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Entering the market with Solar Pumps at the Base of the Pyramid

A case study of Nicaragua

- Master Thesis –

Submitted by:
Michael Sinniger (10-168-953)
Bächenstrasse 21, 8274 Tägerwilen

Supervisor:
Ph.D. Urs Heierli

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Abstract

According to the latest data on global poverty, 767 million people have been living with less than 1.90$ per day, from which a large majority live in rural areas and their main source of livelihood is agriculture. These smallholder farmers highly depend on rainfall or physically demanding irrigation by hand, since they do not have the required capital to purchase irrigation systems. Climate change exacerbates their vulnerability even more and increases the probability of crop failures. These circumstances call for a small-scale solar water pump to use in irrigation. The sunlight pump, developed by the Swiss company ennos, represents such an environment-friendly technology. ennos aims to disseminate the pump to smallholder farmers in developing countries and help improving the income and life situation of the people at the “Base of the Pyramid” (BoP). After gaining a foothold in several countries, ennos now seeks to enter the market through suitable local partners in Nicaragua, the country with the lowest agriculture productivity per hectare in Central America.

The purpose of this thesis is to analyze if a market potential for the sunlight pump in Nicaragua exists and under which conditions the marketing can successfully be implemented. The combination of in-depth secondary research, the insights of interviews with market players and focus groups as well as the findings in the course of field observations, allow to provide the reader with a detailed overview of the relevant market.

Acknowledgments

First of all, I would like to express my gratitude to Professor Urs Heierli and the whole team of ennos for giving me the opportunity to come to Nicaragua. Special thanks also go to iDEal Tecnologías who welcomed me to their wonderful family. I will surely never forget the time with you in Nicaragua! Last but not least, I dedicate this thesis to my family. They always support me, no matter what happens.

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List of abbreviations

AHK	German-Nicaraguan Chamber of Commerce and Industry
BCN	Banco Central de Nicaragua
BoP	Base of the Pyramid
BFH	Bern University of Applied Sciences
CAFTA-DR	Central America-Dominican Republic Free Trade Agreement
CEPAL	Economic Commission for Latin America and the Caribbean
CENAGRO	National Agricultural Census
CIA	Central Intelligence Agency
CONAMI	National Microfinance Commission
ENATREL	National Electric Transmission Company
ENEL	Nicaraguan Electricity Company
FSLN	Sandinista National Liberation Front
GDP	Gross Domestic Product
GHI	Global Horizontal Irradiance
Ha	Hectare
IMF	International Monetary Fund
INE	Nicaraguan Energy Institute
INIDE	National Institute of Development Information
INPESCA	Nicaraguan Institute of Fisheries and Aquaculture
JISL	Jain Irrigation Systems
kWh	Kilowatt hour
Lbs	Pounds
m^2	Square meter
MEM	Ministry of Energy and Mines
MITRAB	Ministry of labor
Mz	Manzana
Q	Quintales
RACCS	Autonomous Region of the South Caribbean Coast
RACCN	Autonomous Region of the North Caribbean Coast
SE4ALL	Sustainable Energy for All
SoPAS	Solar Pump Association Switzerland
UNDP	United Nations Development Programme

1 Introduction

1.1 Problem Definition

According to the latest data on global poverty, 767 million people have been living with less than 1.90$ per day, from which a large majority live in rural areas and their main source of livelihood is agriculture (World Bank, 2016, p. 3). These smallholder farmers highly depend on rainfall or physically demanding irrigation by hand, since they do not have the required capital to purchase irrigation systems. Climate change exacerbates their vulnerability even more and increases the probability of crop failures. If smallholder farmers do have the financial means, they often buy fuel or electric water pumps. However, these pumps are linked with high operational costs and maintenance expenses, as they are of low quality. Fuel pumps are harmful to the health of the user and furthermore pollute the environment. And electric pumps, on the other hand, require access to electricity, which is for 1.2 billion people worldwide not given (UNDP, 2017, p. 79) and therefore drastically limit the scope of application. These circumstances call for an environmental-friendly, off-grid alternative for smallholder farmers.

The sunlight pump, a small scale solar water pump developed by the Swiss company ennos, meets these criteria. ennos aims to disseminate the pump to smallholder farmers in developing countries for use in irrigation and domestic water supply. At the same time, the technology should help improving the income and life situation of the people at the “Base of the Pyramid” (BoP). After gaining a foothold in several countries, ennos now seeks to enter the market through adequate local partners in Nicaragua, the country with the lowest agriculture productivity per hectare in Central America. Given that Nicaragua has a large agriculture sector that accounts for almost 70% of the country’s export and that of all the cultivated area only 5.5% is irrigated, there seems to be a potential for the sunlight pump. However, typical for a BoP market, infrastructure is insufficient, the agricultural labor force is unskilled and smallholder farmers lack financial capital. These barriers complicate the market entry of the sunlight pump and hence more research about the market is needed.

1.2 Research Focus and Objectives

“After all, we do not sell water pumps, we sell solutions to people's problems.”
Luis Cuadra, small retailer of agroforestry equipment in Matagalpa (Focus Group 5)

This quote from a focus group attendee in Nicaragua summarizes the objectives of the present thesis appropriately. Simply put, the author intends to find out if the sunlight pump can contribute to solve smallholder farmers’ problems. In doing so, in-depth research was conducted in Nicaragua as part of an internship at iDEal Tecnologías. The focus lied on the elaboration of relevant market players and the insights gained from them, as well as the findings from focus groups carried out in different regions of Nicaragua. According to the terms of reference provided by ennos, the author carried out further research in order to gather the required data for the possible market entry of the sunlight pumps.
More specifically, the present thesis intends to answer the following research question:

Is there a market potential for the sunlight pump in Nicaragua and under which conditions can the marketing be successfully implemented?

1.3 Structure of the present paper

The practice-oriented thesis is divided into a theoretical and a practical part. After the introduction, chapter 2 outlines the theoretical focus of the thesis; more precisely, the particular characteristics of the BoP market. Subsequently, in chapter 3 brief background information of the sunlight pump and the involved partner companies are presented. In chapter 4 relevant market data is discussed in order to give the reader an overview of the specific market context in Nicaragua. Thereby, the focal point lies on the solar and agriculture sector.

The second part of the paper comprises the results of the interviews with individuals and focus groups as well as the findings in the course of field observations. Initially, chapter 5 includes an extensive review of market players that are considered as potential cooperation partners along the value chain. Then, in chapter 6, the author introduces potential add-on and competitor products regarding the sunlight pump. Chapter 7 deals with the logistics, on one hand regarding import incentives in order to keep the price of the sunlight pump low for the end user, and on the other hand on distribution channels. Subsequently, the insights of seven sunlight pump field demonstrations - combined with focus groups - serve to better understand the needs of the end users and show possible scopes for the application of the sunlight pump. The thesis finally concludes with possible initiatives on the marketing of the sunlight pump in Nicaragua by addressing the critical success factors based on the concept of the 5 Cs[1].

1.4 Research Design

The first part of this thesis is based on secondary research that includes academic literature, reports from the government of Nicaragua as well as international / national organizations.

After elaborating the theory and the context, the findings of the second part of this thesis are mainly drawn by primary research, and partly secondary sources. The conducted primary research accounts for the major content of the case study in order to gain qualitative information at first hand and establishes contacts from the relevant market in Nicaragua. The interviews were structured in two parts: In a first part, the narrative interview method was used. Unlike the question-answer scheme of most interviews, the narrative interview uses a specific type of everyday communicative interaction, namely storytelling and listening, to gather information. In narrative interviews, interviewees are given considerable control over the course of the interview. This research method provides flexibility in conversation and enables the exploration of spontaneous comments. (Corbin & Morse, 2003, p. 337-342)

In a second phase, the author changed to a structured interview. This research method was used to acquire specific information to fill the knowledge gap.

Thereby, 24 interviews were accomplished:

- 7 with leading companies in the area of solar energy,
- 12 with organizations and small enterprises,
- 2 with microfinance institutions and
- 6 with market experts. (see appendix A-D)

[1] Belz & Bieger, 2006, pp. 219-355

The gained findings of the interviews were used to create a guideline for the ensuing interviews with focus groups consisting of smallholder farmers and representatives of Nicaraguan based organizations. Focus groups are a moderated and focused discussion of a group of people who, through mutual exchange and confrontation with the perceptions, opinions, and ideas of other attendees, provide a significant amount of information. Generally speaking, focus groups are an appropriate approach when it is necessary to gain in-depth and comprehensive insights from the customers, to understand behavior-based motivations or to discover existing customer problems. (Vogl, 2014, pp. 581-585)
Eventually, 11 focus groups with a total of 93 participants were implemented in the field. The results are summarized according to the qualitative content analysis (Mayring & Fenzl, 2014 pp. 543-544).

Part I: Theory and Basics

2 Focus on the Base of the Pyramid

As the sunlight pump is specifically designed for the “Base of the Pyramid” market, the particular characteristics of this market segment are discussed on the basis of relevant literature. By means of this chapter, the reader better understands on what basis the research of the following practice-oriented case study is conducted. However, it is essential to mention that the elaboration of general BoP literature is not the purpose of the present thesis. For detailed information, the author refers to the subsequently cited literature.

2.1 Definition

“The poor deserve world class products and services”, states C.K. Prahalad (2008) and turns against the idea of providing the poorest with simplified products, but instead calls for innovative technologies. The marketing of products designed to address the market segment of the "world's poorest" is foremost based on the BoP concept originally developed in 2002 by Prahalad and his colleagues Stuart L. Hart as well as Allen Hammond and has been evolved by many scholars ever since. Prahalad and Hart (2002, p. 4) identify the lower part of the pyramid, measured by the indicator "purchasing power parity in US $ per day", as the world’s population that lives in extreme and moderate poverty. They refer to four billion people representing the bottom tiers of the world income pyramid. Regardless of setting exact income lines, the BoP usually includes people who are “generally excluded from the current system of global capitalism” (Arnold & Williams, 2012, p. 4). Although the exact market size is therefore controversial, the markets of the BoP pose great potential for companies to position themselves (Karnani, 2006, pp. 100-101; Prahalad, 2011, pp. xxvii-xxviii). In fact, a growing number of companies have attempted to enter the market, which initially was regarded as too risky and expensive to serve. The market-based BoP-approach aims at creating a mutual value in terms of generating earnings for both the company and the consumer, respectively the particular local community (Anupindi et al. 2010, p. 582). Prahalad (2004, p. 3) argues that by means of such a win-win situation, poverty can be alleviated.

