
TBS	Tanzanian Bureau of Statistics
VAT	Value Added Tax

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A. Introductory Section

I. Problem Analysis

Today, there are still 1.4 billion people on our planet who do not have access to reliable energy. An estimated 85% of the people without access to electricity live in rural areas or in the outskirts of big cities, where the expansion of electricity grids is expensive and thus insufficient. The UN estimates that an average of USD 35-40 billion need to be invested every year until 2030 in order to achieve universal access to modern energy services for cooking, lighting, heating and other productive uses (The Economist, 2010). Apart from large-scale top-down projects, new and innovative technologies need to be developed to provide reliable and sustainable energy to as many rural households as possible (The Economist, 2010). Combined with flexible and carefully designed business models, such new technologies can reach a huge market that has been largely neglected in the past. This market is commonly referred to as "the base of the pyramid" (BOP). While reaching universal access to energy is a big challenge, it also creates opportunities for diverse public and private actors to offer innovative solutions. To be successful, these solutions need to take specific difficulties related to BOP markets into account and develop business models designed to address them.

One such technological invention aimed at serving BOP markets is OOLUX, a solar-powered charging and lighting solution currently marketed in six developing countries. OOLUX was developed by Antenna Technologies in cooperation with Caritas Switzerland and the Berne University of Applied Sciences. It is especially designed to serve basic energy needs of people living in rural off-grid areas. Based on solar energy, OOLUX intends to serve as a valuable and sustainable alternative to kerosene, which is today's prevailing source of energy in the project's target areas. The approach chosen by Antenna and its partners was to offer a high-quality device that not only guarantees quality, but also reliability and modularity. To reach customers at the base of the pyramid, however, OOLUX needed to be affordable as well. To combine those key features and adapt OOLUX to the need of BOP customers, an innovative micro-finance solution was already incorporated on product level.

For a first pilot phase, starting in April 2013, three students from the University of St. Gallen were employed by Antenna Technologies as Field Project Assistants to support local partners with the market launch of OOLUX in Tanzania (Simon Moser), Zambia (Bettina

Naef) and India (Thomas Tenchio). Apart from testing the performance of the devices in their every day use, assessing their acceptance by typical target beneficiaries, and carrying out market research; the pilots' purpose was to smooth the way for a viable local distribution network that can ensure a continuous delivery of OOLUX. On a more general level, these field-tests are an important step in the long-term process aimed at providing proof of concept for a suitable business plan to distribute OOLUX. The present paper intends to contribute to this process by evaluating if and how the OOLUX business model provides viable solutions to overcome challenges faced in serving the rural BOP market in Tanzania.

II. Methodology

Prior to the pilot, the three research assistants jointly developed common research tools and co-authored a working-paper. The commonly developed research tools served as a basis for semi-structured interviews held with involved stakeholders to evaluate and assess the devices' performance, its usability and the overall concept. Although some of the interview's key findings will contribute to the thesis at hand, they are not considered explicitly as methodology, since much of their content is outside the thesis' subject.

The primary purpose of the working paper was to embed the research question, namely whether the OOLUX business model is apt to overcome the challenges posed by the BOP market, within a theoretical framework and to serve as a guideline for the numerous informal discussions with stakeholders held in the field. The co-authored working paper features a literature review of articles about the various market challenges of serving people at the bottom of the pyramid as well as the respective approaches to these challenges as identified and suggested by scholars and practitioners. In the pilot, equipped with the theoretical knowledge about the BOP market challenges, numerous informal discussions and observations have contributed to identify the country and context specific challenges. The case study at hand will, however, focus only on those difficulties, which are considered as the most pressing ones by the author at this early stage of OOLUX's market launch, namely hurdles related to its distribution and affordability. Apart from identifying these challenges and evaluating current approaches, possible alternative strategies are discussed, and recommendations are given on how the OOLUX business model should further be developed. Overall, the evaluation is based on desk-research, own observations in the field, as well as numerous informal discussions with local partners, retailers and customers.

III. Structure

The first three chapters of the paper at hand provide background information on the case study in Tanzania. The present chapter will close with an introduction to the BOP market challenges in general, and to the co-authored working paper in particular. Then, in a second chapter, attention will be drawn on OOLUX and its features specifically designed to circumvent obstacles posed by the BOP market. Given that the focus of the present paper is on Tanzania, the third chapter will introduce the reader to Tanzania's national energy market especially emphasising its off-grid solar lighting market.

The second part of this research paper – a case study on Tanzania - is dedicated to the main research question and evaluates OOLUX' first steps in Tanzania. A first section provides the reader with background information on the context of the field test and on the involved partners. A second section is then dedicated to the identification of challenges summarized under the umbrella of "Availability". The current OOLUX business model is mirrored to each of the identified challenges and where weaknesses are found, possible alternative approaches are being outlined. A third section subsequently identifies challenges that fall under the umbrella of "Affordability". Again, the current OOLUX business model is evaluated and, if necessary, alternative approaches are outlined and recommendations given. Finally, a fourth and last section summarizes the insights gained and attempts to review the recommendations deemed the most interesting and urgent ones.

IV. The BOP Market

The term "base of the pyramid" became widely known when C.K. Prahalad's and S.L. Hart's article "The Fortune at the Bottom of the Pyramid" was published in 2002. The two authors argue that a new way of thinking, where the poor are not longer seen as victims but as resilient and creative entrepreneurs and value conscious consumers, could open a whole new world of opportunities for business and poverty alleviation strategies. In Prahalad's and Hart's opinion, multinational companies should include emerging markets in their globalisation strategies and leverage the huge potential of the four billion people in the world who live on less than 1500 USD[1] a year and comprise the base of the economic pyramid (Prahalad & Hart, 2002, pp. 1–3).

[1] The debate on the number of people comprising the base of the pyramid as well as on their income level is highly controversial. Prahalad and Hart (2002) suggest that the BOP market comprises 4 billion people living on

Ever since Prahalad's and Hart's article gained wide-soared attention, a growing number of multinational companies, as well as small- and medium sized enterprises have tried to invest in technologies and business models that tap the BOP market, a market segment that used to be regarded as too risky and costly to serve. The subject drew more and more attention and practitioners and scholars increasingly began to publish reports and journal articles on the specific challenges of the BOP, as well as on potential strategies to address them. The above-mentioned co-authored working paper builds on this existing literature and provides an overview of the challenging characteristics of BOP markets and outlines approaches to address them.

Before elaborating on the content of the working paper, it is important to mention that the BOP market does in no way constitute monolithic market. Rather, the market is highly complex and comprises different cultures, ethnicities, capabilities and needs. Thus, succeeding in rural Tanzania does not necessarily mean to succeed in rural India as well. To summarize the BOP market challenges and correspondent strategies in a meaningful way, the co-authored working paper has built on the so-called "4-A framework" proposed by Jamie Anderson and Niels Billou (2007). The two authors suggest that in order for businesses to succeed in serving BOP markets, they need to adopt a holistic approach aimed at successfully delivering the four A's, namely availability, affordability, acceptability and awareness. While Anderson and Billou's framework is not specifically related to BOP market challenges (but rather to how and with which products and services BOP markets should be served), it nevertheless served as a useful basis for the classification of the identified challenges and strategies.

Since it is not the primary purpose of the present thesis to explain general BOP market challenges in detail, the author refers interested readers to the working paper "The challenges of serving rural BOP markets" in the appendix. This thesis chooses to focus on the challenges that are considered the most pressing ones at this early stage of the OOLUX market launch, thereby putting special emphasis on challenges that jeopardise the availability and the affordability of OOLUX. Before, however, dipping into the case study, the subsequent chapter introduces OOLUX and the solar off-grid lighting market in Tanzania.

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less than 1500 USD a year whereas in e.g. the WEF (2009) refers to 3.7 billion with an income threshold of 3000 USD a year.

B. OOLUX – An Innovative Solar Off-Grid Solution

I. The Project

OOLUX is the result of a collaborative project that has been launched in 2011 by the Geneva based Antenna Technologies Foundation in partnership with Caritas Switzerland and the Berne University of Applied Sciences. Its goal is to develop and distribute an innovative lighting and charging solution for people living in off-grid areas, mainly in the global south. Drawing on many years of experience in the field of developing cooperation, Antenna Technologies and Caritas, as well as their consultants, have realised that many of the existing off-grid energy solutions failed to adapt to the needs of poor customers living in rural off-grid areas and were thus unsuccessful in replacing the widely used but unsafe and unhealthy kerosene (IFC, 2012, p. 23). In earlier pilots, Antenna and its partners had identified the demand for a good lighting solution that is reliable and affordable at the same time and can thus match the advantages of kerosene. (Antenna Technologies, 2013a). To put it in a nutshell, a novel high-quality product that satisfies the basic energy needs of small households at the same cost of kerosene was needed.

It is on this premise that the Berne University of Applied Sciences invested its technological excellence and knowledge in the field of solar technology into developing a solar kit prototype later named OOLUX (Antenna Technologies, 2013a). After more than twelve months of intensive research and development, a pre-series of 1000 OOLUX kits was produced in the beginning of 2013. This pre-series is currently being tested with eight partners in six different countries in South-Asia (India and Bangladesh), Eastern-Africa (Zambia, Tanzania, Kenya, Uganda) and West-Africa (Cameroon) (Antenna Technologies, 2013b).

II. The Product

OOLUX is a modular solar kit composed by one battery, one solar panel, two high-performance LED lights, one lamp stand and one multi-phone charger. As mentioned above, the aspiration of Antenna and its partners was to produce a kit made of high-quality components. Accordingly, latest technologies such as Lithium Ion batteries, advanced power electronics and high power LEDs were used to increase durability and system performance, as well as to lower energy losses. To allow customers certain flexibility, the battery (called PowerBox) was designed to be chargeable by different types of solar panels, but also by a

car battery or a grid adapter. As suggested above, the principal purpose of OOLUX is to provide light. It was observed, however, that customers increasingly needed energy to power other devices as well, especially mobile phones. To respond to this need, the PowerBox is equipped with two USB interfaces. The battery powers the LED lights included in the kit and any other USB device such as mobile phones or small radios. The idea was to keep OOLUX as modular as possible, in order to allow users to best adapt OOLUX to their needs.

Figure 1: Promotional Photographs (Antenna Technologies, 2013a; Hassler, 2013)

Thanks to the employment of high-performing materials, the PowerBox has a high capacity to charge rapidly and assure a sufficient electricity supply. To fully charge a PowerBox, ten hours of direct exposure to sunlight are needed. In turn, a fully charged PowerBox can power both included LED lights for up to 16 hours, or can alternatively be used to charge up to 10 cell phones of basic quality (Hassler, 2013, p. 18).

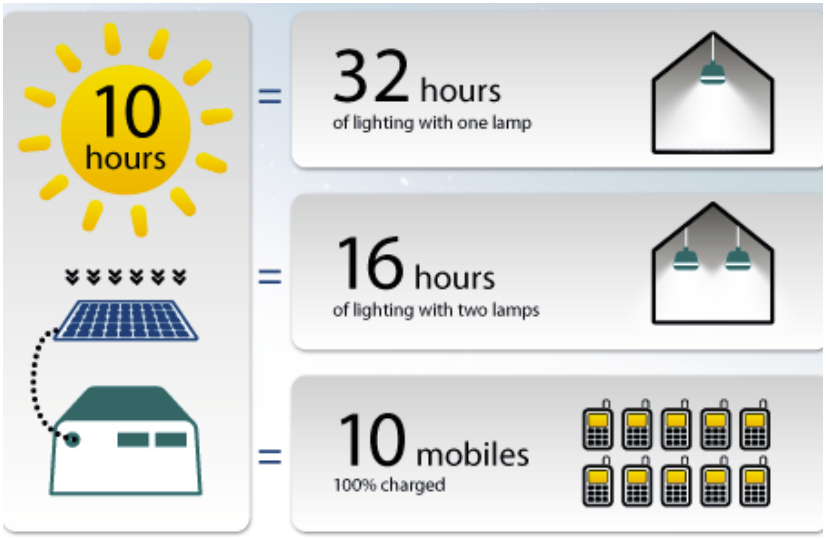

Figure 2: OOLUX kit performance (Antenna Technologies, 2013c)

To increase the product's longevity, a robust design and a unique hang-up interface were created. Furthermore, capacitive touch buttons, well known from Smartphones, have replaced easily damageable mechanical switches.

Antenna Technologies' intention was to provide a high-quality solar kit that is affordable for people at the base of the economic pyramid. An innovative solution was needed to reach those customers and developers came up with the idea of equipping the PowerBox with a novel micro-finance software. The software would render the PowerBox – and with it the electricity – contingent on payments made by the customer, and thus include a micro-finance solution incorporated already at product level (Hassler, 2013, p. 19). Given that this integrated micro-finance management software is a key determinant of the OOLUX business model, its functioning will be outlined in the following chapter.

III. The Micro-Finance Solution

The micro-finance management software, called OOLUX-manager, was developed to increase OOLUX's affordability and is intended to simulate the cost structure of kerosene by linking the functioning of the PowerBox to the instalments paid by the customers. Typically, customers make a down payment of 10-15 per cent and repay the full retail price in regular instalments over a credit period determined in advance (6-12 months). Within the agreed time period the customer can purchase energy for varying amounts of time (weeks/months), making the system adaptable to the varying financial situation of customers. This flexibility is the feature that makes OOLUX comparable to lighting with kerosene lamps: The amount of funds spent on light can be adapted to the fluctuation of the customer's income. The

OOLUX-manager is operated with a computer and enables the retailer to activate the PowerBox for the amount of time the customer has purchased. At the end of the paid period of time, the PowerBox switches off. The basic idea is that the automatic deactivation of the kit at the time when the next payment is due ought to encourage the customer to make the subsequent payment. The OOLUX-manager thus reduces the risk of non-repayment and payment delays. To facilitate the management of multiple instalment plans, the OOLUX-manager furthermore allows to manage and control payment histories and offers a variety of instalment plans at different conditions (Antenna Technologies, 2013c).

Customers need to pay the instalments at the sales operator's shop. As a result, the area of sales operations is considerably limited. The advantage of this system, however, is close customer contact serving as a base for an important feature of the OOLUX concept, namely a high-quality after-sale service: Technically skilled sales forces, a two years warrantee and a replaceable battery should maximise customer loyalty and guarantee recycling (Antenna Technologies, 2013c). Such a concept, however, is strongly contingent upon local partners. They are essential to setting-up a dense distribution network and thus ensuring the performance quality OOLUX aspires. Ideally, these networks are composed of regional branch offices providing continuous customer care services and supplying spare parts, as well as of local sales operators assuring last-mile distribution and after-sales services.

C. Energy Market in Tanzania

The subsequent chapter on Tanzania's energy market is divided in three parts. The first part consists of key facts and figures on Tanzania, providing the broader context of the case study at hand. While the second part primarily focuses on energy sources and supply as well as on latest government initiatives, a third part analyses Tanzania's off-grid solar lighting market in more detail. Overall the chapter should contribute to a broader understating about how OOLUX positions itself in Tanzania's energy market.