2.2 Specific Market Characteristics

The BoP market comprises distinct features that have to be considered. Since each BoP market is different and cannot be compared to others, an enterprise that operates in various countries has to gain local knowledge. Therefore, the need arises for enterprises to collaborate with country based partners in order to reach the BoP and facilitate the supply and value chain. In other words, companies need to create a "holistic ecosystem of partners" that provides local knowledge, contacts and expertise (Hahn & Gold, 2014, pp. 1321 & 1331; London, Sheth & Hart, 2014, p. 7). On the other side, the local network often lacks technical as well as business knowledge and needs adequate training and access to information with the objective "to build capacity at all levels" (London et al., 2014, p. 20). The gained know-how can then be passed and communicated to the consumers, which often have a low education level and insufficient communication structures as well as limited knowledge about products. (Vachani & Smith, 2010, pp. 6-7; Schuster & Holtbrügge, 2012, p. 817; Khalid, 2015, p. 682)

According to Klein (2008, p. 817) the main strategic obstacle for companies operating at the BoP is dealing with the minimal purchasing power of the customers, whereby the insufficient access to financial services and unreliable income streams exacerbate the general low-income level (Karamchandani, Kubzansky & Lalwani, 2011 p. 3-5; Schuster & Holtbrügge 2012, p. 817). Although the individual purchasing power is limited, a study in rural India reveals, however, that BoP consumers are willing to pay a premium for products which entail a popular label (Shukla, 2012, p. 267-269).

On the other hand, unfamiliar companies and products arouse distrust of the BoP population. As a consequence, Schuster and Holtbrügge (2012, p. 827) suggest moving "from an outsider to an insider position to get access to the prerequisite knowledge" by familiarizing with market conditions and customer needs, building relationships with potential consumers and using existing customer networks of local associates. By doing so, the business activities can also be shaped in such a way that they reflect, as far as possible, the fundamental needs and demands of the potential consumers (Hahn & Wagner, 2009, p. 101).

Furthermore, the distribution of products to the consumer is impeded due to fragmented or non-existing supply channels and thus increases the distribution and maintenance costs (Anderson & Billou, 2007, p. 14; Vachani & Smith, 2010, p. 24). To reach the predominantly rural BoP as a sales market, it makes sense to involve people from those areas in the supply and value chain (Sodhi & Tang, 2016, p. 128). Through the inclusive approach, companies create further sales opportunities and support income for the BoP simultaneously (Hahn, 2009, p. 404). Simanis and Hart (2008, p. 30) add that the enterprises would also be able to establish mutual commitment with the BoP and deepen community integration. In sum, Panapanaan, Bruce, Virkki-Hatakka and Linnanen (2016, p. 306), who conducted a study of energy enterprises operating at the BoP, determine that the use of an inclusive approach for technical products, which require installation, maintenance and higher levels of user commitment, "can be a necessity" for an enterprise in order to reduce costs and achieve trust of consumers. Consequently, the inclusive approach is another driver to gain trust from the BoP population.

Before delving into the case study, the two subsequent chapters introduce the sunlight pump and the market context in Nicaragua regarding solar energy and agriculture.

3 Sunlight Pump – What is behind this technology?

3.1 Ennos – a Swiss start-up and its current partners

The sunlight pump was developed by ennos, a company that was founded in 2006 as a spin-off of the Berne University of Applied Sciences (BFH). As a result of the comprehensive research of the university, ennos has gained an in-depth knowledge in the photovoltaic field. The focus lies in the Research & Development and marketing of cost-optimized and CO_2 neutral technologies, which is represented by the sunlight pump - the hitherto only marketable product. ennos aims to disseminate the small-scale solar-powered water pump to developing countries to be used for irrigation and domestic water supply. The objective is to increase agricultural productivity and income of smallholder farmers at the Base of the Pyramid. (Jeanneret, 2017a, p. 3-5)
ennos is therefore dependent on reliable partners in the different countries and so far, has gained a foothold in Bangladesh, Kenia, Uganda, Honduras, Burkina Faso, Rwanda and plans to enter the market in Nicaragua.

In order to better understand the market situation in Nicaragua, ennos cooperates with iDEal Tecnologías (iDEal) as their local partner (Jeanneret, 2017b). The task of iDEal is to organize reference installations with the sunlight pump in order to raise awareness, assess the performance of the pump in the field and to analyze the market potential in Nicaragua in collaboration with the author. iDEal is a social business that distributes affordable micro irrigation systems. To guarantee the long-term quality of the technology, iDEal trains farmers on the use and maintenance of the particular system and consults on crop and water management. The nine-person team operates throughout Nicaragua except of the two independent eastern regions RACCS[2] (Región Autónoma de la Costa Caribe Sur) and RACCN[3] (Región Autónoma de la Costa Caribe Norte). iDEal cooperates with 20 family-owned retailers from rural communities in order to improve the weak supply channels in rural areas and offer job opportunities to the rural population.

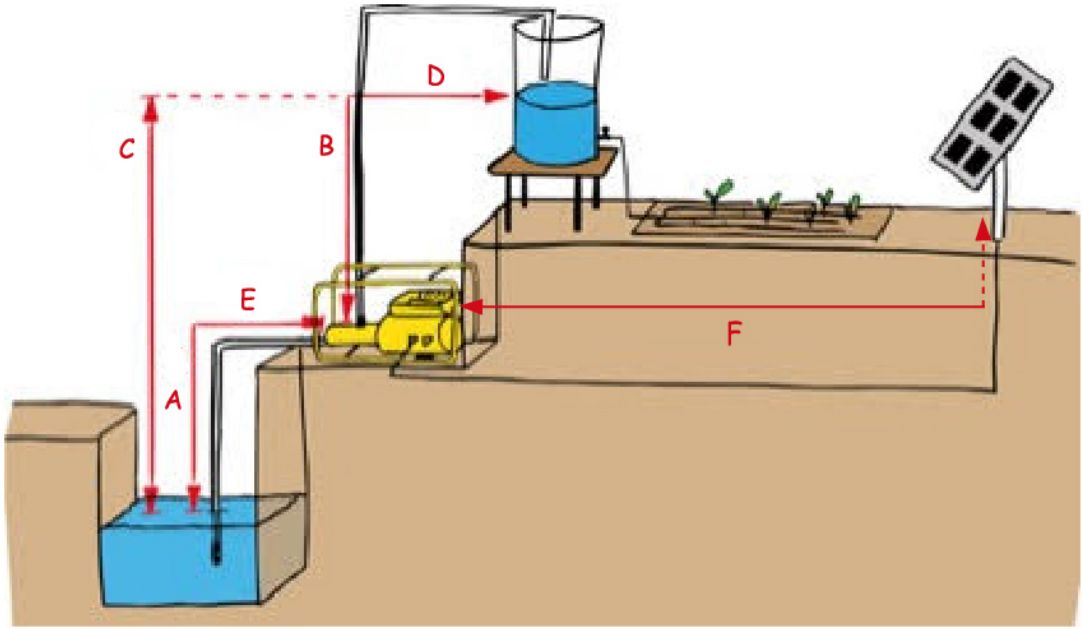
The sunlight pumps are manufactured by the Indian based company Jain Irrigation Systems (JISL). The solar pump will directly be exported to Nicaragua from India. Because of the broad product portfolio of JISL, ennos also has the opportunity to ship add-on products, such as solar panels or drip irrigation systems to Nicaragua. In doing so they are able to distribute complete packages in case that the price for add-on products in Nicaragua is excessive, respectively the quality inferior. With the production site in India, ennos can keep the costs of the pump low, from which the end user eventually benefits. But what are the advantages of the sunlight pump exactly?

3.2 Product Specifications of the Sunlight Pump

After various field tests with prototypes, the environmental friendly sunlight pump was created (see product shot in appendix E). It is a surface pump that operates with solar energy instead of fuel or

[2] Former name: Región Autónoma del Atlántico Sur (RAAS)
[3] Former name: Región Autónoma del Atlántico Norte (RAAN)

electricity from the grid. Depending on the discharge head and the water demand of the end user, the sunlight pump requires solar panels between 80 – 400 watts.
The following figure shows a possible application with a well and the general technical specifications (A – F).



A) Suction depth	maximum 7 meters (limited to by atmospheric pressure)
B) Water lift	up to 50 meters
C) Total lift	suction depth + water lift (he higher the total lift, the more energy is required)
D) Horizontal distance between pump and tank	maximum about 1500 meters (the longer the distance, the more energy is required)
E) Horizontal suction line	up to 40 meters
F) Horizontal distance between pump and panel	maximum 15 meters

Figure 1: sunlight pump application
Source: adapted from Ennos, n.d. b

If the suction depth of the well exceeds the maximum, the sunlight pump can be dropped into the well in order to extend the application possibilities. Apart from the automated irrigation system that saves much physical exertion, the pump can also be used for domestic water supply (cleaning, hygiene). The solar panels on the other hand can generate electricity for illumination, television, cooling or for charging cell phones and batteries. The 0.5 horse power water pump supplies up to 50 liters of water per minute (in perfect conditions), according to field tests in Nicaragua. This leads to maximum 18'000 liters per day assuming six hours sunlight. With the use of 12 – 36 volt batteries, which also can be connected directly to the pump, the water flow can reach approximately 55'000 liters per day (Jeanneret, 2017a, pp. 9-12).

The engineers of the BFH, who developed the electronics and the motor of the sunlight pump, identified four competitive advantages:

- High efficiency → Compared to other pumps, the efficiency of the sunlight pump is higher, which diminishes the needed panel size and therefore decreases the total cost of the sunlight pump system.
- Quality & Reliability → The long life span is guaranteed by high standard production processes and quality testing protocols. Thus, the life time of the electronics lasts approximately 10 years, the pump head up to 8 years and the motor until 20 years with minimal maintenance. Besides, an average solar panel endures about 20 years.
- User friendliness → The sunlight pump is robust, withstands heat to a high degree and avoids continuous operational costs such as fuel or electricity. It is equipped with a tank sensor (allowing an automatic operation) as well as a user-interface that illustrates the pumping status and displays possible technical problems.
- Portability & Flexibility → Due to the compact design, the sunlight pump only weighs 11.5 kilograms, which facilitates the transport. Also, the pump can be easily installed on the surface and needs simply be connected to a solar panel or battery. (SoPAS, 2016, p. 3).

Due to low or non-existent operational costs, solar pumps can run continuously the entire year in order to fulfill the needs of end users. In combination with energy storage devices (batteries) the pump even operates at times without sunlight. Electric and fuel pumps, in contrast, are usually only used for a short period per day because of financial reasons.
One of the main objectives is to keep the price of the sunlight pump as low as possible for the end user while providing the respective supply chain actors with a profitable margin. iDEal estimates the retail price of the pump in Nicaragua at approximately 750$.

4 The Market Context in Nicaragua

4.1 PEST – Analysis

PEST is the abbreviation for political-, economic-, social- and technological factors and describes the basic conditions of the macro surrounding in which a company exists (Fahey & Narayanan, 1986).

4.1.1 Political factors

Nicaragua is a republic with a presidential constitution consisting of 15 departments and two autonomous regions (RACCS and RACCN). The country is governed by Daniel Ortega, who led Nicaragua through revolution and civil war against the Somoza dynasty in the late 1970s. After losing various elections, he regained power in the 2006 poll with his party FSLN (Frente Sandinista de Liberación Nacional) and is president since then. In order to continue his presidency, he changed the constitution so that it permits him to retain power indefinitely. Thus, Daniel Ortega was able to win a third consecutive five-year term in 2016 with his wife as vice-president. Neutral election observers expressed serious doubts about the fairness of the election. (Schobel & Elsemann, 2008, pp. 420-441)

There are uncertainties in the legal context of Nicaragua as private property rights are not defended adequately and contracts are not constantly secure. The corruption and delays in the judicial system, the bribery of public officials and the lack of transparency in the regulatory system are further challenges. According to the "Corruption Perceptions Index" of Transparency International in 2016, Nicaragua is ranked 145th out of 176 after its neighboring countries (Transparency International, 2017).

The government determined agriculture as the sector with the highest potential for growth and has also put much effort in the renewable electricity sector since 2007 with significant advances (SE4ALL, 2013, p. 39). From a macro perspective, the government supports the reduction of fossil fuels. This is reflected by Nicaragua's ambitious goal of generating 74 percent of the electricity from renewable resources by 2018 (ProNicaragua, 2014).

4.1.2 Economic factors

Nicaragua's exports have increased significantly, because of the accession to the Central America-Dominican Republic Free Trade Agreement (CAFTA-DR) with the United States in 2006. Agriculture accounts for almost 70% of Nicaragua's primary exports. Apart from insulated wires, knit clothing and gold, agriculture commodities like coffee, meat and dairy products belong to the top export commodities (World Bank, 2015, p. 8).

Nicaragua has the lowest gross domestic product (GDP) per capita in Central America, whereby agriculture accounts for 17.3% and employs almost a third of the labor force (The Global Economy, 2016; Index Mundi, 2017; Acosta, Almeida, Gindling & Peña, 2017, p. 3).
The country has been experiencing a continuous growth over the last few years, whereas the expected growth rate in 2017 is 4%. The macroeconomic stability allows the country to plan in long-term strategies to reduce poverty, especially in rural communities. The Standard of Living Survey by INIDE (National Institute of Development Information) from 2014 shows that Nicaragua's extreme poverty has diminished from 14.6 to 8.3%[4] between 2009 and 2014. During the same time period, overall poverty declined from 42.5 to 29.6%[5]. Regardless of this positive development, poverty remains particularly high in rural parts of the country with 50.1% poor and 16.3% extreme poor (INIDE, 2015, p. 11). Bad infrastructure limits the rural poor's access to basic services such as water, electricity or sanitary facilities. In the two Atlantic coastal areas, the social and basic service indicators are even considerably lower. (World Bank, 2017)

The financing of a business investment poses another obstacle as many residents do not have a bank account at a formal financial institution and because of the high interest rates for loans. Almost a third

[4] Extreme poverty is defined as the costs of total annual food consumption per person necessary to satisfy the minimum daily calorie requirements, estimated in an average of 2'282 calories. This leads to an extreme poverty line of 344.2$ annually per capita or in other words less than 0.94$ per day.

[5] Overall poverty is defined as the extreme poverty line plus an additional amount for the consumption of services and non-food items such as housing, transportation, education healthcare or clothing. This leads to an overall poverty threshold of 556.3$ annually per capita or 1.5$ per day.

of the population do not meet the basic needs of the financial institutions. However, Nicaragua is making efforts in regulatory improvements in the microfinance sector, particularly in the agriculture sector which was most affected by the "No Payment Movement"[6]. (Inclusion Social Ratings, 2016, p. 3; Central America Data, 2015)

4.1.3 Socio-cultural factors

In the last years the population has been slightly growing to 6.2 million in 2017 and the median age is 25.6 years (UNDP, 2017).

The education system contains deficits and is underfunded, since the compulsory schooling is limited to an average of six years of primary school. This figure barely reaches the bottom of international standards. The total illiteracy rate was 17.2% in 2015 lagging behind neighboring countries (CIA, 2015). Many families are "incomplete" in the sense that the man has left the woman alone with her children. As a result, they fall into poverty with little chance of finding formal employment and are therefore forced to work in the informal market. In general, the proportion of a single woman being the head of the family is above average (Lara, 2009, p. 2). This problem is not only a result of the "machismo" behaviors of men who do not perceive their responsibility to the woman and the children or the legal prohibition of abortion. It is also seen as a companion for widespread migrant and occasional work, since necessity imposes enormous mobility to earning opportunities such as coffee, sugar cane and banana harvesting or large construction projects. Another widespread problem is the excessive alcohol consumption of men, which often causes intra-family violence (Salazar Agudelo, 2008, p. 34). Nevertheless, Nicaragua is considered to be the second most peaceful country in Central America after Costa Rica (Global Peace Index, 2017).

Owing to the history of civil wars, natural catastrophes and economic crises, the Nicaraguans, especially the rural poor, live in high uncertainty and therefore, they usually think and plan in the short term and are more risk-averse (Adsera & Menendez, 2010, p. 41). Besides, religion and tradition influence Nicaraguans strongly, which makes it more difficult for companies to convince them of a new technology, method or product. Family cohesion is a crucial cultural aspect and is reflected by many family businesses and profound trust amongst family members. In general, Nicaragua's culture is rather characterized by cooperation and collectivism than competition and individualism (Vázquez & Panadero, 2016, p. 389).

4.1.4 Technological factors

Technology is in constant progress in various areas such as energy generation, irrigation, sanitation, telecommunication or banking. There are many small and medium-sized enterprises that offer decentralized energy supply as well as irrigation systems. Rural access to improved sanitation amounts to 68% (World Bank, 2015a). An important trend is the continuous increase in mobile phone penetration since the telecommunication duopoly, Claro and Movistar, are continuously expanding the mobile phone network throughout the country, reaching 7.7 million mobile subscriptions in 2016, thereof 2.2

[6] „No Pago" (No Payment) was a social movement in 2008 against micro financial institutions (MFI), where many money borrowers, mostly farmers, collectively decided to refuse their repayment obligations and eventually, forced MFIs to declare bankruptcy. The protest was supported by President Daniel Ortega.

million smart phones. Besides, there is a high density of internet cafés and public free WiFi spots established by the government (CIA, 2016).

4.2 A Glance at the Solar Cornerstones

4.2.1 Nicaragua's renewable energy goals

As already briefly mentioned in the PEST analysis, renewable energy plays a progressively important role. In 2007 Nicaragua approved the "Central American Sustainable Energy Strategy 2020" that outlines a common vision of energy integration, such as independence on hydrocarbons or to raise the proportion of renewable sources. (CEPAL, 2007, pp. 98-102).

Furthermore, Nicaragua is part of the Sustainable Energy for All (SE4ALL) initiative launched by the United Nations in 2012. Within the program, the first objective is to ensure modern energy services universally. Although Nicaragua was recently successful in covering more parts of the country with electricity, it still does not benefit the whole population. Of the 2.5 million rural population, 42.9% still do not have access to electrical services, which poses a barrier to accomplish the electrification target of 90% coverage in 2020 (SE4ALL, 2013, p. 33; World Bank, 2014). In conjunction with the second SE4ALL objective, increasing energy efficiency, Nicaragua promotes the identification of energy efficiency in all electrical equipment that enters the country and has started an educational campaign about the sustainable use of electricity. The third objective deals with the greater integration of renewable energy. In 2016, 52% of the produced energy of 2396 GWh came from renewable sources (see figure 2) (SE4ALL, 2013, pp. 66-116).

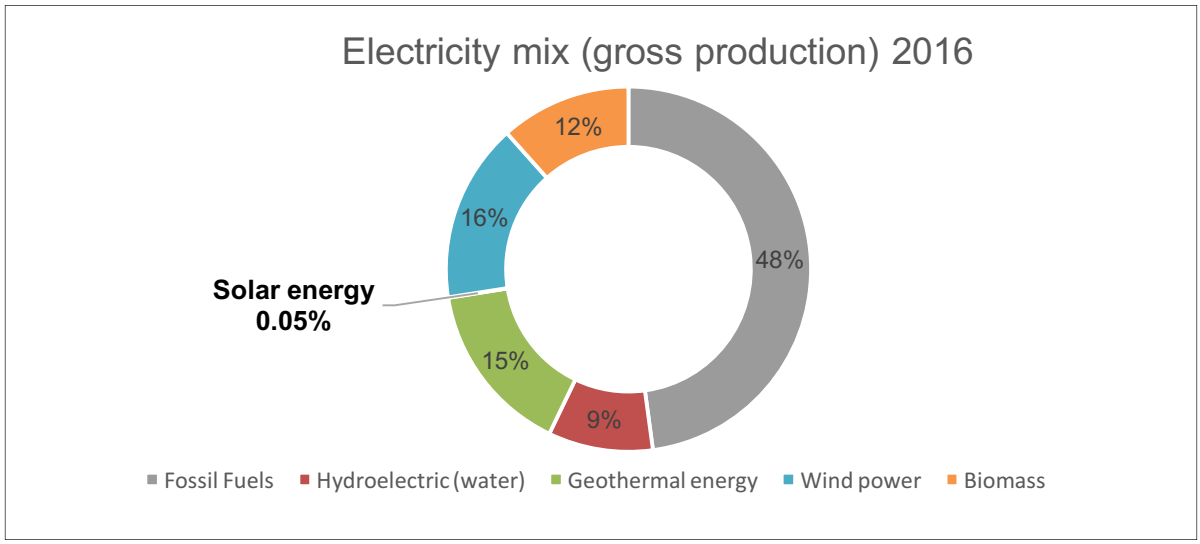


Figure 2: Electricity mix 2016
Source: INE, 2016

The figure shows that photovoltaic (PV) energy has a great potential for expansion as only 0.05% of the produced electricity for the national power grid originates from solar energy. According to the International Renewable Energy Agency (IRENA, 2015, pp. 4-5), especially the rural PV off-grid application still is an unfulfilled market, particularly for small-scale projects. In favor of the direction to solar energy is the steady price reduction of PV panels and the possible reform of the Law 532 for the

promotion of electric generation with renewable sources, which would allow individuals to feed PV electricity into the national grid without an extraordinary power input license (AHK, 2016, pp. 41 & 53).

The energy policies of Nicaragua are clearly in favor of the intended market entry of the sunlight pump as the product meets the described objective by SE4ALL in full.