I. Country Profile

With an area extending to 947'300 km^2, the United Republic of Tanzania is the world's 31st-largest country. The country climate varies from tropical along the ocean coast to temperate in the highlands north and south (CIA, 2013). With an average of 3'107 hours of sunlight per year and radiation intensity of 4,6 kWh per m^2 per day Tanzania has a high potential for solar thermal and photovoltaic exploitation (Hanko & Völler, 2011, p. 23). Dar es Salaam is

Tanzania's largest and principal commercial city and has a population of 4.3 millions (2012 census) (NBS, 2013, p. 26). While Dar es Salaam is the commercial capital, Dodoma, a medium-sized city in Tanzania's centre, is the official political capital (BBC, 2013).

The country's population was estimated to about 48 million people in 2013 and consists of more than 130 tribes. While over 100 different tribal languages are spoken in Tanzania, Kiswahili and English are the official languages. The former is considered as the unifying language between the different ethnic groups. Roughly 75 per cent of Tanzania's population live in rural areas (CIA, 2013).

Figure 3: Map of Tanzania (CIA, 2013)

Since several years, Tanzania does well in maintaining macroeconomic stability. Between 2001 and 2007 GDP per capita has increased by 29.9 per cent and Tanzania's medium-term growth prospects are around 7%, albeit boosted by natural gas discoveries (African Economic Outlook, 2013; Atkinson & Lugo, 2010, p. 3). Other main drivers of growth have been agriculture, manufacturing, wholesale and retail trade, transport and communication economies. The agriculture sector, which accounts for more than one-quarter of GDP, remains the largest employment sector, absorbing 74 per cent of labour forces. In recent years the sector has, however, underperformed and has been a key factor in jobless growth and chronic underemployment (African Economic Outlook, 2013).

Despite Tanzania's impressive economic growth, poverty rates have not been reduced significantly (Atkinson & Lugo, 2010, p. 3). Furthermore, structural problems such as a high level of corruption impede significant improvements in infrastructure.[2] This is reflected in poor transport facilities and an energy sector that is plagued by inefficiencies in distribution and revenue collection and, according to the 2013 African Economic Outlook, is on the brink of collapse (African Economic Outlook, 2013; CIA, 2013).

II. The Energy Sector in Tanzania

After this overview of key facts and figures on Tanzania, the subsequent chapter analyses Tanzania's energy sources and supplies, and provides an overview of the latest government initiatives regarding the energy sector in general, and rural electrification in particular.

1. Energy Sources And Supply

The State-owned Tanzania Electricity Supply Company Ltd (TANESCO) manages Tanzania's grid. Electricity provided by TANESCO is derived from local hydroelectric plants and fossil fuels (60.5 and 39.5 per cent respectively) (CIA, 2013). Despite Tanzania's wide array of natural resources such as uranium, wind, solar, hydropower and geothermal power and a growth in power generation of about 6 per cent annually, commercial energy sources (petroleum, hydropower, natural gas and coal) only account for 10 per cent and electricity only for 6 per cent of total energy consumption. Biomass-based fuel, particularly wood-fuel, which has significant impact on the process of environmental degradation, accounts for the remaining 85% of total energy consumption (Ministry of Energy and Mineral, 2013; Mwakapugi, Samji, & Smith, 2010, p. 6).

As these figures suggest, Tanzania's national grid is scarce. In fact, it only reaches around 14-17 per cent of the total population, leaving 38 million people without access to electricity (IEA, 2011, p. 473; NBS, 2013, p. iv). However, these numbers do not reveal the significant disparities between urban and rural electrification access. An isolated measurement reveals a rural connectivity rate of 5.3 per cent (NBS, 2013, p. iv). Therefore, rural households rely heavily on traditional biomass, mainly used for cooking. Energy for transport and power generation markets stem from imported petroleum, diesel, petrol and jet fuel. Liquefied petroleum gas (LPG) is the predominant source of energy in urban cooking markets (Lighting Africa, 2012, p. 1).

[2] According to Transparency International's Corruption Perception Index, Tanzania is ranked 102th of 176

2. Government Initiatives And Policies

From Tanzania's independence in 1961 until the early 1990's, Tanzania's electricity supply industry was exclusively state-controlled. Only in 1992, a combination of macro-economic reforms and international donor policies, as well as a drought-induced energy crisis paved the way for the National Energy Policy introduced in 1992. A policy framework that included plans to involve private companies in the development of the energy sector. The subsequent implementation of two large power projects (IPTL and Songas) in collaboration with private sector companies and international institutions, such as the World Bank, not only marked the renunciation of the exclusive government controlled approach, but also signified the beginning of the diversification of energy resources. These trends were politically articulated in the most recent National Energy Policy adopted in 2003. The policy is based on a wide range of socio-political and economic reforms, including a liberalization of the energy market. Despite these tendencies, however, the industry remains state-owned and state-controlled to a great extent (Gratwick, Ghanadan, & Eberhard, 2006, pp. 40–41; Mwakapugi et al., 2010, p. 8).

Lighting Africa (2012), suggests dividing current government initiatives in the energy sector into four groups: general grid based extension efforts, rural grid extension efforts, funding and dissemination of independent mini-grids, as well as support of the commercial sector in supplying household-level devices. Before elaborating on the government's rural electrification efforts, an overview of the most relevant involved government agencies is provided in Table 1.

Key Government Agencies in Tanzania's Energy Sector:

- **Ministry of Energy and Minerals (MEM).** Responsible for overseeing the development of energy and mineral resources. http://www.mem.go.tz
- **Rural Energy Agency (REA).** Government implementing agency for rural electrification and energy sector development programs. Also manages a rural Energy Fund (REF). http://www.rea.go.tz
- **Energy and Water Utilities Regulatory Authority (EWURA).** Autonomous multi-sectorial regulatory authority responsible for technical and economic regulation of the electricity, petroleum, natural gas, and water sectors. Functions include licensing, tariff review, monitoring performance, and standards with regards to quality, safety, health and environment. http://www.ewura.go.tz
- **Tanzania Electricity Supply Company (TANESCO).** Responsible for the generation, transmission, and supply of electricity in the most effective, competitive, and sustainable manner possible. http://www.tanesco.co.tz

Table 1: Key Government Agencies in Tanzania's Energy Sector (Lighting Africa, 2012)

Tanzania's rural electrification policy is based on the Rural Energy Act passed in 2005. The government's goal is to facilitate activities and investments by private and community entities. To pursue this objective, the Rural Energy Agency (REA) was established in 2007. The REA provides grants and subsidies through the Rural Energy Fund (REF) for rural grid extension, as well as for off-grid energy access projects. Most of these projects are implemented in collaboration with the private sector, non-governmental organisations (NGOs) as well as with other governmental agencies. Projects funded by the REF are mostly targeted at supplying electricity to schools and improving health and water facilities but also include energy access improvement of commercial centres and private households (Mwakapugi et al., 2010, pp. 10–11).

In recent years, the availability of funds for rural electrification has increased steadily. In 2008, Tanzania received the Millennium Challenge Compact Grant[3], worth USD 698 million, with the explicit goal to enhance the coverage, transmission and distribution capacity of rural electrification, as well as to reinforce the existing network (Spitsen, 2012). Similarly, according to Lighting Africa, governmental funding for rural electrification has increased from USD 7.4 million in 2007/2008 to USD 27 million in 2009/2010 (Lighting Africa, 2012, p. 2). In

[3] The Millennium Challenge Compact Grant is a multi-year agreement between the Millennium Challenge Corporation (MCC), a United States aid agency, and a specific country with the aim to fund programs to reduce poverty. See more on the Millennium Challenge Compact Grant on the MCC website: http://www.mcc.gov/pages/activities.

the field of private sector support, a noteworthy initiative, specially also in light of OOLUX, is REA's yearly-held Lighting Rural Tanzania Competition. This initiative is a competitive grant programme, aimed at supporting private enterprises in developing and delivering modern lighting products to rural households and businesses (REA, 2012).

The increase in the availability of funds and the above-mentioned initiatives indicate that rural electrification has gained momentum in Tanzania's national policy. But even though these government initiatives are scaled-up, low-income and distant households are still very likely to be left behind. An estimation of Lighting Africa on the electricity access rates in 2020 provides some impressive numbers to demonstrate the challenge Tanzania is facing. On the – admittedly rather optimistic assumption - that connection rates will increase 13 per cent per year in urban areas and 30 per cent per year in rural areas, the study concludes that urban electricity access will exceed 90 per cent by 2020, whereas rural electricity access will still be as low as 20 per cent at the same time (Lighting Africa, 2012, p. 4).

Policy statements as well as grant programmes supporting entrepreneurship and private initiatives indicate that there is – even if modest - political intent to partner with the private sector to tackle the challenge of rural electrification (Lighting Africa, 2012, pp. 2–3; Ministry of Energy and Mineral, 2003, pp. 23–27). Finally, this intention is also reflected in the abolishment of a value added tax (VAT) and import duties for solar photovoltaic products, including solar modules, charge controllers, solar-specific batteries, lights and associated products determined in 2005 (Lighting Africa, 2012, p. 6).

Recent policies and initiatives indicate a trend in the diversification of energy sources and an increasing emphasis on rural electrification initiatives. Furthermore could recently launched grant programmes aimed at supporting private enterprises operating in the field of rural electrification, be an interesting opportunity for the OOLUX project. Yet, governmental support for renewable energy in general and solar power specifically should not be overestimated as the government's long-term plan for the energy sector focuses almost exclusively on the expansion of natural gas, coal and hydro power (Ondraczek, 2013, p. 411).

III. Tanzania's Off-Grid Solar Lighting Market

After a general introduction to Tanzania's energy industry and an overview of the most important government initiatives and policies, the next chapter will investigate Tanzania's off-grid solar lighting market. The chapter starts with an overview of the different solar photovoltaic (SPV) technologies involved and a short historical rundown of the SPV market in

Tanzania. The two subsequent sections elaborate on the various off-grid solar lighting market segments and shed light on the profile of an average rural customer, thereby providing the reader with an understanding of the customer segments targeted in the OOLUX pilot. Finally, a competition analysis and a look at some industry trends aim at positioning OOLUX against its competitors while at the same time providing an outlook of the most important trends.

1. General Information on Off-Grid SPV Technology

Solar photovoltaic technology directly converts solar energy into electricity using semiconductor materials known as solar cells. In the rural context, solar photovoltaic (SPV) technology is mainly used in the form of “mini-grid systems” or “household-level systems and devices”. Mini-grid systems generally have a capacity from about 30 to 500 kilowatts (kW) and can be run by photovoltaic or other power sources including diesel, biomass or even hybrid systems (IFC, 2012, p. 14). Because mini-grid systems are not widely spread in Tanzania and rather designed to power entire villages than single households, the following analysis will focus on so-called household-level systems and devices (Ondraczek, 2013, p. 412).

Household-level systems and devices can be broadly divided into rooftop solar home systems (SHS), solar kits and solar lanterns, as well as other productive devices such as solar powered water pumps, which are not considered in this thesis. Rooftop SHS differ from solar kits mainly in price and power capacity. SHS cost between USD 300 to USD 500 and provide sufficient power for a household, small retail businesses or even small public institutions. Solar kits like OOLUX, however, are “portable solar home systems” priced at USD 100 to USD 150 and allow households to run multiple lights and charge small electronic devices. Finally, solar lanterns, normally exclusively providing light, have retail prices from around USD 20 to USD 50 and are the most affordable way for BOP customers to purchase improved lighting technologies (IFC, 2012, p. 13).

2. SPV Off-grid Technology - Market Development

SPV off-grid technology first entered Tanzania in the mid 1970s, partly as a reaction to rising gasoline and fuel prices triggered by the oil crisis in 1973/74 (Sheya & J.S. Mushi, 2000, p. 263). At that time, the main driver of the SPV market development was the public sector, through projects such as electrifying rural social institutions like schools, churches and health centres with SPV off-grid technology. Only in the late 1990s and early 2000s, when the demand for SHS was driven by the spread of broadcasting signals and the availability of TV

sets and radios, private companies began to target Tanzania's private rural households. Apart from the demand created by the availability of such technologies, the emergence of Tanzania's commercial market was also triggered by spill-overs from Kenya's solar market that had already established two decades earlier (Ondraczek, 2013, pp. 410–415).

Since the late 1990s, Tanzania's solar market has expanded rapidly. The annual growth rate has been ranging between 15 to 30 per cent. Also, has solar PV capacity grown from 1.2 Megawatt peak (MWp) in 2003, to some 3-4 MWp in 2009. By 2008 a total number of 40'000 SHS was estimated to be sold with annual sales rates of 4000-8000 systems. Of the overall installed SPV capacity, SHS and small-scale commercial systems account for three-quarters of the total output, while the remainder consists of larger institutional systems that are mainly procured by the public sector. In view of increasing rural incomes, falling SHS prices and a increasing variety of system sizes, the SHS market is estimated to further expand and to reach increasingly a number of low income households (Ondraczek, 2013, pp. 410–412).

In line with this development, a *modern* off-grid lighting market has recently developed focusing on high-quality lighting products including solar kits and solar lanterns (Lighting Africa, 2012, p. 3). Companies serving this market are often start-ups based in the global north that focus on the design and marketing of a single product or segment. The manufacturing, however, is often outsourced and the distribution in target markets organized through local partner companies, NGOs or farmer associations (IFC, 2012, p. 44; Lighting Africa, 2012, p. 3). It goes without saying that OOLUX is part of this modern off-grid lighting market and, against this backdrop, the subsequent section will analyse the different market segments that can potentially be targeted with modern off-grid lighting products.

3. Market Segments

Note that, because of the absence of alternative sources, the subsequent analysis is largely based on the analytical framework provided by the Lighting Africa Policy Note on Tanzania (2012). Wherever useful, the framework was supplemented with the author's own observations.

The modern off-grid lighting market can be roughly divided into a rural and an urban market. According to Lighting Africa (2012), the rural lighting product market comprises a total of 5.6 million households, whereas the urban market is estimated to merely cover 2.1 million households. The above-mentioned report further suggests to divide the market for modern off-grid lighting products into six different markets described below. (Note that a lack of data on poverty and purchasing power renders an exact differentiation of these market segments difficult (Lighting Africa, 2012, p. 5).)

The rural off-grid poverty market

This market is by far the biggest off-grid market covering 75-80 per cent of the total rural lighting market. Customers of this segment belong to “the base of the energy pyramid” meaning that they have restricted, if any, access to modern energy technologies. Due to geographic isolation and the inefficiency of informal markets, BOP customers in rural areas generally pay higher prices for lighting products or charging services than customers in urban areas (Hammond, Kramer, Katz, Tran, & Walker, 2007, p. 84). Furthermore, are customers of this segment characterized by an insufficient income, low risk-taking capabilities and little awareness of modern SPV off-grid technologies. Hence, innovative distribution channels and financial services need to be established in order to actually reach these customers.

The rural off-grid middle-class commercial market

The rural off-grid middle-class commercial market comprises 15-20 per cent of the total rural lighting market and is characterized by customers with slightly higher incomes, mainly due to fixed employment or the ownership of small businesses. Consequently, this group exhibits higher risk-taking capabilities and – depending on the availability of products – has more experience with modern SPV off-grid technologies.

The rural grid connected market

The rural grid connected market is, with 1-5 per cent of the total rural lighting market, very small. Since rural electrification access is progressing very slowly, these numbers are likely to remain low. Rural grid connection is, however, often expensive and unreliable, and modern SPV off-grid technology can therefore serve as a cheaper alternative or as a backup solution.

The urban poverty market

The urban poverty market is with 20-25 per cent of the total urban lighting product market modest in size. Similarly to the rural off-grid poverty market, this market segment is constrained by households with insufficient and volatile incomes and customers with little experience with modern SPV off-grid technologies. Compared to the rural poverty market, this market segment, however, is easily accessible.

The urban off-grid commercial market

Recently, a commercial market for lighting has developed to serve the 25-30 per cent of the 2.1 million households that make up the urban lighting product market. Compared to their rural counterparts, customers of this market segment have slightly higher incomes and are more easily accessible.

The urban grid connected market

Finally, the urban grid connected market, covering 50 per cent of urban households, is highly competitive and is interested in lighting and charging products that primarily serve as a backup when the grid fails.

Overall, this analysis reveals that the rural off-grid poverty market is by far the largest. It is, however, also the most difficult to serve. Both, the rural off-grid and the urban off-grid commercial markets account for an important share of the total lighting market and are thus of interest for OOLUX, especially since the customers of the latter segment are more easily accessible and customers of both segments are less constrained financially. Further investigations are needed to evaluate OOLUX's potential in the urban grid connected market. Note that in the context of the pilot, the rural off-grid poverty and the rural off-grid middle-class and commercial market have been targeted. Thus, the following section introduces an average *rural* customer profile in order to get a better understanding of the customers that make out these market segments.

4. Average Rural Customer Profile

In rural Tanzania, an average household has, according to the Household Budget Survey of 2007, 5.1 family members (NBS, 2007, p. 6). For almost 70 per cent of rural Tanzanians, agriculture, hunting and forestry are the main activities to generate an income (NBS, 2007, p. 5). According to a Lighting Africa survey (2011), an average monthly income for a rural household is around $90, leaving limited room for purchasing any other goods than basic commodities such as modern lighting technologies (Lighting Africa, 2011, p. 15). Estimations of rural income should, however, be treated consciously, since sources of income and income patterns are often volatile and people rather reluctant to share information about their financial situation.

Only around 5.3 per cent of rural areas have access to any form of electricity. The by far most commonly used energy source for lighting is therefore kerosene (NBS, 2013, p. iv; 47). Additionally, people often use battery-powered flashlights for moving after dark. On an average day in Tanzania, dusk is falling between 6:00pm and 7:30pm. Preparing dinner,

doing homework or socializing, are some of the activities that are taking place after dark and need lighting. Two rooms, usually the main room and the kitchen room are lit, while other areas of the house remain under-lit to save energy expenditures. Some Tanzanians, especially mothers, use dimmed kerosene lights during the night for security reasons or breast-feeding their small children. Before dawn, lighting is used for preparing breakfast and doing household chores. Figured up, approximately 5-6 hours of lighting per day are required in a typically Tanzanian household (Lighting Africa, 2011, pp. 17–19).

Besides lighting needs, charging mobile phones is the most urgent energy need in rural Tanzania. The number of people owning mobile phones has increased rapidly over the past 6 years. Whereas in 2006 less than 20 per cent of adult Tanzanians owned a mobile phone, 59 per cent were subscribed as mobile phone users in 2011 (van Genuchten, Haring, van Kassel, & Yakubi, 2012, p. 6). Due to the populations' low electrification access, many rural mobile phone owners charge their devices at charging stations in shops. These offer mobile phone charging for fees of around $ 0.20 - $ 0.40 per charge (Tracy & Jacobson, 2012, p. 9). As shops with access to electricity are scarce, costs in terms of time and transport fees have to be considered in over-all energy expenditure calculations as well.

Total energy expenditure amongst the poorest of the poor is estimated to account for 10-15 per cent of total household income (Lighting Africa, 2011, p. 12). Appling the same energy expenditure rate to the average rural income of 90 USD per month, energy expenditure would figure around 9-12 USD a month. Similar results yielded calculations based on informal discussions with customers that are leasing solar lanterns instead of using kerosene. Based on the assumption that households charge their mobiles 10-20 times per month (300 TZS per charge) and use 1-2 lanterns every day (300 TZS per lantern per day), monthly expenses per household range from minimum 9'000 to maximum 24'000 TZS (6-15 USD). Average expenses could, however, be higher as some customers reported buying kerosene to cover additional lighting needs.

5. Competition Analysis

This section aims at shedding light on the principal competitors of OOLUX. As the subsequent analysis shows, the principle competitors can be broadly be located in either a largely unregulated fast-moving consumer goods (FMCG) market and/or a high-quality product market (Lighting Africa, 2012, p.3).

Low quality off-grid lighting products are predominantly supplied by producers from the Far East. Their products are generally inexpensive and include solar devices as well as lighting products based on other energy sources such as batteries (Lighting Africa, 2012, p. 3). A

visit to Dar es Salaam's main commercial district Kariako and to several solar shops in rural areas revealed that the great majority of shops selling electronic devices also sell low quality off-grid lighting products such as simple lanterns, desk lamps and solar kits including batteries, panels and lamps. According to shop-owners, no after-sales services are provided for these products.

Next to low-quality off-grid lighting products, a small but increasing range of high-quality solar products from companies based in the global north, such as Barefoot[4] and D-Light[5] have entered the market in the past years. These products profit from an increasing demand that stems from consumers' negative experiences with low-quality off-grid lighting products and the promotional efforts of governmental institutions such as the REA, as well as non-governmental organizations, including Lighting Africa and the Tanzania Renewable Energy Association[6] (TAREA) (Lighting Africa, 2012, p. 3). The above-mentioned products were found in most shops in Kariako and in some of the shops visited in rural areas.

Recently, the Tanzania Bureau of Standards (TBS) has been pressured to improve the implementation of existing quality standards. In February 2012, a pre-shipment quality inspection was introduced to curb the import of low-quality goods. These inspection procedures are applied to solar products as well as to other types of consumer goods. Further, new national quality standards have been developed for solar lighting products in order to harmonize with the East African Standards (EAS). The new standards that have yet to be officially published, have already been approved by the parliament. Although efforts are clearly made to improve the situation of the modern off-grid lighting market, actual improvements will depend on effective enforcement of quality standards. In practice, the market is not sufficiently regulated yet, a fact that still allows opportunistic traders with no quality oversight to enter the market (Lighting Africa, 2012, p. 7).

6. Important Trends

A first important tendency observed in rural areas is the increase of kerosene prices. The price of kerosene depends on oil prices, which have undergone large fluctuations in the past decade and are generally on the increase. In 2012, the price of kerosene was around USD 1.2 per litre in rural, and USD 1 per litre in urban Tanzania. Compared to other Sub-Saharan African countries, kerosene in general is readily available in both urban and rural regions

[4] Barefoot Power: http://www.barefootpower.com/ (accessed 11.11.2013)

[5] D.Light: http://www.dlightdesign.com/ (accessed 11.11.2013)

[6] TAREA: http://www.tarea-tz.org/ (accessed 11.11.2013)

(Tracy & Jacobson, 2012, pp. 5–8). The total expenditure on importation of petroleum products amounts to USD 190 million per year. An important part of it is illumination kerosene. While most petroleum products are assessed with a VAT of 25 per cent, kerosene is exempted from taxation. The measure was introduced to improve access to lighting options for the rural population. The indirect price reduction for kerosene results, however, in a competitive disadvantage for modern off-grid lighting solutions (Lighting Africa, 2012, p. 6).

A second important industry trend is the continuous increase in mobile phone penetration. As already mentioned-above, almost 60 per cent of Tanzanians own a mobile phone. Although mobile penetration is certainly significantly higher in urban areas, this trend is likely to spread in Tanzanian rural areas in the coming years (van Genuchten et al., 2012, pp. 6–7). Already today, Vodacom Tanzania, the country's leading mobile phone company, provides a GSM network with a countrywide coverage of 75.82 per cent of the total population (Vodacom, 2013). Tanzania's telecommunication market is highly competitive and offers not only standard mobile services but also payment services. In 2011, the number of financial transactions via mobile services has exceeded 150,000,000 with a value of 6.75 trillion Tanzanian shilling (USD 4.28 billion). Like the use of mobile phones, the provision of charging services is increasingly gaining importance in Tanzanians daily life. As smart phones are beginning to penetrate the market, the amounts of energy needed per phone and also prices for charging services are likely to increase as well (van Genuchten et al., 2012, pp. 6–10).

IV. Conclusion on Tanzania's Energy Sector

In sum, this analysis revealed that the government of Tanzania is increasingly putting effort into the development of the national energy industry. Although the focus is on the expansion of natural gas, coal and hydro power, some governmental initiatives emphasise rural electrification in general, and solar energy in particular. Accordingly, governmental initiatives, especially those supporting the private sector, might be an opportunity for Antenna and its partners to get financial support for the distribution of OOLUX.

The evaluation of the Tanzania's SPV off-grid market and the overview of different market segments further demonstrated that the SPV market is still relatively small and has only recently been targeted by companies offering high-quality off-grid solar products. Furthermore, has a closer look to the different market segments revealed that next to the rural off-grid poverty and rural off-grid commercial markets that have been targeted in the pilot, also the urban off-grid commercial market could be of interest for OOLUX in the future.

The competition analysis ultimately revealed that the main competitors of OOLUX are currently low quality off-grid lighting products, mainly because of their price advantage. Although the demand for high-quality solar products is increasing due to customers' bad experiences with the former and due to promotional efforts by government agencies and non-governmental organizations, low quality products still dominate the market. The increasing efforts of the government of Tanzania, such as tax exemptions and the implementation of quality standards, however, give hope for the future prosper of the modern off-grid solar lighting market. It is important to add that the development of kerosene prices and therewith-related import regulations (e.g. VAT), as well as the development of the mobile phone market, will considerably impact on the future of the modern off-grid solar lighting market.

D. Case Study Tanzania

The case study starts with a brief introduction to the particular context of the field test in Tanzania and introduces the reader to the local partner. The main focus is then placed on the identification of the most relevant country-specific market challenges encountered during the field test. As mentioned above, these challenges are grouped in two main difficulties that are to overcome: to make OOLUX available and affordable. Each identified market challenge is described, and followed by an evaluation of the OOLUX business model. In other words, it will be assessed to what extent OOLUX is apt to overcome the respective challenge and how alternative solutions could improve OOLUX. Based on this analysis, recommendations will be given.

I. Field-Test in Tanzania

1. Context of the Field-test

The partner chosen to realise the pilot in Tanzania is Sunjua Energy (hereinafter called "Sunjua"). Sunjua is a start-up business providing rural villages with high-quality solar systems and after-sales services. It was founded in 2012 by Bahat Tweve, who is responsible for marketing and sales, and Amour Taha Usi, who has the technical expertise. Elibariki Tweve, who is in charge of administrative and coordination tasks, further supports Bahat and Amour. OOLUX is the first high-quality solar kit in Sunjua's product range and is therefore a foundational stone for Amour and Bahat's start-up business. Antenna

Technologies met Sunjua through Rural Africa Ventures Investment (RAVI)[7], which is a so-called "incubator" company that identifies, explores and builds ventures in rural Africa by, for and with rural Africans (RAVI, 2013).

Although OOLUX is Sunjua's first product, the solar business is not all new to Bahat and Amour. In 2009, Amour and Bahat gathered their first experiences within the field of solar business through a project led by the Fund for Development and Partnership in Africa (FEPA)[8]. FEPA provided funds to create so-called "ICT Youth Groups", who would operate solar lantern leasing and charging stations. Bahat and Amour were both chosen by FEPA to supervise those youth groups, who are today successfully operating solar lantern leasing and charging stations in Maganguli, Ihomasa and Kigwe (FEPA, 2012). Although supervised by Bahat and Amour, the ICT Youth Groups are self-managed and therefore independent from Sunjua. Nonetheless, proved the relation and trust built between the Youth Groups and Sunjua's founding partners to be very important for the market launch of OOLUX. Despite the risk of making an investment in a new and unknown product, all Youth Groups decided to purchase OOLUX kits from Sunjua and started to hire-purchase them in their areas. Accordingly, Bahat and Amour's involvement in this FEPA project was not only an important first step into the solar business, but provided the later founded start-up business with important commercial relations in the rural areas of Tanzania.

A similar network existed through Bahat's involvement in a company called TruTrade Ltd. TruTrade Ltd. was founded by RAVI and is a company registered in Kenya. Its purpose is to franchise a network of independent entrepreneurs throughout East Africa to work as agents of "Transaction Security Services" (TSS). The goal of this TSS network is to link agricultural suppliers to buyers, in order to enable more secure, efficient and transparent agricultural trade. TruTrade's long-term vision is to build and maintain centres, which will serve as platforms for trading agricultural goods. The trading centres will be rented to trained and franchised TSS agents who will operate these centres as their own businesses (RAVI, 2010). Bahat Tweve, the marketing and sales manager of Sunjua, is a regional coordinator of TSS agents and currently supervises the construction of a TSS trading centre outside his home-village Makambako. The importance of Bahat's involvement in TruTrade lies in the fact that Sunjua had the chance to recruit TSS agents to work as OOLUX retailers. For the beginning, two TSS agents have started hire-purchasing OOLUX kits in the areas where they operate. Similarly to the case of the Youth Groups, Sunjua's network in rural Tanzania turned out to be an important starting point in placing OOLUX on the market.

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[7] RAVI: http://www.ravinvest.biz/index.php (accessed: 13.11.2013)

[8] FEPA: http://www.fepafrika.ch/ (accessed: 13.11.2013)

Sunjua has thus recruited two groups of retailers for the pilot. Both of them have had previous commercial relations with Sunjua or members of the staff, and had experience as entrepreneurs. This pre-existing relation ensures a certain confidence between the different actors and allowed to start testing OOLUX and its business model as soon as the kits arrived in Dar es Salaam in May 2013. Before briefly illustrating the procedure of the field test and Sunjua's area of operation in the next sub-chapter, a few words should be added to further clarify RAVI's role.

RAVI's role was not only to introduce Sunjua to Antenna, but also to enable Sunjua to engage in this pilot. The terms of the contract concluded between Sunjua and Antenna for the duration of the pilot are not subject of this thesis, since emphasis is put on Sunjua's distribution model, rather than on legal issues. To gain an overall insight to this pilot it is nevertheless important to clarify that Sunjua purchased 100 OOLUX kits from Antenna for a reduced price. In return, it committed itself to conduct the pilot, to co-operate with the field assistant and to provide extensive feedback at the end of the pilot. Despite the reduced price, the start-up business Sunjua would not have been able to bear the costs on its own. RAVI therefore provided Sunjua with a loan for the phase of the pilot to be refunded at the end of it. The relations between the stakeholders involved in the OOLUX pilot conducted in Tanzania are schematically illustrated in the next figure.