4.2.2 Four Benefits of Solar Pumps

There is already a broad range of fuel and electric water pumps available in Nicaragua. The question arises: *Why should solar water pumps be used instead?*

The first reason is because there are no expensive inputs needed to operate the system. The electricity costs on average 6 Córdobas per kWh in 2017 which equals to approximately 0.20$ (BCN, 2017). According to CEPAL (Economic Commission for Latin America and the Caribbean), Nicaragua has the most expensive electricity tariffs in Central America in the consumer range of up to 200 kWh per month, where most residential customers are located (2015, p. 33). The price of diesel is 0.82$ per liter and petrol costs 1.01$ per liter (INE, 2017). A solar pump would decrease input costs leading to higher profits for farmers.

The dependency of oil as well as the lack of electricity is the second reason. Nicaragua is part of the Petrocaribe alliance with Venezuela. The agreement allows Nicaragua to purchase oil at a preferential price and is therefore highly reliant on these oil imports. The pending turmoil in Venezuela hazards the alliance and Nicaragua's guarantee to buy oil at a more favorable price. This uncertainty causes a risk for the national economy and traditional pump users, especially when oil prices rise in the near future. (IMF, 2017, pp. 42-45). With the use of solar pumps, the risk of rising oil prices would not affect the end users. Since there are 1.1 million people who lack access to electricity, they are not able to use electric water pumps as a substitute to fuel pumps (World Bank, 2014). Moreover, there are still frequent electricity outages, particularly in rural areas, which shrink the reliability of electric pumps.

Nicaragua's geographic premise outlines the third reason. As a tropical country, only twelve degrees north of the equator, Nicaragua has optimal conditions for the use of solar energy. The areas with the greatest potential for the use of solar energy are primarily located in the north-west of the country, in the provinces of León and Chinandega. These regions have a Global Horizontal Irradiance (GHI) of more than 6 kWh / m^2 per day, respectively 2191 kWh / m^2 per year, whereas in Bluefields (on the Atlantic coast) the solar radiation is about 5 kWh / m^2 per day (see GHI map in appendix F). In general, the entire Pacific coast has the highest potential, nonetheless the Atlantic coast also has above average conditions. As a reference point, Germany has a maximum GHI of approximately 1200 kWh / m^2. The mean sunshine duration reaches an average of 7.1 hours per day in Chinandega (measured in El Picacho) and 6.1 hours in the area of Matagalpa (measured in Muy Muy) (World Meteorological Organization, n.d.). On the Atlantic coast the average sunshine duration is usually less than 6 hours per day due to cloudiness.

The fourth reason is the implementable redistribution of subsidies by the government. On the basis of less oil imports and the subsequent improvement of the trade balance, the country would be able to subsidize solar technologies, such as solar pumps. In this way, the SE4ALL renewable energy targets would be more reachable. Although Nicaragua fosters low-income electricity consumers (below 150 kWh/month) and pensioners with subsidized tariffs, the IMF (2017, p. 49) determines that "there is scope for phasing out fuel and electricity subsidies which do not benefit the poorest households and introduce mechanisms that target better the poor". (Bella et al., 2015, p. 16)
After having gained an overview of the solar sector and its trends, the next chapter focuses on relevant topics within the agriculture sector regarding the sunlight pump.

4.3 A Glance at the Agriculture Cornerstones

4.3.1 Characteristics of Smallholder Farmers

The initially determined target group of the sunlight pump are smallholder farmers, as the solar pump is designed for this specific group. *Hence, who are smallholder farmers and how many are there?*

Smallholder farmers, known in Nicaragua as *productores pequeños,* have remained crucial to the countries development and food production. The "Ministerio Agropecuario" (MAGFOR) defines small-holder farmers as peasants who cultivate less than 50 manzanas[7] (mz), which are 35 hectares (ha). A comprehensive report from INIDE (National Institute of Development Information) from 2011 indicates that out of total 261'321 agricultural farms, 85.2% belong to this smallholder category (see following table).

Size of agricultural land[9]	**Number of farms**	**Proportion**
less than 0.5 manzanas	31'758	12.2%
0.51 – 1 mz	16'660	6.4%
1.01 – 2.5 mz	38'215	14.6%
2.51 – 5 mz	35'580	13.6%
5.01 – 10 mz	33'591	12.9%
10.01 – 20 mz	29'775	11.4%
20.01 – 50 mz	37'246	14.3%
Smallholder farms	**222'759**	**85.2%**
more than 50 mz	38'562	14.8%
Total farms	**261'321**	**100%**

Table 1: Number of farms and their size
Source: CENAGRO, 2011, p. 6

[7] 1 manzana = 0.7 hectares

[9] Agriculture land is the area that is permanently or partially used for agricultural production, livestock or the combination of both

It stands out that, compared to other developing countries, smallholder farmers in Nicaragua have generally good access to land. Average smallholder farms in Bangladesh with 0.24ha, Kenya with 0.47ha or Bolivia with 0.89ha are significantly smaller (Rapsomanikis, 2015, p. 5). In spite of the relatively large proportion of agricultural land many of the smallholder farmers cannot take advantage of it. In fact, Nicaragua exhibits the lowest productivity per hectare amongst its peers in Central America (USDA/ERS, 2013, pp. 36-38). Even the livestock sector only has a relative marginal yield / animal of 79% in meat and 59% in milk compared the other Central American countries. The productivity gap of other key commodities in the agriculture sector is even larger. The reasons are insufficient infrastructure, unskilled labor force, unorganized transport and logistics service and the lack of access to electricity and financial assistance. (World Bank, 2015, p. 33-37).

The above given definition of smallholder farms is vague and therefore a more precise category is introduced, namely the subsistence farms (see table 2). These are smallholder farmers who own less than 5 manzanas of agricultural land and account for 46.8% of all the farms (see the first four rows in table 1). Subsistence farmers have a Gross Value Added (GVA) of only 1'141$ per year[10]. They foremost cultivate basic food, particularly grains, which are hardly marketable but serve as a protective shield from falling in extreme poverty. They exhibit the lowest access to water (74.1%) and have to engage in other work (38.4%) in order to survive economically. The minimum salary in the agriculture sector, however, is the lowest compared to all the other sectors. In 2016, the minimum wage lied at 3.8$ per day[11] (Mitrab, 2016).

Criteria	**Subsistence Farms**
Average Land	1.9 mz
Gross Value Added (GVA) per year	1'141$
Hired labor	21%
Did other work	38.4%
Access to water	74.1%
Received agriculture training	12.9%
Received technical training	12.3%

Table 2: Characterization of subsistence farms
Source: World Bank, 2015, pp. 47-48; cited in CENAGRO, 2011 & Ortega 2013

4.3.2 Agriculture land use

In the previous chapter smallholder farmers were described and quantified, now it is essential to determine *where* the agriculture land, and hence the smallholder farmers are located.

[10] Gross value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs.
[11] Calculation: Minimum wage per month is 114.4$ (3'480.72C$ * 0.033 exchange rate) / 30 days = 3.8$

Crop Production Areas

42.1% of Nicaragua's surface is cultivated (FAO, 2015a). Within this agriculture land, different cultivation areas have to be taken into account due to the agro-ecological and socio-economic heterogeneity. Climate, soil conditions, rain patterns, terrain structures as well as access to land, infrastructure and markets vary within the country. Therefore, the following map, which is reconciled with data from the Food and Agriculture Organization (n.d.), shows the land use of Nicaragua, and the agriculture land in particular.

Generalized, Nicaragua consists of three distinct macro regions:

- The Central region with higher elevation, a cooler climate away from the coast and mostly coffee, livestock or basic grains cultivation
- The Pacific dry lowland with fertile plains, several volcanoes and mostly sugar cane as well as peanut cultivation
- The Atlantic lowland with a large rainforest, various rivers and mostly livestock as well as basic grains cultivation (Baumeister & Rocha, 2009, p.16; Solé, 2016, p. 448)

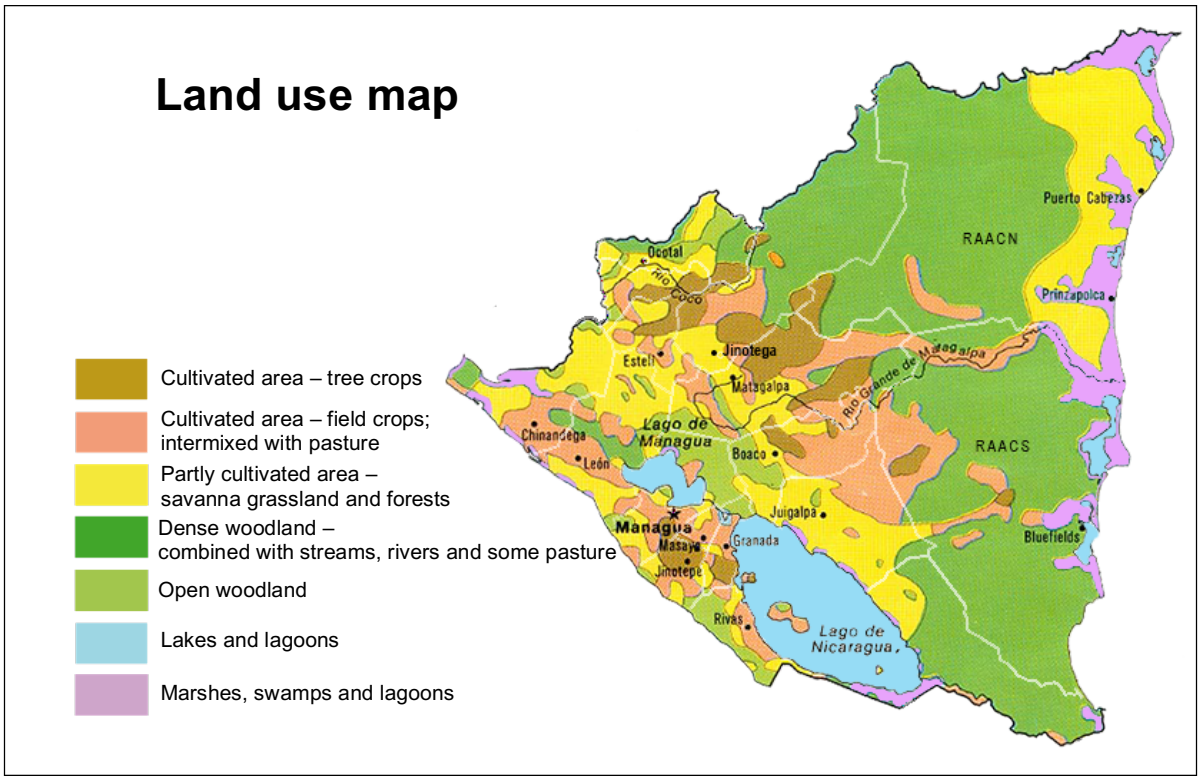


Figure 3: Land use map
Source: adapted from University of Texas Libraries, 1979; FAO n.d.