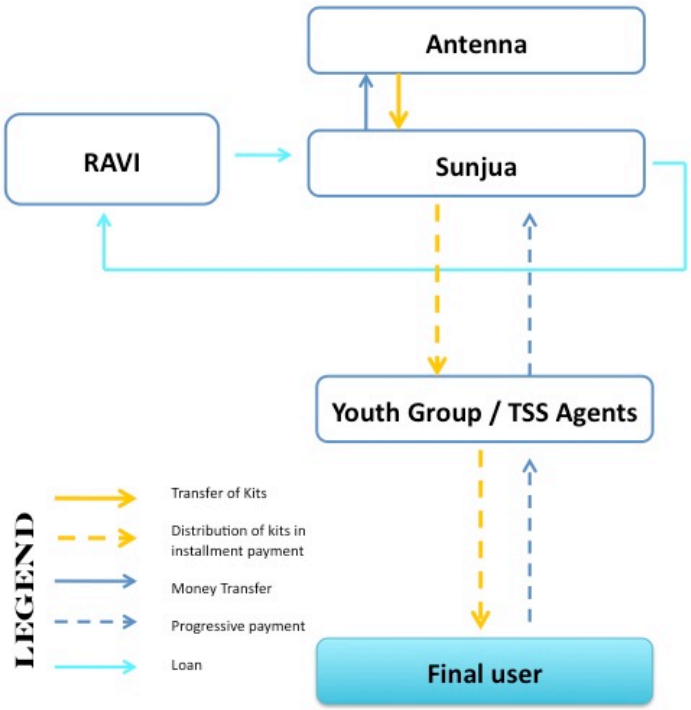

Figure 5: Stakeholders involved in the Tanzania field test (author's elaboration)

2. Procedure of the Field-test

After the arrival of the kits in May 2013, a first round trip to Sunjua's area of operation around Dodoma and around Makambako was used for marketing and sales. Approximately fifty OOLUX kits were sold to members of ICT Youth Groups and to two TSS Agents. A second round trip was then dedicated to after-sales services and research. Both round trips offered the possibility to extensively discuss all aspects of OOLUX with Sunjua and to canvass retailers as well as customers. During these round trips and during discussions held before and after them, the field project assistant generally received a very positive feedback. Customers valued the high quality of OOLUX and very much appreciated the possibility to charge mobile phones. In addition, retailers and customers were impressed by the incorporated micro-finance solution and esteemed the possibility to pay the product in instalments. Apart of this first, very positive feedback, however, the field test also revealed some weaknesses of the current OOLUX business model. These feedbacks were carefully compared to the BOP market challenges identified by scholars and summarised in the working-paper annexed to the present thesis. On the basis of this comparison the present case study assesses, whether the OOLUX model is apt to overcome these challenges in Tanzania or not. In the following chapters, the author will therefore carefully describe a number of difficulties that have been observed. These difficulties and weaknesses relate to two main challenges in serving the BOP market. Namely, to ensure the availability of OOLUX and to make it affordable for customers as well as for the different stakeholders in the supply chain.

II. Availability

According to Anderson and Billou (2007) ensuring availability of products and services depicts one of the biggest challenges for BOP ventures. Not surprisingly the physical distribution of OOLUX kits to remote rural areas in Tanzania is thus a considerable hurdle for Antenna's partner. The subsequent section aims to identify the most relevant obstacles for ensuring continuous availability of OOLUX kits, to evaluate different aspects of the current OOLUX concept and reveal where possible, alternative strategies. The focus in this chapter is on hard and soft infrastructure constraints and the implications on the physical distribution of OOLUX kits.

1. Hard Versus Soft Infrastructure Constraints in Tanzania

Markets at the base of the pyramid are often characterized by gaps in hard infrastructure including lacking access to storage facilities, adequate transportation, communication networks as well as to energy and water supply (Bairiganjan & Sachin, 2011, p. 7; WEF, 2009, p. 18). Next to hard infrastructure constraints, businesses in developing countries are also constraint by a lack of soft features, such as missing financial services or educational and training programmes, limited market information or the absence of the rule of law that would normally facilitate and strengthen business operations (Chesbrough, Shane, Megan, & Stephane, 2006, p. 57; WEF, 2009, p. 18).

This chapter's focus is on hurdles related to hard infrastructure constraints, as these are related to the question of accessibility. The physical distribution of OOLUX kits is the most pressing challenge at this stage of the OOLUX market launch. Most of the soft infrastructure constraints including for example the absence of the rule of law and lack of market information are not considered less important, but will challenge Sunjua in the future, rather than today. The only soft infrastructure constraint that challenges OOLUX urgently is the absence of missing financial services in rural areas. This subject will be discussed within the chapter on "Affordability".

2. Physical Distribution With Hard Infrastructure Constraints

The two major hard infrastructure constraints for the OOLUX business in Tanzania are the poor developed transportation system and the restricted energy connectivity rate in rural areas. Only 6500 kilometres of Tanzania's 90'000 kilometres roadway network were paved in 2007 (CIA, 2013). Whereas all major cities are connected with paved roads, rural areas and city outskirts often remain accessible only with four-wheel drive vehicles. Especially in the rainy season, roads can become impassable and thus rural villages inaccessible for short time periods.

Not without irony, the second hard infrastructure constraint is related to the low energy access rate in Tanzania's rural areas figuring around 5.3 per cent of the total rural population (NBS, 2013). As will be outlined in more detail below, the low energy access rates limit small- and medium enterprises in their ability to implement business concepts based on modern internet and communication technologies.

A first section evaluates the implications of these hard infrastructure constraints on the organisation of the first level distribution, whereas the second section focuses on the

implications on the last-mile distribution in general and the micro-finance solution more specifically.

2.1. The Organisation of First Level Distribution

The term first level distribution is employed here to describe the physical transportation of products from the distributor - in this case Antenna's partner Sunjua - to its rural retailer network. The task is thus to transport OOLUX kits that ought to arrive in Dar es Salaam to major hubs inland and finally to distribute them to the retailer network based in surrounding rural villages. Regarding the constant supply of products, it is of course rather the poor transportation network than the absence of a rural energy network, that does constitutes a challenge. On the one hand, poor road conditions, especially in the rainy season, jeopardise the viability of delivery routes. Smart seasonal timing of logistics and fallback procedures as well as more flexible and adapted transportation vehicles, such as motorbikes, will, however, help to mitigate the risk of product and service delivery short cuts. On the other hand, high transportation costs and a limited number of professional logistic services challenge Sunjua's first level distribution organisation. In what follows, Sunjua's current approach to the first level distribution is evaluated and possible alternatives are outlined.

At present, Sunjua does neither dispose over an own vehicle fleet nor has it partnered with any organisation or firm that would take over the task of transporting products from major hubs to rural villages. Thus, for the field test a private car was hired to transport the products to Sunjua's retailer network. Hiring cars for transportation is, however, not a suitable solution in the long-term as shipping space is limited and thus transportation costs per unit very high. Yet in the pilot phase, where field trips not only involve physical transportation of products but also night-market demonstrations, sales negotiations with potential retailers and the collection of customer feedback, hiring a private four wheel-drive was the appropriate solution as it provided the necessary flexibility and reliability.

2.2. Alternative First-Level Distribution Strategies

As variously stressed in the BOP literature, a fundamental strategy for BOP ventures to overcome infrastructure constraints is partnering with other actors such as private businesses, non-governmental organizations and governments to leverage shared resources (Jenkins & Ishikawa, 2009, p. 15; Vachani & Smith, 2010, pp. 24–27; WEF, 2009, p. 18). Along these lines, a possible strategy for the shipment of smaller quantities (50-100 units) for Sunjua would be to engage with public transport offices usually providing cheap and uncomplicated transport services between all major cities. Although relatively easy to implement, the principle problem of this approach is the lack of security in terms of loss and

damage of cargo. Bus stations in Tanzania are overcrowded and chaotic and buses often overloaded, thus making professional cargo handling difficult. According to Sunjua, no uniform metrics for unit transportation costs exist, what makes pricing for the distributor unpredictable. Long-term partnerships with specific public transport offices could probably help to overcome problems of pricing and reduce the risks related to cargo handling. Overall this option remains interesting for the transportation of small cargo quantities between major hubs. Because of limited cargo quantities however, public transportation offices are not suitable partners once Sunjua widens its product range or scales-up the sales of OOLUX kits.

Another interesting strategy is the concept of bidirectional distribution suggested by Vachani & Smith (2010), referring to a two-way flow of different products using the same logistics. In the case of Sunjua, where among other so-called TSS agents – responsible for agricultural trade services – sale OOLUX kits, a bidirectional distribution system is probably the most promising option. Evidentially, by loading the trucks twice, first for bringing solar products to the villages and then to transport agricultural products from the villages to the markets, unit transport cost could be optimized and additional synergies generated (such as implementing a "solar-for-crops" payment system that is further discussed in chapter D.III.3.2.). The efficiency of this transportation system – either operated by an own fleet or by partnering with logistic service companies – could further be increased by allying with other partners such as agricultural input suppliers (Vachani & Smith, 2010, pp. 25–26). One possible challenge of a bidirectional distribution system together with the TSS network could however result of the unequal timing of demand and supply of the two different products respectively services.

Of course distribution could be organized also in collaboration with other partners including governmental agencies, microfinance institutions, private companies or other non-governmental organizations once these actors would have been identified and shared goals established. These hypothetical options, and this holds for the entire thesis, are however intentionally not discussed in detail as the case study at hand is mainly interested to focus on tangible options.

Conclusively, given the financial capacity and the early-stage of Sunjua's business development, relying on public transport services for the shipment of small quantities is probably the most economic solution. In view of a future scaling-phase, however, further investigations are needed to evaluate the potential and feasibility of the above-outlined bidirectional distribution system. Finally no uniform solution for transportation exists. Rather, it is very likely that Sunjua will need to dispose over multiple transportation means that are

adapted to the retailer's context and different logistic needs in order to successfully serving the base of the pyramid consumers.

2.3. The Organisation of Last-mile Distribution

The distribution to the end consumer or so-called "last-mile distribution" is one of the overriding challenges for BOP ventures. In very general terms, companies aiming at serving BOP markets have three options available to organize their last-mile distribution. The first option is to set up a company-owned retail network. The implementation of this option is, however, time consuming and coupled with high initial investments. It is therefore rather an option for companies with high financial capacity and a wide product range, making the investment worth (Dutt, 2012, p. 2; Lighting Africa, 2010, p. 38). A second, more cost-efficient approach is to partner with an existing network either by implementing traditional distributor-dealer channels or by establishing specific institutional partnerships with microfinance institutions, non-governmental organizations or e.g. post-office networks (Agrawal & Dutt, 2013; Jenkins & Ishikawa, 2009, p. 35 ff.; Lighting Africa, 2010, p. 38 ff.). Finally, a third option, also employed by Sunjua, is a village entrepreneur model. This business model integrates independent entrepreneurs that are responsible for sales, customer support and promotional activities (Dutt, 2012). The subsequent section will focus on the implications of hard infrastructure constraints on the current last-mile distribution concept, and reveal if necessary, possible alternative strategies to overcome them. In chapter D.III., it will additionally be explained why this village entrepreneur model has important implications on the availability of OOLUX.

The physical distribution of OOLUX kits on the last-mile notably from the retailer to the end-customer has, with regard to the poor transportation network, up today not proven to be a major hurdle. The current OOLUX business model is based on the idea of fixed sales locations and thus its success depends on population density and the peoples' ability and willingness to travel for the offered products and services. Hence, it is of principal importance that sales shops are established at strategic locations. Fortunately, all of the current retailers are based in villages where important trade markets are taking place and thus the majority of people living in the region are passing the sales station relatively regularly. Therefore, at least at the current stage, poor transportation networks remain a minor challenge to the business. This is, however, only to remain so as long as the concept of fixed sales stations succeeds and only little at doorstep after-sales service needs to be provided.

The second hard infrastructure constraint, that is the absence of a rural energy network, has proven to challenge the OOLUX business model much more. The current micro-finance solution, as already explained in the chapter on OOLUX, is based on a software, managed

by the retailer on a laptop. Whereas the Youth Group ICT station are equipped with big solar panels and thus have no constraints to power the laptops, other potential OOLUX retailer, such as TSS agents, lack this infrastructure. Against the background that rural electrification rate in Tanzania is still low, the micro-finance solutions' dependency on a laptop considerably limits the business' potential to scale. An additional consequence of this dependency is that no other than a retail concept based on fixed sales stations can be implemented. In view of the low population density, that is 51 people per square kilometre and restricted mobility of target customers, a micro-finance solution allowing a mobile and more decentralized sales system is needed. (NBS, 2013, p. 23).

2.4. Alternative Last-mile Distribution Strategies

Inspired by the first insights of the field-test in summer 2013, Antenna's student team started to conceptualize alternative micro-finance solutions that allow for a more mobile and decentralized sales system and that are better adapted to the prevailing hard infrastructure constraints (Antenna Technologies, 2013b).

One strategy envisaged was the development of an android application with features similar to the computer-based software. The advantage of this approach is that smartphones can be powered by the OOLUX solar kit itself, making the whole micro-finance solution independent of any other electricity infrastructure. A further advantage is also that at doorstep sales systems can be implemented due to the smartphones portability. A disadvantage of both, the old computer- and the new smartphone-based system is that entrepreneurs still need a minimum of technological skills in order to be able to manage and control activation processes and payment histories. One key learning of the field test was that only few rural Tanzanians possess over these skills and thus both systems have a certain constraint with regard to staff recruitment (Antenna Technologies, 2013b).

A second, radically different approach is a micro-finance solution based on a USB key activation system. The idea comprises a two-level microfinance solution at the distributor-retailer and the retailer-customer level. Compared to the approaches outlined-above, the micro-finance solution based on the USB key activation system brings along considerable changes not only regarding the technical design of the system but also to the conceptual design of the OOLUX business model. Whereas this section is focusing on the technical design, the chapter on "Affordability" will focus on the system's implication regarding the OOLUX business model in general and the product- and retailer affordability specifically.

Without going too much into detail, a short introduction to the conceptual idea of the USB key activation system is needed. In this system, identically to the current micro-finance solution,

the retailer activates the OOLUX kit for a limited period of time corresponding to the value of the instalment payment made by the customer. Compared to the current system however, the customers is instead of agreeing on a predefined instalment plan, collecting so-called OOLUX credits in order to fully activate OOLUX. The same principle can be applied on the retailer-distributor level: Instead that the retailer is buying OOLUX on direct purchase, the retailer receives OOLUX kits by only purchasing OOLUX credits. The clue of this system is that retailer can start a business without high initial investments needed but are, because of the demand of OOLUX credits by customer, pressured to progressively purchase OOLUX credits from the distributor, thereby paying off their debts (Antenna Technologies, 2013e).

Figure 6: OOLUX credit system (Antenna Technologies, 2013e)

Important for the present discussion is however that the USB key activation system, as the name already suggest, provides a radically different technical solution. For transferring the OOLUX credits, the retailer simply plugs a USB activation key into the customer's PowerBox. Consequently, compared to the above-discussed approaches, the digital management of the micro-finance solution is transferred to the distributor. Accordingly, it is the distributor that transfers OOLUX credits on to USB activation kits and supervises, with the help of a software, the retailers' payment histories (Antenna Technologies, 2013e).

In sum, the principle added value of this approach with regard to its technical innovation is its independency of additional energy infrastructure and the fact that it enables a mobile sales system. An additional advantage is the easy and convenient activation process, considerably reducing the required technological skills that retailers need to manage sales. One risk of the system is that it requires relatively complex logistics, as distributors need to physically transfer OOLUX credits in form of the USB activation keys to retailers. It is however important to note that the logistical effort depends on the amount of OOLUX credits purchased in each transfer, thereby indirectly depending on the amount of working capital

retailers dispose. This conceptual aspect of the USB activation system is, however, discussed in more detail in the chapter on “Affordability”.