The majority of smallholder farmers in Nicaragua are located in the north of the *Central region*, namely in **Matagalpa** and **Jinotega**. Due to altitude and relatively cool temperatures, the two departments are designated for coffee production *(also leading in producing maize, beans, tomatoes, sweet pepper, potatoes, onions & cabbage)*. A further important area for agriculture is **Estelí** *(leading in producing tobacco)*.

In the *Pacific lowland*, there is much production of basic grains, fruits, vegetables and sesame as the soil is drier than in the rest of the country. Departments with many smallholder farmers are in the north-west of the pacific lowlands in **León** *(leading in producing sorghum, peanuts & soy)* as well as **Chinandega** *(leading in producing sesame & sugar cane)* and in the southern pacific in **Masaya** (leading in producing pipián, squash, citrus fruits, mango, avocado & dragon fruit) as well as **Rivas** *(leading in producing upland rice, plantains, musacea & papaya)*. The agriculture around **Managua** consist to a large extent of cash crops, for instance fruits and several vegetables *(leading in producing watermelon & pineapple)* (Rodríguez, Torres, Gómez, Bayres & Velásquez, 2013, pp. 3-4). The two departments **RAACN** and **RAACS** (former RAAN and RAAS) that are located in the *Atlantic region* are the largest in Nicaragua but the least populated and account for only 20% of smallholder farmers. The principal agriculture production is situated on the east side growing foremost maize, beans and musacea *(besides, leading in producing cassava, malanga & cocoa)*. However, the soil is mostly arenaceous and acidic, hence the region is more suitable for forestry (Ruíz & Marín, 2005 p. 19). (CENAGRO, 2011, pp. 20-26)

Risk of basic grains monoculture

Overall, farmers in Nicaragua grow a great variety of crops. However, due to the traditional diet of beans and maize and the need for self-sufficiency the large majority of the land is dedicated to these two basic grains (CENAGRO, 2011, p. 21). Although the smallholder farmers are rather able to feed their family with basic grains, they cannot generate an added income since market prices are unstable due to fluctuations and generally low for crops like maize and beans. In fact, the market price of 100 pounds beans at the market “Oriental” on November 10, 2017, was only 46$ (FHIA, 2017). Considering the input costs of fertilizers, pesticides and labor, can turn the production into a net loss. Many farmers attempt to enlarge their land with the aim to reduce their vulnerability, which, however, often leads to the contrary. The more land is cultivated, the higher are the input costs and therefore, the bigger is the loss for the smallholder farmer if the market price of beans decreases. This implies that, in order to make profits and invest in further value adding agriculture inputs, smallholder farmers have to cultivate diversified crops. This includes high-yield crops such as vegetables, fruits and coffee, climate-smart crops, for instance, yucca, cassava and moringa, or integrated crop-livestock systems (Azzu & Redfern, 2013, p. 197; Opportunity, n.d.). (Smith, 2014)

The importance of livestock for Nicaragua

Livestock constitutes a key agriculture activity, in particular for the southern Atlantic department **RAACS** with total 1.1 million cattle. The subsequent map shows that the departments **Matagalpa**, **Boaco**, **Chontales** and **Rio San Juan** also belong to the dominant livestock production areas. (CENAGRO, 2011, pp. 20-26)

The number of cattle has grown by 52% from 2001 to 2011 to a total stock of 4.1 million (Holmann, Mtimet, Mora, & Hoek, 2014, pp. 14-15; cited in Pérez, 2013).

In the same period Nicaragua has been the primary livestock producer and exporter in Central America. Due to the high international demand, this development is assumed to continue. (World Bank, 2015, p. 22)

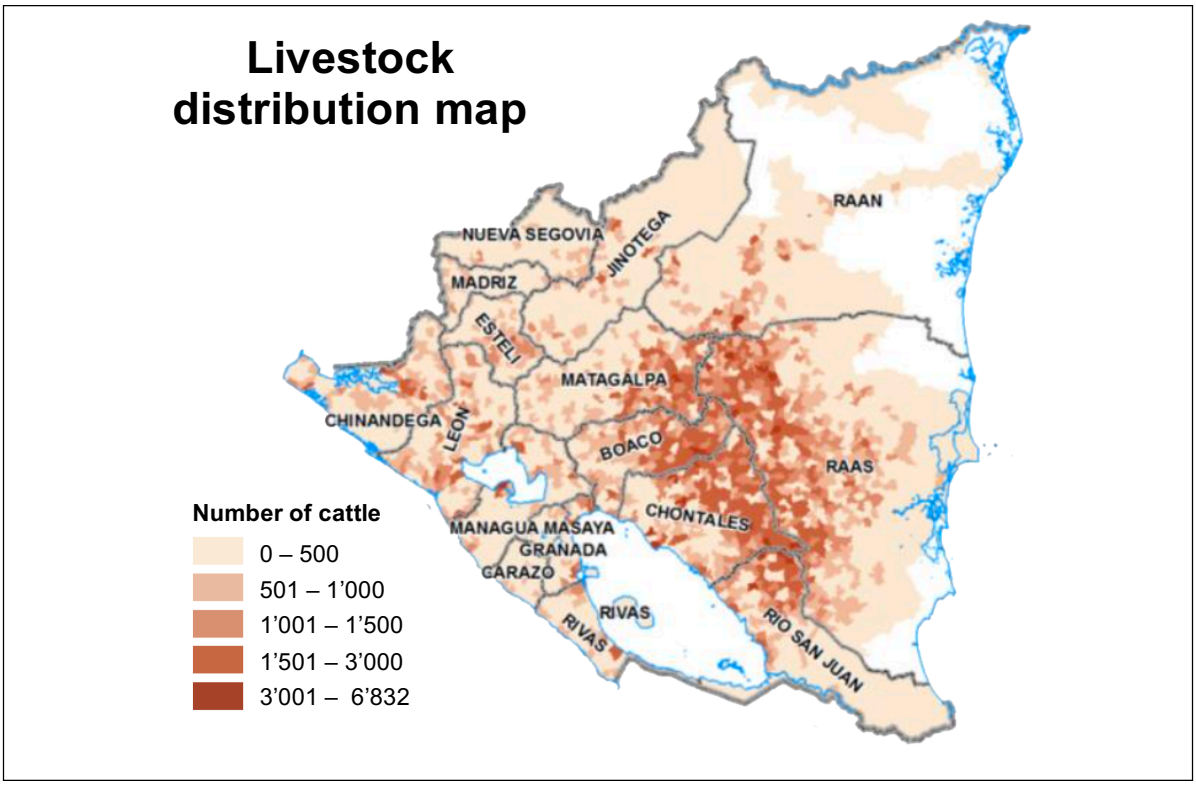


Figure 4: Livestock distribution map
Source: adapted from International Center for Tropical Agriculture, 2015, p. 3

4.3.3 Status Quo of the Water and Irrigation Situation

Nicaragua is privileged in water resources. The available water resource is 38,668 m^3 per capita per year, which places the country above the Central American average. It stands out that it has approximately four times the water availability of the United States or Switzerland (Hurtado et al., 2013, p. 466). However, the country is highly vulnerable to climate change because of hurricanes and the phenomenon "El Niño". The results are droughts, floods and erratic variations in climate, especially in the dry corridor on the west side of Nicaragua (CIAT, 2015, p. 5-6). In fact, Nicaragua ranks fourth in the Global Climate Risk Index 2014, which identifies the most affected countries by climate change in the world (Kreft, Eckstein, Junghans, Kerestan & Hagen, 2014, p. 5-6).

The agriculture sector is mostly affected by the dry weather in the past few years. Since many farmers depend solely on the dwindling rainy season from May to October, the crop output reduces and endangers food security, especially for smallholder farmers. In 2015 for instance, 50% of the entire cultivated area in Nicaragua was damaged, forcing the government to subsidies rice and beans in order to prevent hunger crisis (FAO, 2015b). These circumstances clearly evoke the need of irrigation systems so that the farmers obtain the necessary water for their fields. But how many farmers make use of irrigation to prevent such catastrophes and to enhance productivity?

Of the total cultivated area throughout Nicaragua only 100'000 hectares, in other words 5.5% are irrigated (Zegarra & Chirinos, 2016, p. 9-10). The number of farms that have installed an irrigation system

is even lower with a value of 4.4%, whereby gravity systems exhibit the highest proportion followed by sprinklers. (CENAGRO, 2011, p. 18-19)

The reasons are that many farmers do not recognize the added value of producing during the dry season or are reluctant to pay a high investment. Moreover, many subsistence farmers (less than 5 manzanas) are not able to pay the initial price without financial support. This explains their lowest usage of irrigation systems with 3.2%. (Espinosa, 2016, p. 15-16)

In total 83% have access to one or more water source, from which 80% have access to surface water. This has to be put in relation, since the access to water recourses depend highly on region and size of the farm. Farms on the pacific lowland, for instance León and Chinandega, exhibit a much higher proportion on groundwater wells. The depth of these wells can vary significantly within short distances depending on the respective aquifer. Moreover, the statement can be made that, the smaller the farm, the lower is the probability of a water source. (CENAGRO, 2011, p. 17; Castillo, Calderón, Delgado, Flores, & Salvatierra, 2006, p. 135)

4.3.4 Water need of crops and livestock farming

Since Nicaragua's smallholder farmers own more cultivated land than in other developing countries, the limited total water output of the sunlight pump poses a hurdle regarding the irrigation. Although it is unfeasible to determine the precise water needs of a certain cropland without an individual diagnosis in the field, a rough valuation helps to obtain an approximate overview of the sunlight pump's irrigation possibilities. However, it has to be mentioned that the different phonological stages of the crop as well as the soil and climatic conditions of each zone are not considered in the calculation. The following table is, hence, an estimation and shows the water requirements of different crop types irrigated by a drip system in relation to the water flow rate of the sunlight pump[12]. Since the agriculture surfaces in Nicaragua are always indicated in manzanas (mz), the author uses the same square measure and converts it afterwards in hectares. Moreover, a sunlight pump's hypothetical water output of 14'000 liters per day without adding a battery is assumed in the calculations.

The table illustrates a significant difference in possible applications for the sunlight pump depending on the particular crop. A passion fruit field of one manzana, for instance, requires a water supply of 8'778 liters per day, knowing that on average 585 plants are bedded in a manzana and one plant needs 15 liters per[13] day. As a result, the sunlight pump could cover a passion fruit field of 1.1ha. Apart from that, the fruit is harvested once per year and only needs water during the dry season and parts of the rainy season, which in total are 210 days. Multiplying this number with the water need per day results in 1'843'380 liters of water per cycle. Because of the different crop cycles, the water requirement per cycle varies considerably. Another example is the tomato, whereby a field of one manzana needs 24'000 l/mz with 1.5 liter per plant and a total of 16'000 plants per manzana. By means of the sunlight pump 0.4ha of tomatoes can be irrigated.