Apart form the technical solutions discussed above, other solutions based on scratch cards or mobile phone use could be envisaged. According to the model implemented, these system enable not only mobile but also very decentralized sales systems where no physical retailer-customer contact is needed for the activation of the OOLUX kit (Antenna Technologies, 2013d). In view of the growing mobile phone penetration and the increase in mobile banking, mobile phone based payment systems gain in attractiveness. Given the fact that the growing mobile phone penetration will stimulate the demand for off-grid mobile charging solutions mobile operators may be increasingly interested in partnerships with solar companies. An attractive way to provide customers cheap mobile charging solution, could be to sell solar kits working with a pay-as-you-go payment system based on mobile phone banking (Lighting Africa, 2010, p. 69). Vodacom already established such a partnership with Fenix International for the East-African market (Fenix International, 2013). Although in case of OOLUX, significant technological investment would be needed to implement a pay-as-you-go system based on mobile banking, a partnership with a mobile operator should be considered as key opportunity for the further development of the OOLUX kit in a mid- to long-term perspective.

3. Concluding Remarks on Availability

Overall, the chapter on „Availability“ has identified the most pressing challenges to the availability of OOLUX. Furthermore it has been examined to what extend the OOLUX business model is prepared to overcome these BOP market challenges and discussed possible alternative routes for the further development of the project. Clearly, hard infrastructure constraints belong to the most urging challenges regarding the successful distribution of OOLUX and the implementation of a micro-finance solution. Poor transportation networks in general and the lack of logistical services more specifically are potentially challenging the physical distribution of OOLUX, especially if Sunjua’s business should further scale. Among the strategies discussed, the most promising approach is to implement a bidirectional distribution system in collaboration with the TSS system and to search for further synergies with e.g. agricultural input suppliers. Against the backdrop of prevailing hard infrastructure constraints, an evaluation of the current micro-finance solution revealed that the major problems are related to the system’s dependency on a computer and energy infrastructure. Subsequently, alternative technical approaches for a micro-finance solution were discussed. Although all approaches seem valid and feasible, the USB key activation system stands out with a simple technical solution that is cost-efficient, easy-to-use and easily implemented.

Apart from infrastructure constraints many other challenges that belong under the umbrella of "Availability" exist. The management and controlling of distribution networks in e.g. will become increasingly complex as soon as Sunjua's business will start to scale. Related questions such as on how to recruit and train retailers as well as on how to guarantee certain after-sales service quality standards will certainly keep Sunjua further busy. Similarly, further thinking is needed on how the various parts of the OOLUX kit can be recycled and what incentives need to be implemented to commit the various stakeholders to the idea of recycling. Given the limited scope of this thesis, these challenges had however to be left aside.

III. Affordability

1. Problem Analysis

According to Anderson and Billou, the second overarching barrier for doing business at the BOP is to ensure that products or services on offer are affordable (Anderson & Billou, 2007, p. 17). Given the fact that the 3.7 billion people comprising the base of the pyramid earn USD 8 per day or less, deal with fluctuating, uncertain income, and have generally limited access to credit or insurance services, distributing an affordable high-quality solar kit to consumers at the base of the pyramid poses a considerable challenge (WEF, 2009, p. 8).

The challenge of affordability is twofold: On the one hand, the product or service on offer has to be affordable for target consumers. On the other hand, the choice taken in Tanzania to organise last-mile distribution by the means of a village entrepreneur model has to be taken into account as well. As mentioned above, a village entrepreneur model integrates independent entrepreneurs that are responsible for sales, customer support and promotional activities. In other words, it must be ensured that those village entrepreneurs, as well as the distributor can start a business and generate sufficient income thereof. Accordingly, to succeed, OOLUX has to overcome a two-sided affordability-challenge. The present chapter will use the term "product affordability" when discussing affordability from a consumer perspective, and "retailer affordability", when referring to retailers and distributors and their ability to run the OOLUX business profitably.

The chapter starts with an introduction to the two types of affordability and reveals how they are interlinked in Sunjua's case. The following section then critically examines the current approach employed in the OOLUX business model to improve product affordability and analyses its implication for retailers. Based on the identified weaknesses, alternative strategies will be presented, that could partly improve affordability of OOLUX for both,

customers, as well as retailers. Finally, the section aims to synthesise these outcomes and provides recommendations on how the OOLUX business model could be further developed in general and in Sunjua's case in particular.

1.1. The Challenge of "Product Affordability"

Product affordability has been identified by practitioners as one of the principle barriers to the rapid adoption of off-grid lighting products in the developing world (Lighting Africa, 2010, p. 63). As mentioned above, a Lighting Africa survey (2011) has revealed that a typical rural household in Tanzania has a monthly income of 90 USD and is primarily concerned about meeting the family's basic needs on a daily basis. As a result, current target customers have very little savings available to purchase a new lighting device.

Increasing product affordability is a complex challenge that can be tackled in multiple ways. Broadly speaking, two lines of strategies exist: The first line includes strategies aiming at reducing the cost in areas such as design innovation, supply chain efficiencies and distribution. The second line focuses on strategies that target product affordability by providing a micro-finance solution or similar flexible payment options, or by providing consumer finance in partnership with microfinance institutions and the like. The present paper will focus on solutions of the second type.

1.2. The Challenge of "Retailer Affordability"

The challenge of retailer affordability results primarily of the fact that retailers have little financial capacity and lack access to credit and other financial services. Consequently, village entrepreneurs face considerable hurdles to start and scale a business (Lighting Africa, 2010, p. 67). In addition, strategies that increase product affordability can have severe consequences on retailer affordability. In the case of OOLUX for instance, the incorporated micro-finance solution can imply a higher risk of default payments as well as the need of additional investments or in delayed revenue streams.

Consequently, two principal factors dominate, when evaluating „retailer affordability" in the case of OOLUX. On the one hand, it has to be considered how financial hurdles for (potential) village entrepreneurs can generally be reduced. On the other hand, it has to be assessed, how strategies aimed at increasing product affordability affect village entrepreneurs and their ability to run their business profitably. Of course, choosing a strategy that jeopardizes OOLUX's last-mile distribution channels would be counterproductive.

After having examined the difficulties related to affordability, the next section will critically analyse OOLUX's current approach to increase product affordability. Apart from evaluating

the current approach's effectiveness to increase product affordability, the goal of this first section is to assess if and how the current solution affects retailer affordability.

2. OOLUX – The Current Approach to Guarantee "Product Affordability"

The current strategy to increase product affordability is best described as a hire-purchase approach. The customer makes a down payment of 10-15 per cent and repays the full price in regular instalments over a predetermined period of 6-12 months. To take the length of the period into account, the total price of OOLUX increases according to the length of the instalment plan. Within the agreed period, customers can purchase energy for varying amounts of time (weeks/months), a feature that makes the system more adaptable to the current financial situation of the customer. The price of activating OOLUX for one week, for instance, is automatically calculated by the OOLUX manager and depends on the instalment plan agreed upon. The principle according to which the OOLUX kit is activated for only the paid amount of time should incite the customer to adhere to his instalment plan. The following figure illustrates, that the PowerBox won't work, unless the customer pays the next instalment.

Figure 7: OOLUX activation process (Antenna Technologies, 2013c)

Consequently, the current micro-finance solution offers a feasible strategy to increase product affordability by reducing up-front costs and offering a limited range of possible instalment plans.

With regard to retailer affordability, the current micro-finance solution, however, faces several constraints. The first constraint relates to overdue payments. The following example illustrates how the current handling of overdue payments provide customers with distorted

incentives. Reliable customer A agrees to an instalment plan of 6 months for a total cost of 180 USD and completes the payment within the agreed time period. Unreliable customer B instead, agrees on an instalment plan of 3 months, which results in a lower total price of 150 USD. For whatever reason, he completes his payment only after 6 months. Thus, whereas customer A is paying a surcharge of 30 USD for a longer instalment period, customer B is paying less, despite finally needing the same amount of time to complete his payment. Compared to customer A, whose OOLUX kit is activated for the entire 6 months, unreliable customer B's OOLUX kit is admittedly only activated for a total of 3 months, thanks to the OOLUX manager. But he could easily substitute OOLUX's lighting function with kerosene during this time and save 30 USD. While this might be a good – and cheaper - solution for customer B, the village entrepreneur would be expecting the full repayment by the end of the three months, but would still have no means to pressure the customer into complying with the agreed payment plan. As a consequence, a main problem for the village entrepreneur results from the unpredictability of revenues of the current payment system. A simple solution to overcome this problem and reduce false incentives would be the implementation of a penalty system that could either be implemented in the form of a one-off lump sum, or with a fine defined according to the amount of the weeks/months that are overdue.

Another important disadvantage of the current micro-finance solution, especially with regard to retailer affordability, is the high initial investment needed. While the costs for the computer used during the field tests were covered by Antenna, the costs for the installation of the necessary power source remained with the retailer. Since initial investments are relatively high for both, Antenna and the retailers, the current micro-finance solution considerably limits the business' potential to scale.

In conclusion, the current micro-finance solution has proved to be a reasonable strategy to increase product affordability. Considering retailer affordability, however, the strategy faces considerable challenges resulting from high capital requirements and the unpredictability of revenue streams. Given the important role of village entrepreneurs in assuring the reliability of the last-mile distribution of OOLUX in the case of Tanzania, a solution must be found that takes the financial constraints faced by rural village entrepreneurs into account. The current micro-finance solution should thus either be adapted to relieve retailers, or parallel mechanisms must be built to ensure retailer affordability. The next section will hence explore adaptations of, and alternatives to the current micro-finance solution and evaluate their respective effects on retailer affordability. Then, in the fourth section of the present chapter, possible parallel strategies to the problem of retailer affordability will be analysed.

3. Alternative Strategies to Guarantee Product Affordability

3.1. USB Key Activation System

An alternative micro-finance solution based on a hire-purchase approach is the USB key activation system discussed in chapter 2. The concept is, as mentioned earlier, based on the idea that a customer is required to collect 100 OOLUX credits to get a fully activated kit (see section D.II.2.4). For each payment, the OOLUX kit is activated for one week and a certain amount of OOLUX credits acquired. An interesting aspect of this approach is that the number of OOLUX credits can vary according to the amount paid. Retailers can offer two payment-options, which, for reasons of simplification, are called the green USB key option and the orange USB key option. Each payment-option includes a different amount of credits. If the customer choses the green option, he purchases a one week activation for USD 2 and receives one credit (customer A). If he opts for the orange option, he will pay USD 6.80 for one-week as well, but will receive 5 credits (customer B). In case both customers would continue to opt for the same option, customer A would pay a total of 200 USD over 100 weeks, whereas customer B only would pay a total of 136 USD over 20 weeks to collect 100 credits. To keep things flexible, however, customers would remain free as to which option they would chose and be allowed to alternate between green and orange. This results in a variety of instalment plan scenarios ranging from 20 weeks to 100 weeks as the graph below illustrates (Antenna Technologies, 2013e).

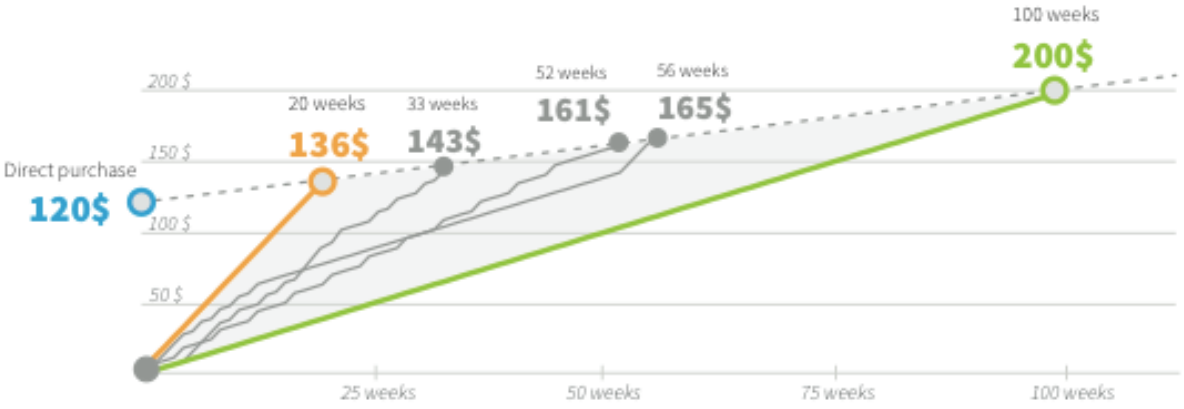

Figure 8: USB key activation system – Instalment plan scenarios (Antenna Technologies, 2013e)

Compared to the current micro-finance solution, in which customers have to decide on a fixed instalment plan, the solution based on the OOLUX credit system would allow the customer to align his expenses with his income on a weekly basis. The OOLUX credit system would furthermore allow a variety of strategies to encourage customers for fast

repayment: Bundle reductions could for instance be offered to customers who are willing to activate their kits for more than one week at a time (Antenna Technologies, 2013e).

This solution would, however, share one disadvantage with the current micro-finance solution. Customers could still refrain from buying activation credit from time to time and substitute OOLUX with kerosene lamps. There is a chance, that the 100 credits to purchase OOLUX would not be collected within the anticipated maximum of time, i.e. 100 weeks in the present example. How could the retailer convince his customers to collect the credits in the anticipated time? This question brings us straight to the effects of the USB key solution on retailer affordability. The next paragraphs will first analyse whether this approach offers the possibility to encourage customers to comply with the agreed instalment plan. In a second step it will be assessed, whether this solution has other positive or negative effects on retailer affordability.

A conceivable option to encourage quick repayment would be to draw on a compensation system with a deterrent effect. Customers with an overdue payment could be asked to pay an extra charge for collecting their remaining credits. This extra charge could even be progressively increased to further encourage delayed customers to clear debts and relieve the retailer.

Nevertheless, the problem of slow and unpredictable cash return remains a fundamental challenge of both micro-finance solutions discussed. On the basis of the above discussed instalment plan scenarios, a village entrepreneur would need, in the worst case, 60 weeks to cover the costs of one OOLUX kit, assuming that the wholesale price per kit is 120 USD. Even if the maximum length of the offered instalment plans would be reduced to one year, the retailer would need a couple of months to break even. Against this background, scaling the business is a fundamental problem, especially in case no other sources of income or access to loans are available. One strategy to tackle this problem includes a complex credit system that will be discussed in more detail in the section D.III.5.

The USB key activation system exhibits another crucial advantage compared to the current computer-based approach in terms of retailer affordability. The USB key solution provides a technical innovation that significantly reduces the amount of initial investment to start a business. Furthermore, the fact that the retailer is able to acquire OOLUX kits by progressively purchasing OOLUX credits, significantly reduces the initial investment as well (see section D.II.2.4).

Overall, the USB key activation system clearly offers a more flexible and sophisticated approach to increase product affordability than the current approach. Furthermore, does it allow for better incentives to encourage customers to repay rapidly. In addition, it reduces the

high initial investment needed by offering a cheap technical solution and the possibility to start the business without being obliged to purchase OOLUX kits directly. However, as any other hire-purchase approach, the business potential to scale is constrained by its slow revenue streams.