[12] Although the FAO states crop water requirement data on their homepage (please see: http://www.fao.org/docrep/S2022E/s2022e07.htm#3.3), the estimates in the table were calculated with information from iDEal Tecnologías in order to be more accurate and to match the data with the conditions in Nicaragua.

[13] Calculation: 15 liters * 585 plants = 8'778 l/mz

Crop	Water need per day, l/mz	Cycle in days	Water need per cycle, l/mz	Surface covered with sunlight pump	
Citrus	2'400	365 (*180)	432'000	5.8mz	**4.1ha**
Squash	600	120	72'000	23.3mz	**16.4ha**
Pipián	1200	65	78'000	11.7mz	**8.2ha**
Cucumber	14'640	70	1'024'800	1mz	**0.7ha**
Cocoa	7'800	365 (*180)	1'404'000	1.8mz	**1.3ha**
Avocado	1'560	365 (*150)	234'000	9mz	**6.3ha**
Watermelon	3'512	90	316'080	4mz	**2.8mz**
Passion fruit	8'778	365 (*210)	1'843'380	1.6mz	**1.1ha**
Sweet pepper	35'000	120	4'200'000	0.4mz	**0.3ha**
Tomato	24'000	120	2'880'000	0.6mz	**0.4ha**
Plantain	44'000	365 (*210)	9'240'000	0.3mz	**0.2ha**

Table 3: Water need for different types of crops
Source: Internal Information from iDEal Tecnologías

By taking the given data into account not all the crops are suitable for the sunlight pump. The water flow rate is too low for plantains and other crops with a high water demand per day, such as rice and sugarcane. The large majority of these farms have several manzanas of land. In case of the extreme example of sugarcane, 79% of the farms that grow sugarcane possess 500 manzanas or more (CENAGRO, 2011, p. 26). Also beans and maize, the two most common basic grains in Nicaragua, are rather inappropriate crops because of their high water demand and low return compared to an investment like the sunlight pump (Gourdji, Läderach, Valle, Martinez & Lobell, 2015, p. 271). Several types of vegetables and fruits exhibit a higher potential because of their lower water requirement and high yield. These include for example squash, pipián, cucumber, small plots of sweet pepper or tomato, respectively citrus, avocado, cocoa, watermelon, dragon fruit and passion fruit.
Also crops that usually are not irrigated, come into consideration for the sunlight pump as the quality and productivity of the harvest can be enhanced through an efficient water distribution system. For instance coffee, which is a crucial sector for economic and social reasons due to a total of 332'000 laborers and 42'700 coffee producers who cultivate less than 20 manzanas, is such a crop (Bolaños, 2017, p. 1-2).

Overall, the sunlight pump is a possible solution but the scopes of application are clearly limited. With the inclusion of batteries, more land can be irrigated because of longer operating periods of the sunlight pump. This step is essential for many crops. Passion fruit fields could be expanded to 5.7mz (4ha) and tomato fields to 2.1mz (1.5ha), assuming a total water output of 50'000 liters per day. Furthermore, it is important to highlight that the above presented irrigation quantities do not necessarily represent the applied water amount by the farmers in Nicaragua, as many do not know better or have limited access to water.

Water need in Livestock Farming

Within the agriculture sector, livestock represents the most important economic activity in terms of GDP and is a crucial income stream for smallholder farmers. Of the 137'000 livestock farmers in Nicargua, 51% have less than 20 manzanas and 20 cattle (CENAGRO, 2011, p. 28). Most of them are dual-purpose businesses, which means they produce milk and practice cattle breeding, whereby several factors limit the income of the ranchers. Obstacles are, amongst others, the low quantity and quality of forage and the lack of water systems, in the dry season particularly. This leads to a decrease of productivity by 30% in the dry six months. As a result, the market prices for livestock and milk is much lower in the rainy season than in the dry season, which affects the income of the ranchers (Holmann, Mora Benard, Mtimet & Hoek, 2014, p. 31).

In order to improve productivity, the cattle need appropriate nutrition. This entails improved pasture, mineral salts and, most importantly in this case, water (USDA, 2016, p. 10 & 26). A dairy cow, for instance, drinks up to 95 liters of water per day, which are 1900 liters for a herd of 20 (Linn & Raeth-Knight, 2010, p. 1). The rest of the available water output could be used for irrigation. However, pasture requires approximately 55'000 liters per manzana. Knowing that Nicaragua has the lowest production density of just 0.8 cows per manzana on average, the application of the sunlight pump to irrigate pasture is extremely limited (USDA, 2016, p. 6). The irrigation of one manzana would only suffice for one cow as additional fodder in the dry season[15] (USDA, 2009, p. 1-3).

4.4 Concluding Remarks

The solar market circumstances and trends clearly pave the way for small-scale solar energy technologies, such as the sunlight pump. Since there are 1.1 million people in Nicaragua without access to electricity, off-grid energy solutions are required. Moreover, the high fuel and electricity costs limit the long-term use of traditional water pumps due to the high running costs.

Also, the agriculture market context has potential for the sunlight pump, as smallholding farming plays an important role for the Nicaraguan economy. However, on average smallholder farmers in Nicaragua possess significantly more land than their peers in other developing countries. As a result, the sunlight pump is not applicable for all of them because of its limited water output. Mainly subsistence farmers, who own on average 1.9 manzanas, would come into consideration with respect to irrigation. On the basis of their low GVA, doubts arise about their ability to pay the initial investment of the sunlight pump without financial support. The poor productivity and monoculture of low-yield crops, aggravate the purchase power of many smallholder farmers in general. Regardless of the available financial means, the need for the sunlight pump exists, amongst other factors, because of droughts and the fact that only 5.5% of the cultivated areas are irrigated.

Moreover, most of the farms have access to a water source. In the case of ground water sources, individual diagnoses have to be conducted in order to determine the depth and hence, suitability of the

[15] Assuming a 545kg cattle and an average pasture yield of 7500kg per year.

sunlight pump. Overall, the scope of applications for the sunlight pump depends highly on the type of crops and the irrigation practices of the respective farmers. Simply put, several kinds of fruits and vegetables show the largest potential due to the low water need and the high yield. The irrigation of pasture, on the other hand, is only applicable to a marginal extent.

After establishing the market context, we shall continue with the specific case study.

Part II: Case Study

The second part of this thesis addresses the particular case of marketing the sunlight pump in Nicaragua. Corresponding to the characteristics of the BoP market, the case study focuses on the following fields: Potential local partners, bundling and competitor products, import and distribution and insight from potential end users of the sunlight pump. Eventually, possible initiatives on marketing the sunlight pump are discussed.

Moreover, it should be mentioned that much data in the following case study is based on interviews. These are cited with the letter of the respective appendix and the number, for instance: (1A).

5 Overview of the Relevant Market Players

This chapter is dedicated to give an overview of local market players, which could play a role in the value chain of the sunlight pump.

5.1 System Integrators in general

System integrators are defined as suitable companies that could import and market the sunlight pump in Nicaragua. They provide integrated solutions to customers, including distribution, installation and maintenance of technologies.

There are several system integrators active in the Nicaraguan market that operate in the realm of either pumps, solar energy or irrigation . Of all the conducted contact approaches and interviews, 6 companies showed interest in the sunlight pump (see appendix A). After a first narrative interview with the management of the respective company and the presentation of the sunlight pump, the six system integrators were further questioned with regard to their business activities, views on the sunlight pump and their potential role within the value chain. Following, a short overview of the companies is provided in conjunction with more precise information gained during the interviews. The complete list with all the relevant companies in the sector is available in appendix G. Furthermore, a more precise evaluation of the system integrators regarding the sunlight pump and a possible collaboration with ennos is discussed in appendix H.

Name	**Description** *(1.who, 2.where)*	**Offer** *(Products/Services)*	**Author's brief evaluation**
Tecnosol	1. Works in the field of renewable energies (especially solar) since 1998 Offers a great range of products mainly for rural areas and has installed approximately 70'000 photovoltaic systems 2. Headquarter in Managua, comprises 16 branches in Nicaragua and has a foothold in Panamá, Honduras and El Salvador	▪ Wide range of solar products such as panels, pumps, batteries, inverters, lamps, electric fences and refrigeration units	+Extensive experience in the solar market +Highest company awareness in Nicaragua in this sector +Wide network of cooperation partners
E-Cami	1. Company which works in the field of photovoltaic energy and telecommunication for more than 25 years 2. Head office in Managua, consists of 12 branches	▪ Wide range of solar products such as panels, water heaters, lamp, pumps, refrigeration units, inverters and batteries	+Extensive network and experience in the solar market +High profile in Nicaragua - Rather a shift from BoP-market to a financially stronger clientel
Enicalsa	1. Founded in 2003, emphasizes on research, training and installations in the area of photovoltaic- and water supply systems; specialized on pumping systems 70% of his project are financed from Germany 2. Located in León but operates nationally	▪ Projects in photovoltaic-, irrigation-, pumping-, cooling- and water purification systems	+Long experience with pumps and solar energy +The owner studied and lived in Germany for 20 years (speaks German) +Is the president of the chamber of commerce (Germany/Nicaragua) and cooperates with several universities in Nicaragua
Altertec	1. Enterprise (no S.A.) that aims to develop the rural market with renewable energies and consulting services since 1984 Collaborates often with Germany and has created his own technical cooperative 2. Operates nationally with an office in Estelí	▪ Projects in photovoltaic-, wind power-, pumps- and biomass systems	+ Comprehensive technical know-how + The owner speaks German + Dynamic person and a doer - Location and business approach not suitable as a principal system integrator
SuniSolar	1. Operates since 1999 and offers solutions for sustainable energy (especially solar systems) Has conducted various projects in the rural area 2. Works in whole Nicaragua but based in Managua	▪ Narrow range of solar products such as panels, inverters, batteries and pumps	+Has different business partners +Rather small and flexible enterprise - Not as professional and well-structured as the rest of the other system integrators
iDEal Tecnologías	1. Social Business that aims to increase the income of small-scale farmers by low-pressure irrigation Consists of 9 employers and 20 micro-retailers 2. Operates nationally (except of RAACS and RAACN) with an office in Managua	▪ Low pressure micro irrigation systems and pedal pumps Focus on research, consulting services and monitoring	+ Comprehensive agricultural know-how + Emphasis on personal relationship with end users + Already reliable partner of Ennos - Little technical expertise in the range of pumps and solar energy

Table 4: System Integrators
Source: Interviews

All of the six system integrators have cooperated or currently work together with microfinance institutions, NGOs and other social organizations. While iDEal Tecnologías primarily markets low pressure micro irrigation systems, the others offer a wider variety of goods. Tecnosol and E-Cami have the broadest product range. Moreover, the two companies both have a branch network and the highest company awareness throughout the country.
The system integrators agree that the main customer needs are illumination, efficient water distribution, cooling of milk and crops, or electrification for home solar systems, televisions, radios, mobile phones, fences and other devices. Furthermore, they state that off-grid self-supply in the realm of water and electricity is less expensive in the medium term than sourcing it from the national grid.