3.2. Energy-For-Crops

An additional way to guarantee product affordability at a lower risk for the village entrepreneur could be achieved through the implementation of an „energy-for-crops" payment system in partnership with the TSS system. TSS agents who also act as OOLUX retailers could accept crops as a payment for OOLUX kits. Within the TSS system, farmers sell their crops to TSS agents during harvest seasons, since farmers usually generate an increased income during this season. The problem is, however, that little or no access to saving accounts exists[9]. If TSS agents would sell OOLUX kits to farmers in exchange for crops, farmers could invest a part of their income in OOLUX. Therefore, buying a solar kit could be a secure and smart investment option. By applying these measures, the risk of default or overdue payments could be reduced as well, since business relations between farmers and TSS agents are based on mutual trust and generally involve multiple crop trades within the same year. This solution could be combined with a hire-purchase approach. TSS agents and farmers agree on a minimal percentage of each trade's total value that would be designated to the repayment of the kit. From the TSS agent's perspective, such a deal is very attractive, since opportunities for profit emerge from both, the trade of crops and the sales of OOLUX kits.

In a nutshell, an „energy-for-crops" approach could be an attractive payment solution for farmers and would furthermore easily allow leveraging an existent customer network. Note that the energy-for-crops approach could also be integrated relatively easily into both, the current micro-finance solution, as well as the one based on the USB key activation system discussed above.

3.3. The Fee-For-Charge System

A completely different approach to increase product affordability is a so-called rental- or fee-for-charge system. In fee-for-charge systems, companies contract or franchise village entrepreneurs who set up a solar charging kiosk. The village entrepreneur normally either rents products out on a hourly/daily basis, or sells lanterns without a power source and offers

[9] The responsAbility Social Investment AG estimates that less than a dozen microfinance institutions in Tanzania serve 390'000 depositors all together (C. Etzensperger, 2013; p. 7).

a fixed fee for charging it (Avato & Madeira, 2010, p. 8; Lighting Africa, 2010, p. 40). Note that the latter system is the one currently applied by the Youth Groups in Tanzania, who are now additionally selling OOULX kits (FEPA, 2012).

A slightly adapted version of a fee-for-charge system could also be implemented with OOLUX PowerBoxes. The basic idea is that a village entrepreneur is equipped with the necessary infrastructure and training to provide all the energy services in a specific rural village. The model includes two separate but interdependent businesses: On the one hand does the village entrepreneur rent out OOLUX PowerBoxes on a daily or weekly basis, while on the other hand, he sells electronic accessories such as solar lights, extension cables, torches, radios and possibly TVs. Thus, customers would rent an OOLUX PowerBox on a daily or weekly basis and purchase the modules needed, instead of buying an entire OOLUX kit.

With regard to product affordability the advantage of this system is that up-front costs can be reduced significantly. Customers could then purchase electronic accessories according to their financial situation and their needs. Given that the OOLUX PowerBox has a remarkable lifespan, the fee charged for the rent of a PowerBox could be relatively small. These low rents would probably get as close to average expenses on kerosene as OOLUX could get.

To proceed the same way as above, it has now to be discussed what the fee-for-charge system really implies with regard to retailer affordability. From a village entrepreneur's perspective, the main advantage of a rental system compared to a hire-purchase approach is the continuous revenue stream guaranteed by the renting scheme. Further, does this approach allow to diversify the sources of income since the business not only includes the rent of PowerBoxes, but also the sale of electronic accessories as well as installation services. In the long-term, one could also envision the development of a second, more powerful OOLUX PowerBox, that would allow to widen the range of compatible accessories. With regard to retailer affordability, the downside to this approach is certainly the high initial investment required to purchase land, a sales store, a recharge system and the product inventory itself.

Apart from evaluating product and retailer affordability of this concept, other aspects of this fee-for-charge system should be taken into consideration. Compared to the hire-purchase approaches outlined above, a rental system provides higher customer convenience. The village entrepreneur is not only responsible for charging batteries, he also provides additional services such as the exchange of PowerBoxes at the customer's doorstep. Ideally, he could also install the electronic accessories purchased by his customers. The provision of such services would not only increase customer convenience, but also reduce the costs of after-

sales services, as the risk of product misuse is reduced. Although the business brings along the potential for scaling the product range, the business' potential for scaling-wide, that is, to serve more customers, is restricted by the fact that only a limited geographic area can be penetrated. Another downside is that a centralized charging system risks lacking the necessary flexibility to grow alongside expanding consumer demands. Also, compared to a hire-purchase approach, a lease system lacks the ability to take up latest innovations of the market, as investment amortisation is slow (Lighting Africa, 2010, p. 40).

Where does that leave the fee-for-charge system? In the authors' opinion, three important arguments exist to further consider this business model. First, it probably offers the most affordable and reliable way for BOP customers to access high-quality solar products as well as after-sales services. Second, unlike the hire-purchase approach, the business model ensures a steady and continuous revenue stream for the village entrepreneur and thereby also guarantees that the after-sales service is ensured over a long period of time. And last but not least, does the centralised and standardised charging procedure provide an attractive way to overcome the problem of product misuse. As a consequence, high costs for after-sales service could be diminished or even avoided.

3.4. Customer Finance– Institutional Partnerships with Microfinance Institutions

An additional strategy to overcome the challenge of low and volatile income of target beneficiaries is to implement a consumer finance model in partnership with microfinance institutions or rural banks. These institutions generally provide either simple consumer financing services, or they additionally establish their own distribution channel by leveraging their customer network (Lighting Africa, 2010, p. 38).

The main advantage of this approach for the solar company and its distributor and retailer network is that the management of loans and the burden of financial risk are - to a large extent - covered by these institutions. This would evidently result in an increase in retailer affordability while maintaining high product affordability. SELCO India for example, works with a number of rural banks that offer micro-loans to their customers. Customers typically make a down payment of 10-25% for a loan with 5-14% interest rate and repay the balance over three to five years (SELCO-India, 2008). In case a customer is unable to repay the loan, SELCO can reclaim the product, resell it on the second-hand market and return the revenues to the bank (IFC, 2012, p. 58). This example shows that the responsibility over the management of loans and the burden of financial risk is not fully transferred to the microfinance institution. One associated risk of SELCO's case is that the microfinance institution could stop giving loans to future customers, should SELCO not prove to be able to handle default payment situations (Hystra, 2013, p. 8). Without wanting to overemphasise

SELCO's case, it provides a good example of how institutional partnerships, whether with microfinance institutions or not, risk disputes over cost and risk sharing, as well as over roles and responsibilities (Lighting Africa, 2010, p. 38).

With regard to the practicability of a partnership with a microfinance institution, several practitioners reported that only few microfinance institutions are actually able and willing to engage in effective partnerships (Hystra, 2013, p. 8; Lighting Africa, 2010, p. 38). It should be added that in Tanzania very few microfinance institutions have rural outreach. This would pose a further hurdle to the practicability of this strategy in Sunjua's case (Etzensperger, 2013, p. 7).

Given the above-outlined constraints and the fact that Sunjua as a company and OOLUX as a product are still in their early phase of development, a partnership with a microfinance institution is rather difficult to realise at this stage. Nevertheless, a microfinance partnership could prove to be an attractive option for the years to come: The OOLUX business will further mature and the microfinance sector is likely to further expand in East Africa, due to the recent development of mobile payment (M-Pesa) and no-branch banking (Etzensperger, 2013, p. 9).

This section has examined current and alternative strategies to make OOLUX affordable for consumers without compromising the village entrepreneur's ability to run the OOLUX business profitably. Before summarizing the most important insights gained, the subsequent section looks into current and alternative strategies that directly aim at overcoming the problem of high initial investments and delayed revenue streams.

4. Sunjua's Current Approach to Increase Retailer Affordability

The first part of this section examines Sunjua's current approach to overcome the challenges arising from the limited financial capacities of village entrepreneurs. The second section then elaborates on an option to improve retailer affordability that is currently discussed among Antenna's partners.

One of the problems with the current hire-purchase approach is that Sunjua as a distributor faces difficulties to recruit village entrepreneurs with the necessary financial capabilities to purchase OOLUX kits. Sunjua therefore provides, constrained by its own financial situation, a loan with a relatively short 3-4 month credit term to its village entrepreneurs. The idea behind this approach is that village entrepreneurs would be able to pay back the loan with the revenue generated of the sales on hire-purchase of OOLUX kits. Although this strategy was a valuable solution to enable the rapid market entry of OOLUX, it restrains the business' full potential to scale because of two reasons. The first reason is that giving out products on

credit is risky and puts constraints on Sunjua's liquidity and thus its ability to scale further. The second reason is that the short loan term offered to village entrepreneurs limits the potential of the hire-purchase approach to increase product affordability. Given the relatively high retail price of OOLUX, an instalment plan of 3-4 months results in high instalments. Too high instalments evidently miss the purpose of reaching the BOP market.

The previous sections showed that, apart from hire-purchase approaches, there are certain strategies that would keep financial hurdles for retailers and distributors low, while still guaranteeing a high level of product affordability. The current situation in Tanzania shows, however, that other strategies, which directly relieve retailers and distributors and thus improve retailer affordability, are needed as well. Antenna's partners in Tanzania currently investigate one very promising strategy. The idea includes a relatively complex credit system and is still under development. The following section will nevertheless provide an introduction to this idea and discuss some of the challenges regarding its implementation.

5. Alternative Strategies to Increase Retailer Affordability

In a nutshell, this strategy comprises a credit system with two different levels. On the first level, a lender provides the distributor – in our case Sunjua - with a short-term loan so that Sunjua can purchase OOLUX kits from Antenna. RAVI already provided Sunjua a short term loan to purchase OOLUX kits for field-test and would continue to do so in return for a small profit. On the second level, a fund provides village entrepreneurs with a loan to enable them to purchase OOLUX kits from Sunjua. This fund, subsequently called „Sunjua Fundi[10] Investment Fund" (SFIF), would be funded by social investors. More practically speaking, the SFIF would compensate Sunjua for each product bundle sold to village entrepreneurs. To show their commitment, village entrepreneurs would need to pay a fraction of the product bundles' value into the SFIF to get the kits from Sunjua. The remaining amount would need to be repaid into the fund in predefined monthly instalments. The duration of the payment plan is determined to 15 months. The idea of this limitation is that village entrepreneurs could offer OOLUX on a hire-purchase model over a period of up to 12 months. The village entrepreneur would thus receive the whole price from retailers early enough to pay back his own loan. Furthermore, and this is the interesting aspect of this system, village entrepreneurs could take out a second loan to purchase a second product bundle from Sunjua, prior to the full reimbursement of the first loan. The only condition to receive a second loan from the SFIF would be that village entrepreneurs have continued to pay the monthly instalments of

[10] "Fundi" means „craftsman" in Kiswahili and is used here as a synonym for village entrepreneur.

the first loan. In this way, the system increases retailer affordability and guarantees the ability of the village entrepreneur to continuously scale their sales, without being dependent on the slow return of profit from the sales on hire-purchase of the first product bundle.

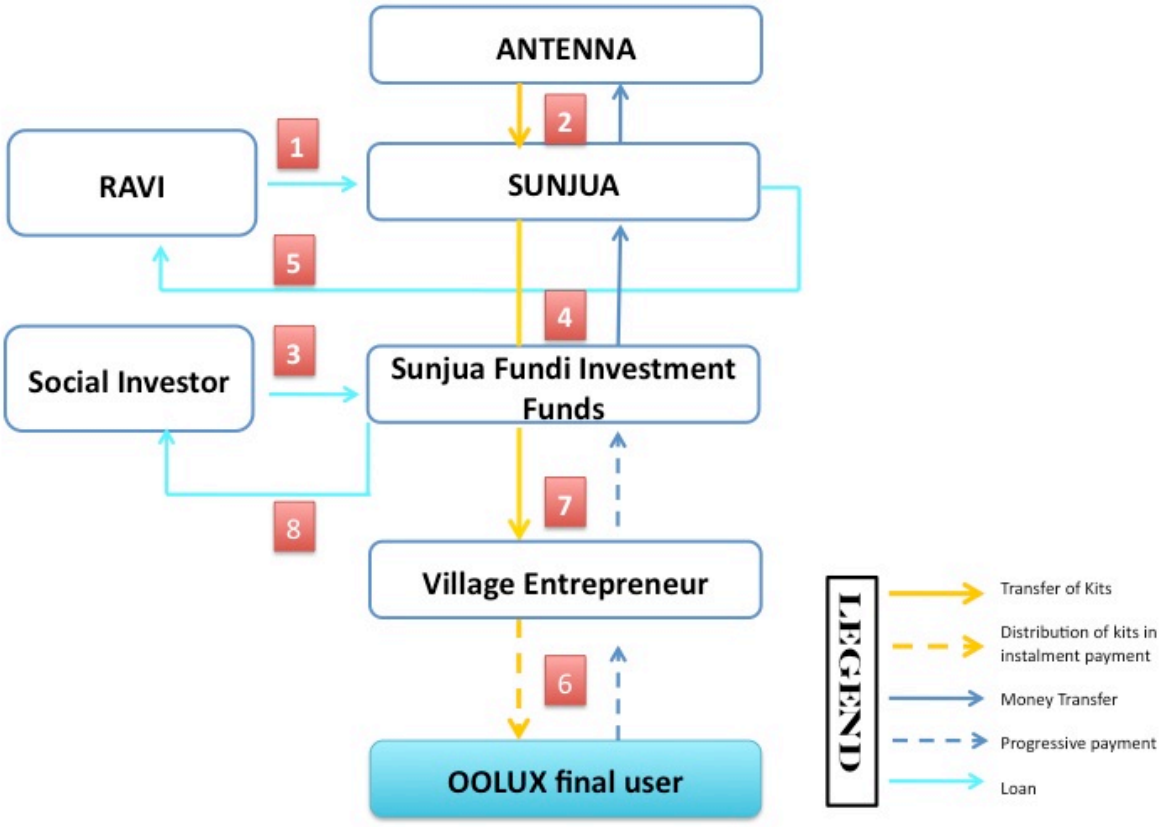

Figure 9: Sunjua Fundi Investment Fund

Stakeholders involved in the credit system (1) SUNJUA takes up a loan from RAVI (2) SUNJUA pays the OOLUX kits to ANTENNA in advance, ANTENNA ships the kits (3) A social investor invests in the Sunjua Fundi Investment Fund (SFIF) (4) Village Entrepreneurs receive the kits from SUNJUA; SUNJUA receives money out of the SFIF (5) SUNJUA pays back the loan to RAVI (6) Village Entrepreneurs hire-purchase the kits to the final user (7) Village Entrepreneurs pay back the loans in monthly instalment payments back to the SFIF (8) SFIF pays back the invested capital including a return on investment to the social investor.

In conclusion, the credit system provides a solution to overcome the hurdle of high initial capital investment for both, Sunjua and village entrepreneurs. The mechanism, after which Sunjua is fully compensated for each product bundle by the SFIF, ensures that Sunjua has both sufficient working capital and enough revenues to further scale its business. The same is true for village entrepreneurs. The system allows them to overcome the high initial

investment to purchase OOLUX kits. The relatively long credit period, furthermore guarantees that village entrepreneurs are able to offer sales on hire-purchase over a maximum period of 12 months and thereby significantly increases product affordability as well.

This system seems to provide valuable solutions for the challenges identified above, but its implementation still faces considerable hurdles. Since the SFIF would have to provide multiple loans to various village entrpreneurs within short intervals, relatively large capital investments are needed to fund the SFIF. Further challenges can be expected with regard to the management of the SFIF: First of all the system is relatively complex and might demand village entrepreneurs a level of competency in financial management that is not given at the moment. Both, sales on hire-purchase and the management of multiple loans, are tasks that are new to most village entrepreneurs. Thus, RAVI and/or Antenna would have to train village entrepreneurs and equip them with the necessary tools. Procedures would furthermore be needed for cases in which village entrepreneurs run into payment defaults. Also, great attention and time would have to be invested into finding competent and trustful staff or partners to manage the SFIF. A possibility to avoid the involvement of another partner would certainly be to train Sunjua to take over the management of the SFIF. It could also be imagined that RAVI itself would fulfil this task, either alone or in cooperation with Sunjua. It is certain that the system requires an additional effort from RAVI and Antenna to provide stakeholders with the necessary tools and training in modern financial management.