In general, the six businesses are interested in the sunlight pump and are willing to cooperate with other system integrators in terms of logistics or technical support. They could not give quantifiable information regarding their expected margins, but pointed out that their respective part in the value chain has to be economical viable.

5.1.1 System integrators with a branch network

Tecnosol places a strong focus on the rural off-grid market, with stand-alone solar energy installations. The company offers products such as cooling systems, solar panels, pumps, batteries and fences. Their customer portfolio comprises rural farmers and ranchers, organizations, cooperatives, and increasingly urban individuals, who want to be independent from the national water and electricity network in order to save costs. Moreover, they receive assignments from the government in the form of national programs or municipality projects and from larger companies within their Corporate Social Responsibility (CSR). The cooperation with universities helps Tecnosol to spread the awareness of the enterprise and to expand the know-how of solar technology. Students can even obtain a diploma / certificate if they pass a course organized by Tecnosol about solar energy and off-grid installations. The enterprise also collaborates closely with finance institutions, like Kiva, the Inter-American Development Bank or the Multilateral Investment Fund, to facilitate the investment of their individual customers. Delagneau says “30% of our sales are financed by loans, whereas 70% are direct sales” (own translation). Their customers demand mainly products for illumination, cooling, water pumping and electrification. Tecnosol applies traditional promotion, such as banners as well as the participation in different fairs and proactively visits current or potential customers through their branch promoters. At the on-site visits, the promoter normally holds a presentation with the aim to train the end users and to incentivize them. Vladimir Delagneau states that the primary barrier in selling to the rural farmers is their lack of financial resources to make the initial investment. Furthermore, the majority of the subsistence farmers depend highly on their current cultivation and are not able to invest in a technology, which is solely rentable in the medium term. (1A)

E-Cami has largely shifted from serving the rural poor to a wealthier target group and industrial customers. Consequently, their most sold water pump is aimed for swimming pools. They sell on average five pumps per month and only possess submergible ones. Max Lacayo mentions that their off-grid installations are diminishing, since the government started with their electricity-coverage strategy a few

years ago. Besides, E-Cami has several customers from the tourism sector because of the steady growth of hostels / hotels constructions of foreigners who emphasis on renewable energy. Overall, 60% of E-Cami's customers are from urban zones and 40% from rural areas, whereby the remote customers are mostly served by 70 retrievable independent technicians. The rural target group, however, are mostly considered within larger projects in partnership with NGOs. Lacayo highlights that E-Cami is a private business and cannot deploy the needed resources to reach the rural poor due to their required intense technical training. They have conducted a microfinance project with 1500 rural clients in the realm of electrification but the project failed because of maintenance and repayment issues. Moreover, they had to sacrifice a lot of human resources for the distribution of the products since the end users lived in extremely remote areas. E-Cami's product range is similar to the one of Tecnosol, but rather geared to a more affluent target group. Because according to Lacayo, also the wealthier population perceives the electricity costs as too expensive and often demand for solar home or solar water supply systems because of frequent emergency reasons induced by failures of the national grid. (3A)

5.1.2 System integrators without branch network

Sunisolar entered the market 18 years ago and is active in photovoltaic and thermal energy including a pumps division. They employ five own and several independent technicians. They have collaborated in projects with the German-Nicaragua chamber of commerce and coordinate partly with microfinance institutions such as FDL or Fundenuse. At the time of the investigation, Sunisolar had more large-scale than small-scale projects in both urban and rural zones. They raise awareness of the company and products through participations at fairs. (5A)

Enicalsa (Empresa Nicaragüense Alemana S.A.) is a social business and serves the rural poor. The company was founded 2003 by three engineers (two from Germany) and is specialized on pumping systems. The owner José Benito Rodríguez, who is in the executive board of the German-Nicaraguan chamber of commerce, has lived in Germany for 20 years and studied in Hamburg. He employs two technicians, has a network of around 100 independent technicians throughout the country and hires three interns each year, mostly from Germany. Scientificity is part of Enicalsa's strategy, and therefore they collaborate closely with universities and technical schools with the aim to spread and transmit solar technology know-how. Rodríguez also teaches at the university. Besides, Enicalsa's main objective is to distribute and install high quality systems. He says that many farmers ask for his technical support after buying pumps from other system integrators because they only sell the technology without instructing the end users. Enicalsa, on the other hand, puts much effort in training on-site. For instance, when they have community projects, Enicalsa gives a brief course to 2-4 persons from the community and installs the system together with them. Moreover, the end user always receives a toolkit with all the instruments needed to do simple maintenance work, an extensive manual and advices about efficient irrigation. He has been implementing this service procedure for 14 years and almost never had to return on-site to carry out maintenance work. Rodríguez is a proponent of water supply systems without battery but rather with suitable water tanks because of the short lifespan of batteries. If the customer requires electricity in remote areas, he usually installs a second solar panel - battery

system, apart from the water supply system, to facilitate utilization and to avoid malfunctions. Enicalsa has already conducted projects in Guatemala and Mexico. They offer mostly German technology, sells rather entire systems than standalone products and works with Grundfos pumps because of their high quality. A main advantage of Grundfos pumps is that they run with both DC and AC, and therefore can be connected to the national grid when no sun is shining. Rodríguez has been seeking for small-scale water pumps for some time without success and thus, prognoses potential for the sunlight pump since many farmers do not need much water.

Altertec (alternativas tecnologías para el desarrollo) offers solar as well as wind power technology and various niche products, such as solar fruit driers. Besides, he founded a technical cooperative, called Copseas, with the aim to improve the technical know-how of the members. Altertec collaborates with several technicians (educated in the cooperative) and operates nationally with a geographical focus on the Estelí surroundings. Similar to Enicalsa, the German owner Jürgen Kulke focuses on accurate installations and training in addition to the sales of his products. Otherwise, projects fail in the medium term according to his experience. He has already distributed various pumping systems combined with drip irrigation to avoid physically demanding irrigation methods often executed by women. (4A)

iDEal Tecnologías was introduced in Chapter 3.1. Through the test phase of the sunlight pump and the close joint work with ennos, iDEal has obtained a general overview of the product. According to Stefan Schäfli, there is market potential for the sunlight pump to a certain extent. However, the commercialization of the pump requires high expenses. (6A)

5.2 Intermediaries

Intermediaries are market players that acquire technologies or know-how from system integrators and cooperate with them on the basis of projects or programs in order to serve end users. Thus, they are the link between the system integrators and the end users. Non-governmental organizations, small businesses, governmental institutions and cooperatives that operate in the realm of agriculture or renewable energy belong to this category.

5.2.1 Non-Governmental Organizations

ANF (American Nicaragua Foundation) is a NGO with various programs, amongst others, in agriculture and sanitation, with the aim to reduce poverty in Nicaragua. By means of their Agriculture Training Center in Tipitapa, ANF shows innovative technologies and farming techniques, such as drip irrigation systems, biodigestors, solar pumps, bee keeping equipments and cultivated reference fields. In addition, they conduct agricultural research in their laboratory and train interested parties. One of ANF's current projects is about the efficient production of beans in Las Manos (Nueva Segovia) in cooperation with the NGO **Fabretto**, an organization that focuses on educational programs, for instance technical vocational education in agribusiness. In this program, they still use treadle pumps to suck and distribute

the water. Keith Poe, the agriculture and rural development projects manager of ANF, recognizes application possibilities for the sunlight pump in such similar projects. In general, he emphasizes that the biggest geographical potential is “in the central part of Nicaragua because there is farming, there is ranching, and less access to electrical grid. […] And in areas that are east”. However, Poe does not think that any farmer with less than four manzanas could raise the needed equity for the sunlight pump without financial assistance. (1B)

A further organization is **SNV** (Netherlands Development Organisation). SNV is acknowledged in Nicaragua for their impact in value chain development of agricultural products and renewable energy. Within the latter field of activity, they presently run the National Biogas Programme by installing biogas plants in several departments. Part of the project is Biobolsa, an international Mexican enterprise, that produces and distributes small-scale biodigesters (Sistema Biobolsa) for smallholder farmers. The commercial director in Nicaragua, Rolando Reyes, explains that Biobolsa is in search of an efficient water pump for the combination with biodigesters, whereby the sunlight pump comes into question. (2B)

CMR (Coordinator of rural women) is an organization that coordinates rural women organizations, mainly in the north of the country, with the objective to improve their rights and standard of living. They bundle their women target groups into cooperatives and give them name, such as “Mujeres en acción”, in order to create a mentality of effort and teamwork instead of them expecting to receive the particular assistance free of charge. Subsequently, CMR provides agriculture technologies (they already possess a sunlight pump) and education in terms of basic commercial training or social-, respective gender equality. María Teresa Fernández, the leader of CMR, underlines the importance of rural development with regard to the sunlight pump, especially for the younger generation:

> "The development of this country is in the field. And many young people want to leave their lands. There is a discouragement, young people do not want to be peasants. That is why one has to collaborate with them to give them a perspective that they can change their life in the countryside and live a life of well-being. But for this you have to prepare, educate […] and teach them how to farm their lands efficiently”.

By this methodology, CMR attempts to generate added value with the available crops and establishes rural micro businesses. This way, the members of the cooperatives obtain an alternative source of income without being forced to leave their land and migrate to cities where women mostly have to work in “maquilas”[16]. CMR has several national and international donors in order to implement their projects. According to Fernández, **Oxfam** is an important partner, as they support rural women cooperatives and agroecological production for smallholder producer. Moreover, Oxfam fosters rural young entrepreneurs by adequate trainings. (3B)

[16] Maquilas are foreign-owned factories in duty-free zones in Mexico and Central America at which imported parts are assembled by lower paid workers into products for export, whereas Nicaragua has the lowest minimum wage in Central America.