6. Concluding Remarks on Affordability

Overall the chapter on affordability revealed that this challenge includes a complex set of partly interdependent factors. On the one hand, strategies are needed to increase the affordability of the product without compromising the village entrepreneurs' ability to run the OOLUX business profitably. On the other hand, solutions are needed to reduce the financial hurdle for the village entrepreneur to start and scale the OOLUX business.

The first part of the chapter on strategies to increase product affordability began with a closer look at the current system and revealed that a penalty system for overdue payments and incentives to honour financial reliability is needed. In this regard, the USB keys activation system seems to provide remedy, since it offers more room for manoeuvre to create incentives and a greater flexibility regarding the fluctuation of incomes of target beneficiaries. It also became clear, however, that providing more payment flexibility for customers happens at the expense of cash-flow continuity and predictability for the village entrepreneur. The option to combine either of these approaches with a "solar-for-crops" system in partnership

with the TSS systems has shown to be an additional and feasible option to increase the affordability of the OOLUX kit. An analysis of the fourth strategy, namely the implementation of a fee-for-charge payment system, has unveiled that the implementation of this system would entail considerable changes to the current OOLUX business model. The most important identified hurdles are related to the high initial investment, the length of the amortisation period and the limited geographical radius a business can penetrate. Nevertheless has this approach revealed an attractive solution to diminish up-front costs, minimize the risk of product misuse and, at the same time, guarantee a continuous revenue stream for village entrepreneurs. Lastly, the potential of an institutional partnership has been examined. Although the "outsourcing" of financial risks and credit management is appealing, a closer look at this option shows that such partnerships are not easily implemented. The difficulties are mainly rooted in the fact that Tanzania currently has a lack of microfinance institutions with rural outreach and that neither Sunjua nor OOLUX exhibit the necessary capabilities to enter such a partnership at this stage.

The second part of the chapter then evaluated Sunjua's current approach to reduce the financial hurdle for village entrepreneurs to start the OOLUX business. The analysis revealed that giving out OOLUX on credit is risky, and considerably limits Sunjua's potential to further scale its business. At the same time, the short-term loan restricts the potential of the hire-purchase approach to increase product affordability. The strategy involving the "Sunjua Fundi Investment Fund" provides remedy for both, the problem of high initial financial hurdles for village entrepreneurs, as well as the challenge of slow revenue streams. The evaluation of this strategy, however, revealed that relatively high amounts of capital are needed for its successful implementation and that challenges regarding the management of the loan could arise.

E. Recommendations and Practical Implications

This last chapter presents the practical implications of the identified challenges and provides recommendations for the future developent of OOLUX in general, and Sunjua's business model in particular. Similarly to the structure of the case study, the recommendations are grouped as "Availability Recommendations" and "Affordability Recommendations". Each section starts with a short recall of the most pressing challenges of the OOLUX business model. It then provides short-, as well as long-term recommendations for Antenna and its partners.

I. Availability Recommendations

The chapter on availability had the purpose to identify the most pressing challenges related to the physical distribution of OOLUX at this early stage of market launch. The evaluation revealed that hard infrastructure constraints jeopardise the physical distribution of OOLUX the most. The first-level distribution of OOLUX is mainly complicated by the poor transportation networks and the lack of logistical services. The last-mile distribution is first and foremost jeopardised by the current micro-finance solution's dependency on energy infrastructure. In what follows, short- and long-term recommendations are provided for the future organisation of the first level distribution, as well as for the further development of the micro-finance solution.

1. The Organisation of First Level Distribution

Short-Term Recommendations: Given that Sunjua currently only needs to ship small quantities, relying on public transport services is probably the most economic solution. Sunjua should, however, seek to establish a partnership with a public transport office to determine fix cargo prices and reduce the risks of poor cargo handling.

Long-Term Recommendations: In view of a future scaling-phase of Sunjua's business, the feasibility of the bidirectional distributions system in partnership with TSS agents should further be examined. Furthermore, partnering with other stakeholders, such as agricultural input suppliers, should be considered to create additional synergies.

2. The Organisation of Last-Mile Distribution

Short-Term Recommendations: The current micro-finance solution based on the OOLUX-manager software has proved to face substantial constraints with regard to the prevailing infrastructure in rural Tanzania. Antenna should therefore continue to develop the USB key activation system, as it provides a simple, non-energy dependent technical solution that can be implemented relatively rapidly, is cost-efficient and easy to use.

Long-Term Recommendations: Considering the growing mobile phone penetration in every corner of the world and the increasing demand for cheap off-grid mobile charging solutions, Antenna should consider a partnership with a mobile operator as a key strategic opportunity

for OOLUX. In a next step, Antenna could try to obtain the support and expertise of a mobile operator in order to implement a pay-as-you-go system based on mobile phone banking.

II. Affordability Recommendations

In the chapter on “Affordability”, the OOLUX business model was evaluated in terms of its potential to overcome product and retailer affordability. The current micro-finance approach proved to be a reasonable strategy to make OOLUX affordable for BOP consumers. In terms of retailer affordability, however, the strategy faces considerable constraints resulting of high capital requirements, as well as unpredictable and slow revenue streams. Given the important role of village entrepreneurs in assuring a reliable last-mile distribution of OOLUX in Tanzania, a solution must be found that takes the financial constraints of rural village entrepreneurs into account.

1. Strategies to Further Increase Product Affordability

Short-Term Recommendations: The USB key activation system offers a flexible and sophisticated approach to increase product affordability and allows for better incentives to encourage customers for rapid repayments. In addition, it reduces the high initial investment by offering a cheap technical solution. This solution should therefore be pursued. However, as for anyother hire-purchase approach, Antenna and its partners need to find a solution to overcome the financial constraints village entrepreneurs and the distributor are facing because of slow and unpredictable revenue streams. Alongside with the implementation of the USB activation system, Sunjua should examine the feasability of a “energy-for-crops” payment system.

Long-Term Recommendations: In the long-term, Antenna should consider to develop the necessary technical innovations to implement a fee-for-charge business model. If the OOLUX PowerBox would be chargeable at central charging stations, OOLUX would have even more flexibility with regard to different business models. The fee-for-charge business revealed to be an attractive solution to diminish up-front costs, minimise the risks of product misuse and guarantee a continuous revenue stream for village entrepreneurs. This business model should be evaluated in a field test on a small scale to avoid the need of high capital investment.

2. Strategies to Increase Retailer Affordability

Short-Term Recommendations: The USB key activation system also provides the most efficient strategy to reduce problems related to retailer affordability in the short term. This solution does not accelerate the revenue streams, but it allows the retailer to start an OOLUX business without high initial investments. Compared to the current situation, Sunjua would also have the possibility to control village entrepreneurs by managing the OOLUX credit system.

Long-Term Recommendations: Antenna and its partners should continue to investigate the strategy involving the "Sunjua Fundi Investment Fund". This strategy could provide remedy to both, the problem of high initial financial hurdles for village entrepreneurs, as well as the slow revenue streams resulting of the hire-purchase approach. In a next step, a detailed business plan should be developed that includes calculations based on different sales scenarios, and a detailed plan of how the SFIF should be managed.

F. Conclusion

By means of a practical example, this thesis provided insights to the challenges faced when serving a modern off-grid lighting solution to the base of the pyramid. On the basis of a co-authored working paper that features a literature review of articles about the various BOP market challenges, the case study identified the most pressing difficulties in the market launch of OOLUX. On a more general level, the present thesis intended to contribute to the evaluation of the OOLUX business model and to provide Antenna Technologies and its partners with recommendations regarding the future development of OOLUX in general, and Sunjua's distribution model in particular.

After an introductory section and the presentation of OOLUX, the paper continued with an analysis of Tanzania's energy market. A slightly positive trend of Tanzania's national energy policy towards renewable energies in general, and solar power in particular has been identified. Evidence for this trend was found in the abolishment of the VAT and import duties for solar photovoltaic products and in the national policies' increasing emphasis on rural electrification initiatives. A closer look at Tanzania's solar off-grid market furthermore unveiled that, in line with the market launch of OOLUX, a market for modern off-grid lighting and charging solutions is developing.

Public product demonstrations held during the field test further confirmed the demand for modern off-grid lighting and charging solutions to meet basic energy needs. In general, customers valued the high quality of OOLUX and very much appreciated the possibility to charge mobile phones. Similarly, village entrepreneurs and customers were impressed by the incorporated micro-finance solution and esteemed the possibility to pay the product in instalments. Apart of this first, very positive feedback, the field test also revealed some weaknesses of the current OOLUX business model – weakness that have been taken up in the fourth chapter of the case study.

The fourth chapter was, in line with Anderson and Billou's suggested "4-A framework" (2007), divided into a sub-chapter on "Availability" and one on "Affordability". The former revealed that the most pressing factors jeopardizing the physical distribution of OOLUX are related to prevailing hard infrastructure constraints. More precisely, poor transportation networks and the absence of logistics services, as well as the underdeveloped energy infrastructure complicated the implementation of the OOLUX business model and Sunjua's distribution of the product. The sub-chapter on affordability evaluated the OOLUX business model in terms of its potential to overcome challenges related to product and retailer affordability. The analysis revealed that although the current micro-finance approach proves to be a valid strategy to make OOLUX affordable for BOP consumers, it jeopardises the viability of a village entrepreneur model because of the high initial investments and the unpredictable and slow revenue streams. The evaluations of possible alternative strategies showed, however, that feasible options exist providing solutions to the identified challenges.

Only part of the challenges identified in the co-authored working paper have been considered in this thesis, partly due to its limited scope, partly because they were not of great importance for the pilot. The challenges grouped under Anderson and Billou's (2007) remaining two "A's", namely "Acceptability" and "Awarness" had to be left aside. Within these overarching subjects, further research could be untertaken. Such research could be dedicated to strategies that help to overcome the problem of intial lack of trust in new products and technologies, or to strategies that aim to rise awareness in a market environment that is largely characterized by the absence of modern communication technologies. Another interesting subject for further research would be to investigate how recycling processes can be implemented in BOP markets and what options would arise for recyling OOLUX. For OOLUX, these will certainly be issues to consider in the future, when the problems identified in this thesis are successfully solved.

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H. Appendix

Working paper for the practical case studies and the Oolux field test

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The challenges of serving rural BOP markets

I. Introduction

The following paper intends to give an overview of the various challenges of serving people at the bottom of the economic pyramid as well the respective approaches to these challenges. Based on existing academic and business literature, the purpose of this working paper is to build a framework for the three practical case studies on the challenges of serving rural low-income markets in India, Tanzania and Zambia. The practical research for each case study is carried out in the framework of the OOLUX field test organised by Antenna Technologies. OOLUX is a product, which has been developed in the collaborative SmartLight project including Antenna Technologies, Caritas Switzerland and the Bern University of Applied Sciences. The project intends to distribute a high quality solar-powered lighting and charging device to households in rural areas. The case studies will examine if the challenges identified in theory correspond to the country-specific situation on the ground, and analyse the conditions for successfully addressing them. The ultimate goal is to evaluate the potential of the OOLUX Business Model and to provide Antenna Technologies with recommendations on possible adaptations and developments.

The following list of distribution challenges is classified according to the so-called "4-A Framework" proposed by Jamie Anderson and Niels Billou (2007). The two authors suggest that those businesses which have successfully developed and delivered products and services to people living at the bottom of the economic pyramid, have adopted a common approach which has been key to their success: the delivering of four A's, namely availability, affordability, acceptability and awareness (Anderson and Billou, 2007, p.14). While Anderson and Billou's framework is not specifically related to distribution challenges (but rather to how and with which products and services BOP markets should be served), it nevertheless

provides a useful basis for the present classification. It should also be noted that the four A's are not themselves challenges but serve as categories for our list of challenges.

Each category of challenges is structured in the same way. After a brief introduction to what the respective "A" means, the corresponding challenges found in the literature are specified. A short explanation of the particular challenge is each followed by a list of the most pertinent strategies to address that challenge.

The list includes challenges on two different levels: one level represents the conditions that one finds on the ground, like bad roads or illiterate consumers. The other level concerns the business itself, such as the difficulty of managing adoption processes. The challenges on the second level are related to the first inasmuch as they may be a result of the complex environment of BOP markets. Challenges that relate to aspects of the business model that are not relevant for the practical case studies, like the organisation of manufacturing, are not considered in the present paper.

II. Availability

According to Anderson and Billou (2007, p. 14-16) ensuring availability of products and services depicts one of the biggest challenges in BOP marketing. Overcoming the obstacle of operating with fragmented or even inexistent distribution channels has been a major issue for many companies trying to enter this allegedly lucrative market of the world's poor. Anderson and Billou put it as follows: "[…] while there might be a market of more than 700 million poor Indians, delivering goods and services to them is not easy." The particular challenge of guaranteeing availability of products and services characterizes an important issue of a conventional distribution channel where goods get passed down the chain from one entity to the next until they reach the end-consumer. The interlinked delivery elements possess specific features that have to be adapted to this unique operational environment (Shukla et al., 2011, p.8). The main challenges and the most pertinent strategies in order to procure availability of products and services in the BOP market are the following:

1. **Reaching target markets with missing hard infrastructure:** Enterprises focusing on customers in low-income groups may have to overcome infrastructure gaps that hinder market activity as well as value creation and have to be addressed through business-led solutions. Gaps in hard infrastructure include lacking access to storage facilities, adequate transportation, communication networks as well as to energy and water supply (WEF, 2009, p.18). What is more, rural BOP markets are often characterized by adverse weather conditions, long distances due to geographical

dispersion and hostile terrain often combined with bad roads (Shukla et al., 2011, p.7).

Strategies:

a. **Distributing via small and micro enterprises** can be an increasingly successful strategy in order to reach BOP customers. These actors benefit from better market penetration due to their ability to operate with smaller volumes and their higher chances to establish relationships of trust with local communities (Jenkins et al., 2009, p.7). It may also contribute to an expanded network of storage facilities (Shukla et al., 2011, p.8).
b. **Distributing via Village Entrepreneurs (VLEs**): VLEs, usually recruited from within a village and earning their income on a commission basis by selling specific products and services (Dutt, 2012, p.1), may operate more effectively than a company-owned retail network. Being familiar with their neighborhood and operating in a restricted area, VLEs are well placed to take advantage of proven local distribution methods, for instance by using alternative means of transport like rickshaws and canoes (Anderson and Billou, 2007, p.16).
c. **Partnering with others and leveraging shared resources**. Examples would be leveraging shared or bidirectional distribution channels (with products and services flowing in two directions, e.g. agents who both stimulate purchases from farmers and sell them goods) (Vachani and Smith, 2010, p. 26), sharing infrastructure with other companies and organizations by allocating common plots and offices or partnering with NGOs, donors and governments in order to combine organizational capabilities (Jenkins et al., 2009, p.14; WEF, 2009, p.7).

2. **Reaching target markets with missing soft infrastructure:** Next to missing hard infrastructure there might also be a lack of soft features such as missing financial services, market information, producer organizations, education programs or policies and regulations that strengthen business operations (WEF, 2009, p.18; Clarke et al., 2010, p.9). Both types of infrastructure gaps are typically considered to be a public responsibility, however, many BOP customers live in remote regions, where public services are underdeveloped (WEF, 2009, p.18).

   Strategies:

   a. **Rearranging the value chain**: It may be useful and cost-effective to create a distribution system that sources from local producers and leverages existing local distribution channels in order to overcome soft infrastructure constraints

that otherwise hinder distribution for non-local companies. A coordinated supply chain can grow into a platform that facilitates business operations and may bring benefits to the producers as well as the consumers (WEF, 2009, p.26).

b. **Forming active partnerships with the public sector and local communities as well as unconventional market-players**. In order to guarantee long-term profitability in low-income markets, private action needs to address institutional misalignments by collaborating with local communities, public actors and organizations that have established networks with deeper reach. For instance, partnering with universities, development agencies or even competitors can help address a lack of skilled people, low access to market information or inexistent quality standards (WEF, 2009, p.18; p.29-30); IFC, 2012, p.66-68).

3. **Making products and services continuously available**: Ensuring availability of products and services in the BOP market means that post-sale services must be guaranteed continuously. This is especially important for organizations delivering products with relatively high degrees of technical complexity and maintenance requirements (Shukla et al., 2011, p.9). Especially in sparsely populated areas, ensuring comprehensive, formalized after-sales service can be complex and expensive, so creative and flexible approaches are needed.

   Strategies:

   a. **Optimize the placement of storage facilities as well as maintenance and repair service centres** to lay the basis for a continuous post-sales service meeting customers' needs.
   b. **Manage inventory correctly**, deploy technological tools and operational processes and provide necessary training to ensure inventory control.
   c. **Arranging maintenance infrastructure and calculating repair cycles** adequately helps establishing after-sales services as well as a continuous delivery of products and spare parts (Shukla et al., 2011, p. 9).

4. **Managing and controlling complex distribution networks**: Given the fact that rural BOP markets are very dispersed and distribution channels often adapted to local contexts, a complex distribution network involving diverse stakeholders with different perspectives and needing different incentives may have to be managed. This leads to

high transaction costs, for instance in the area of recruitment, management and training of last mile distribution sales forces. (Hystra, 2013, p.13).

Strategies:

a. **Decentralizing and externalizing**: working with local institutions and entrepreneurs and give them decision-making power leads to high responsiveness and more collaborative relationships between companies, consumers and entrepreneurs (Viswanathan, 2011, p.157ff).
b. **Motivated and skilled employees/entrepreneurs** facilitate the management of complex distribution networks as well. By developing shared goals and values, offering career opportunities and organizing team events, a company can ensure an attractive work environment. Providing competitive compensation particularly enhances the satisfaction and thus the reliability of employees, thereby leading to continuity in staff (Hystra, 2013, p.13; WEF, 2009, p.22).
c. **Make an effort to find the right staff and partners.** Leveraging partnerships, global and local networks as well as personal connections – if necessary with a lot of persistence – can help finding the right staff for positions at various levels (or finding partners that will support the recruitment of suitable employees) (Hammond, 2011, p.197ff).

III. Affordability

Anderson and Billou state that the second overarching barrier for doing business at the BOP is to ensure that products or services on offer are affordable (Anderson and Billou, 2007, p.9). This barrier is obvious, given the fact that the 3.7 billion people comprising the "base of the pyramid" (BOP) earn USD 8 per day or less, deal with fluctuating, uncertain income and have generally limited access to credit or insurances. These circumstances make BOP customers smart shoppers and risk-averse investors (WEF, 2009, p.5). The main market challenges related to this barrier, as well as relevant business strategies to increase affordability are the following:

1. **Low purchasing power and income volatility:** Rural BOP customers typically have both low income per capita, and low disposable incomes. Income flows of BOP households are further often volatile and unpredictable. In addition, access to saving and affordable credit institutions is low (WEF, 2009, p.11).

   Strategies:

a. **Consumer financing**: Increase affordability through the provision of access to credit, thereby raising the end customer's ability to pay for product and service offerings. Possible strategies to provide financial products and services that are accessible, convenient, flexible, continuous and affordable include providing in-house credit and partnering with NGOs, microfinance institutions or rural banks (IFC, 2012, p.58).
b. **Flexible payment methods**: Maximize affordability through the implementation of flexible payment methods better suitable for the volatile income patterns of many BOP customers. (IFC, 2012, p.61).

2. **Product Affordability**: As BOP customers are characterized by low incomes and little savings, they are reluctant to make large up-front purchases. However, even though BOP customers are price sensitive, they cannot afford to invest their money into products with a short lifespan and thus are often ready to pay a premium for quality and reliability (WEF, 2009, p.25).
   Strategies:
   a. **Innovative packaging and product design**: Maximize affordability through innovative packaging, like offering products in very small units, and/or intelligent cost-effective product design (Anderson & Billou, 2007, p.16-17).

Contrary to the challenges listed above, the subsequent challenge does not concern affordability on the end-customer level, but on the level of small and medium enterprises and other stakeholders securing the last-mile distribution.

3. **SME's barriers (low access to capital)**: Small and medium enterprises involved in the local distribution chains often have little financial capabilities and lack access to capital.
   Strategies:
   a. **Channel financing**: Ensure the proper functioning of channel operations by providing partners with access to financing through partnerships with social investors, microfinance institutions and rural banks (Shukla et al., 2011, p 9).

Strategies to cut costs and increase affordability exist for almost every stage of a supply chain and are thus not explicitly mentioned in this section. While cost efficiency in distribution systems is addressed under "availability", strategies to cut production costs are not considered in this paper, because this stage of the value chain will not be evaluated in the field test.

IV. Acceptability

Another critical factor when serving the world's poor is, according to Anderson and Billou (2007, p.15ff), gaining acceptability – or willingness to consume, distribute or sell – for the product or service offered. To achieve acceptability, products or services need to be adapted to the distinct needs of both target consumers and the actors involved in their distribution and sale. There can be country- or region-specific aspects, or distinctive local business practices that distributors have to take into account. As with all consumers, it is crucial to understand their daily lives and the related needs[11] (Anderson and Billou, 2007, p.18). The following distribution challenges as well as the most relevant strategies to address them relate to the fact that business must in some way ensure the acceptance of their products and services by target users:

1. **Initial lack of trust in new products and brands**: Rural, low-income consumers usually prefer known brands and products (Hystra, 2013, p.9; IFS, 2012, p.51). One major reason is their risk-adverseness. There is often a fear that something will go wrong with unproven offerings, or that the purchase is not worthwhile the investment: BOP consumers may be unaware of future benefits – it takes some time for customers to see themselves that a product was worthwhile the investment – or wary of potential technical issues, maintenance and replacements (IFS, 2012, p.63; Hystra, 2013, p2ff; Shukla et al., 2011, p.3ff).

   Strategies:

   a. **Offer real economic benefits** – and make them as tangible as possible, best using marketing slogans with straightforward economic arguments (Hystra, 2013, p.5).
   b. **Lower the (perceived) risk of being disappointed**. One way is to make people experience themselves how much they can actually benefit from and/or save with an improved device (like a cooking stove or a solar lantern)[12], or in what ways it brings advantages over alternative choices.

[11] A good example is the Chinese appliance maker Haier, who discovered that rural, low-income customers in China did not seem to perceive the purchase of a washing machine just for laundering clothes an investment worth the money. Instead, they used the machines also for other purposes like cleaning vegetables. Haier took this habit serious and consequently developed a washing machine for the dual usage of laundry and vegetable cleaning, and another model to make goat cheese. Similarly, Coca-Cola provides their distributors in BOP markets with iceboxes due to the frequent lack of electricity and refrigerators (Anderson and Billou, 2007, p.18).

[12] One example is Toyola, who proposed the customers of their cooking stoves to hire the stove for a certain period, during which they are encouraged to deposit the savings from reduced charcoal usage to see how much they save (Hystra, 2013, p.6).

Another is to provide complementary services dealing with the perceived risks (Hystra, 2013, p.6; Shukla et al., p.11).

c. Try to understand and **leverage local institutions and village politics**. Such strategies may include seeking the endorsement of community chiefs, engage entrusted locals or making opinion leaders test the product for free, and hopefully lead to positive word-of-mouth (Hystra, 2013, p.10; see also "Awareness" point 1.a).
d. **Build consumer trust**, for instance by developing a recognisable brand, hiring reputable locals as sales or marketing agents or leveraging existing consumer brands (e.g. partnering with a well-known company to distribute a product) (Hystra, 2013, p.6; IFS, 2012, p.60ff).
e. **Incite potential customers to adopt a new product or brand** by designing products and services that (seemingly) enhance their social status, for instance by offering a basic as well as an improved version of a product (Hystra, 2013, p.6).
f. **Offer a warranty as well as professional and consumer-friendly after-sales service**, for instance by engaging a trained agent in each village, ensuring that broken parts can easily be repaired or replaced (IFS 2012, p.56 ff). This requires the agents to have a stock of spare parts and to know how to service the devices (Vachani and Smith, 2010, p.13).

2. **Manage longer-term acceptability**: Sometimes a product is not used anymore when customers would have to make a proactive effort in order to allow a continuous use. How can customers be incited to make proactive efforts in case of technical problems or replacements? (Hystra, 2013, p.11).
   Strategies:
   a. **Avert negative word-to-mouth** by evaluating and instantly following up with customer dissatisfaction (Hystra, 2013, p.11).
   b. **Provide professional after-sales services** and promote these services to make sure potential customers know what they will be offered (Hystra, 2013, p.11; see also point 1.f).

3. **Localisation of products/services and delivery processes**: Offerings and delivery channels must be fitted and shaped according to the needs of target customers in order to be successful (Shukla et al., 2011, p.10). Yet, it may not be easy for

outsiders to understand local markets and the diverse consumer preferences and needs (Debelak, 2011, p.23).

Strategies:

a. **Conduct primary and secondary research** (on population, usage rates, demographics, behavioural patterns, alternate product choices and lifestyle) and collect and distribute intelligence information about the marketing environment to understand the different needs of various customer segments (Shukla et al., 2011, p.10). **Field research**, with staff extensively dealing with local communities and partners, particularly helps to understand consumer needs. The insights gathered must then be integrated in the product development in order to design appropriate, possibly customized offerings (IFS, 2012, p.45).
b. **Offer complementary products** in order to modify or complete the product portfolio so that it best matches customer needs and preferences (Shukla et al., 2011, p.10).
c. **Collaborate with local intermediaries, village level entrepreneurs and/or opinion leaders** who have a deep understanding of local economic processes, consumer needs and pathways to influence local businesses, households and individuals. Also, potential buyers should be involved in developing and communicating the value propositions of a product or service (Shukla et al., 2011, p.10).

4. **Adapt to cultural diversity and overcome cultural barriers**: Decisions of local consumers as well as staff members are influenced by cultural norms, preconceived notions or conventional wisdom that may be difficult to understand for outsiders (Vachani and Smith, 2010, p.8; Shukla et al., 2011, p.4ff). In addition, target markets are often characterised by high cultural diversity, so distribution channels must be apt to handle different cultural groups (Debelak, 2011, p.23).

   Strategies:

   a. **Collaborate with local communities** and partner with organisations that are deeply familiar with the region in order to develop a good understanding of the local cultural circumstances (WEF, 2009, p.29).
   b. Staff of foreign companies or organisations should carry out **field research** in order to get familiar with the local social and cultural context (IFS, 2012, p.45).

V. Awareness

Awareness refers to the extent to which consumers know about a product or service (Anderson and Billou, 2007, p.15). The lack of access to conventional advertising media like television and Internet makes awareness-building among low-income consumers an important challenge. Companies must find alternative information channels like billboards along roads, marketing material tailored for small shops, street performances and product demonstrations in the local communities (Anderson and Billou, 2007, p.19). What is more, rural low-income consumers often have low education levels and may thus not be able to derive value from existing information (Vachani and Smith, 2010, p.6ff). The following challenges and related strategies to successfully tackle them exist under the category of awareness:

1. **Limited access to modern communication and media platforms**: Even if mobile phone subscriptions and Internet access have increased a lot in recent years, access to communication infrastructure is still often unsatisfactory in rural areas, leaving BOP consumers unfamiliar with new offerings and their proposed benefits. The **lack of electricity** is an additional obstacle to straightforward access to information (Vachani and Smith, 2010, p.8; WEF, 2009, p.28).

   Strategies:

   a. **Use unconventional marketing channels**: While billboards or radio ads can contribute to raising awareness, the best publicity is good experience of friends and relatives and individual experience from testing a product. Business should thus in particular capitalise word-of-mouth and relationships at local level, for instance by offering free trials to opinion leaders. Village-level demonstrations or road shows are also important, allowing target customers to experience and test the product themselves[13] (IFS, 2012, p.51; Hystra, 2013, p.9ff; WEF, 2009, p.12)
   b. Related to the strategy above is the need to put emphasis on **measuring and ensuring customer satisfaction**, which in turn generates positive mouth-of-word (Hystra, 2013, p.11).
   c. **Set up a communication infrastructure oneself**, for instance by procuring one farmer per village with a computer so that he can access information, e.g. on current market prices or agricultural practices provided on a special

[13] Greenlight Planet, for instance, pour water on their solar panels to demonstrate that they are waterproof; and d.light throw their lanterns on the floor to give proof of their robustness (Hystra, 2013, p.10).

website for farmers. Such a setting will facilitate the circulation of valuable market information among the community members so productivity can be enhanced and more informed purchases made (Vachani and Smith, 2010, p.8).

2. **Low literacy and education levels**: rural BOP consumers often do not have enough knowledge and skills to understand and analyse market information, and consequently to derive value from it (Vachani and Smith, 2010, p.6ff). In addition, poor education levels prevent the development of conventional, cost effective marketing and communication materials resulting in information asymmetries and prolonging new product introductions. Rural BOP consumers do thus often not possess accurate information to make informed purchasing decisions (Shukla et al., 2011, p.4).

   Strategies:

   a. **Educate end consumers about product offerings and benefits**, for instance through farmer-training programmes or promoters visiting villages to educate community members. Such strategies can involve guided product testing, or training village agents (including women!) to communicate relevant information to fellow villagers. The latter additionally generates income, which may contribute to a better education of the children (Vachani and Smith, 2010, p.14ff; WEF, 2009, p.28).
   b. **Elaborate powerful messaging** which is easily understandable for target consumers and which incites them to take action (Shukla et al., 2011, p.9).
   c. **Install Internet community portals** using voice-over design in the local language (Vachani and Smith, 2010, p.14ff).
   d. **Identify and partner with opinion leaders or local media**, who can play an important role in mobilising early adopters and followers (Shukla et al., 2011, p.6; WEF, 2009, p.28).

VI. Conclusion

This paper intended to identify a variety of strategies to overcome the most pertinent distribution challenges in the BOP market. Anderson's and Billou's (2007) "4-A's" served as a framework for categorizing these challenges and proximate strategies addressing the complex requirements of last-mile distribution. All the findings have been compiled from existing academic and business literature and should eventually serve as a mean to evaluate the potential of the OOLUX Business Model and to provide Antenna Technologies

recommendations on possible adaptations and developments for marketing its product successfully in BOP regions around the globe.

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