FUPROSOMUNIC (Solar Project Foundation for Nicaraguan Women) is another organization that focuses on the development of women and their families. The foundation, which is financially supported by the Swiss association Nicasolar, promotes the use of solar energy technologies, such as solar cookers, solar dehydrators and the implementation of the SODIS method to purify water. They involve the beneficiaries in the production or installation process of the products. In doing so, the end users directly learn about the technology and maintain the product with caution, says Mercedes Alvarez, the project manager of FUPROSOMUNIC. Moreover, it is a way to break through their traditions. She adds that they never give anything away for free. The foundation works in several communities in the Central and Pacific area of Nicaragua and have a solar center in Catarina, where the sunlight pump could be promoted. Members of FUPROSOMUNIC state that besides the utilization for irrigation and charging cell phones, they could use the sunlight pump for domestic water distribution in various communities, since there is no large distance between the houses. Also, other partners of FUPROSOMUNC that implement solar projects and operate in rural areas are interested in the sunlight pump. The Irish development organization **Trócaire** and **Asociación Fénix** (an association which currently uses Grundfos pumps) state that they could utilize a small-scale solar water pump for community programs. (4B)

Peace & Hope Frontier Mission operates on the Atlantic side of Nicaragua, primarily in the Miskito coast. The US NGO runs several sanitation and drinking water projects in remote villages. They have already purchased a sunlight pump with the aim to establish a water distribution system in a clinic. Apart from that, Peter Coleman, the executive director, sees great potential for the sunlight pump on the Atlantic coast of Nicaragua because of the unavailability of electricity. Moreover, one could implement cell phone charging or drinking water services in El Rama, where most of the population in the Atlantic coast make their purchases. (8B)

5.2.2 Organizations with technological know-how

There are several rather technical organizations in Nicaragua. This includes **Grupo Fenix,** which runs various projects in the north (Madriz, Nueva Segovia and Estelí) and is based in Totogalpa. Jorge Lopez, responsible for the Solar Center, perceives the sunlight pump as an interesting option for their projects, for example in the irrigation of tomato plantations. They could even connect the pump to their own produced solar panels since the sunlight pump does not need much energy.

Also, **IDEAS** (Institute for Development, Evaluation, Assistance and Solution) with its technology program TecAp (Tecnología Apropiada) works in northern municipalities with the rural poor, mostly in the coffee sector. Hermogenes Zelaya, technical coordinator, says that TecAp is the first micro franchise program in the area of renewable energy. The franchisers receive comprehensive technical and commercial training and are divided into “micro enterprises” (women) and “micro technicians” (men). The franchisers are part of the organization and promote, sell, install and maintain renewable energy products provided by TecAp. Within TecAp, they sell products with a margin of 20% while compensating their franchisers fairly because of their high amount of additional work, including explaining the product, convincing potential end users and calculating economic advantages of the respective technology.

With regard to the sunlight pump, Zelaya highlights that it is crucial to establish further reference installations in order to show the system to the end users. He justifies his argument by pointing out that the potential end users have never seen a product like the sunlight pump and can only be convinced by experiencing the pump in action. Overall, he detects many possible applications for the sunlight pump but fears that the initial investment of the pump is too high for many potential clients and the water level too deep in several sites.
IDEAS already owns a sunlight pump and, according to Zelaya, has many interested parties. However, he did not want to promote the pump at the time of the investigation, as he was not content with the installation of the system and the lack of information about the product as well as the guaranty. (5B)

Similar to IDEAS, **blueEnergy** has a wide technical knowledge, which they apply on the Carribbean coast of Nicaragua with a headquarter in Bluefields. They focus on building solar energy and water systems. Due to the interest of blueEnergy in the sunlight pump, one of their technician participated partly in the installation process of the sunlight pump on the demonstration spots. Javier Espinoza, the energy program manager, says the sunlight pump is utilized for irrigation, such as tuber and domestic and drinking water distribution in entire communities. The solar panels, which generate the energy for the sunlight pump could be used for other applications. He adds:

> "The main need is access to energy for illumination, since we operate in isolated communities. Where we work there is no national electricity grid. […] For example, there are small schools in the communities that provide basic education but the desired night classes cannot be offered because of the lack of light." (own translation)[17]

Within a project, for instance, they install 65 solar home systems in three communities in the Rio Escondido area in cooperation with **FADCANIC** (Foundation for Autonomy and Development of the Atlantic Coast) and a French foundation for donations. FADCANIC undertakes the credit check process with possible borrowers and sends the customer data to blueEnergy, which subsequently compose the respective home solar system according to the payment capacity of the borrower. By means of the decentral generated energy, it is also possible to electrify milk skimmers, animal fences, hair trimmers or refrigeration systems for fruits, vegetables, milk or fish in order to gain added value.
Espinoza continues, the major obstacle in serving the end users in their area is the costly distribution and maintenance of products as there are only rivers to move between communities. Therefore, blueEnergy trains people from remote communities as technicians in order to decentralize technical support. (7B)

As part of the "Cleaner Production Center" Program by the United Nations Industrial Development Organization, **CPmL-N** (Center for Cleaner Production of Nicaragua) promotes sustainable development and plays an important role in the advancement of small-scale renewable technologies. CPml-N trains individual professionals as technicians and small and medium-sized enterprises with a program called "aprender haciendo" (learning by doing). The director of CPml-N, Ronald Fonseca, states that

[17] Author's note: Sunset on the Atlantic coast is between 5 – 6pm.

the sunlight pump is an interesting option for smallholder farmers. They could promote the pump and give technical assistance as they have a large network of governmental agencies, financial institutions, organizations, universities and technicians. He highlights that CPml-N has already taught a solar pumping course and supported a small-scale water pumping project in Somoto in cooperation with Sersolar and Lorentz. (10B)

5.2.3 Cooperatives and Hardware Stores

Besides larger organizations functioning in several regions in Nicaragua, there are many small cooperatives which have a significant impact on the development of the particular area. The leaders of these cooperatives often are role models, important decision makers and early adapters in one. **Agrofor** (Civil Association of San Francisco de Asís) is one example of such a cooperative. Bayardo Alonzo, the legal representative and user of the sunlight pump, explains that many farmers of Agrofor would be interested in a technology like the sunlight pump and is certain that many other cooperatives in the country are suitable as intermediaries too (9B)

Moreover, there is a great amount of agriculture hardware stores and agriculture machinery companies in the municipalities of Nicaragua. The Matagalpa based **company Agrofor**[18], with its owner Luis Cuadra, serves as a reference example for small agriculture machinery business because of its professionality and strong connection to the community. Agrofor offers different agriculture technologies, such as water pumps, chainsaws, fences, hoses or mowing machines and repairing services. He has already received products and training from Switzerland as well as Germany and highlights that he values a comprehensive sales and technical education as crucial in order to advise his clients profoundly about the respective products. Unlike the six mentioned solar system integrators, Agrofor obtains its products from a wholesaler in Nicaragua. As an example, Cuadra orders his Briggs & Stratton fuel pumps from Casa McGregor in Managua and receives the products the next day in his store. In doing so he avoids importing himself and having a large stock with a high value of goods. Regarding the sunlight pump Cuadra explains that he has not had solar pumps in his product range so far but is not reluctant to do so if he receives an adequate training. (11B)

5.2.4 Actors in the range of livestock

Since livestock is a key agriculture production sector, there are several organizations that foster and coordinate groups of ranchers and provide financial assistance. Guillermo Lizano Vargas, a representative of the large slaughterhouse **Nuevo Carnic,** expresses interest in the pump since several of their smallholder farmers could utilize an efficient and solar powered pump. Furthermore, **CANICARNE** (Nicaraguan Chamber of Beef Exporters) is an association composed of four slaughterhouses (including Nuevo Carnic) exporting bovine meat products. In addition, the foundation **CONAGAN** (National Livestock Commission of Nicaragua) engages in the development of Nicaraguan livestock. Both organizations promote renewable energy for the ranchers and could function as intermediaries for the sunlight pump as ranchers are a promising target group. (4D)

[18] Author's note: This company is not connected to the cooperative Agrofor.

5.2.5 Governmental Institutions

Also, governmental agencies serve as intermediaries since they launch and finance various programs in the area of renewable technology and development.
INTA (National Institute of Agricultural Technology), for instance, runs a four-years project called *Agriadapta* in which renewable technologies are promoted to smallholder farmers. On the basis of a product description and business plan, private companies can integrate their innovative technology in a "catalog" managed by INTA. The different technologies are then advertised to smallholder farmers. Furthermore, **INATEC** (National Technology Institute) and **MAGFOR** (Ministry of Agriculture and Forestry) have launched ongoing financial support programs. INATEC, through the program Crisol, supports smallholder farmers financially and technologically, whereby MAGFOR focuses on female entrepreneurs with the program "Usura Cero". (2D)

Other important governmental authorities are **MINSA** (Ministry of Health), **MEM** (Ministry of Energy and Mines), **MEFCCA** (Ministry of Family, Community, Cooperative and Associative Economy) and **MARENA** (Ministry of Environment and Natural Resources), **UNAG** (National Union of Farmers and Ranchers) and **Renovables**, a governmental NGO that coordinates the renewable energy sector to a certain extent.

Finally, the author was referenced to other organizations that might come into question as intermediaries. **BioNica** gives comprehensive cultivation training and runs various workshops and projects. **Opportunity International Nicaragua** and **SosteNica** provides micro credits, alongside their agriculture education in rural areas. **Finca Pandora** is one of the leading organizations in the production of hydroponic products and extend their network of producers throughout Nicaragua. Moreover, **REEEP** as well as **Caritas** (Caritas Jinotega has already bought sunlight pumps) foster renewable energy in the agriculture sector and **Water for People** as well as **WaterAid** focus on sanitation and clean water projects.

5.3 Supporting cooperation partners

Supporting cooperation partners are needed to enhance the value creating process in terms of financial aid and awareness for the sunlight pump.

5.3.1 Micro Finance Institutions

As mentioned, the BoP population has difficulties in accessing financial support. As a result, they are not able to pay the high price of a product upfront and need the financial support of microfinance institutions (MFIs). In connection with the aftermath of the worldwide financial crisis and the "No Payment Movement", Nicaragua has made decisive efforts to reinforce its regulatory framework, including consumer protection, transparency to enhance consumers' confidence in the financial sector and the introduction of a new supervisor for MFIs called CONAMI (National Microfinance Commission) (Clark, 2016, p. 6-10). Although different financial products are available, the microcredit is the most common form. However, many smallholder farmers do not fulfill the legal and collateral requirements of the

formal financial institutions, as they do not possess the traditional collaterals. Elke Rivas, Chief Business Management Analysist of the microfinance institution FDL (Local Development Fund), explains that co-signers, cars, televisions or other household appliances can serve as substitutes to traditional collaterals (2C). A part of the MFIs also offers group lending. The group microcredit bears on a collective responsibility to repay the loan, which facilitates the lack of collateral.

There are several MFIs that have collaboration potential due to their product offerings. Nonetheless, the interest rates are high and hence, many smallholder farmers do not have the repayment capacity. Table 6 shows nine MFIs that are worth considering to financially assist sunlight pump purchasers.

Criteria	**FDL**	**ACODEP**	**ALDEA GLOBAL**	**PRESTANIC**	**FUNDENUSE**	**MICREDITO**	**FUDEMI**	**FINANCIERA FINCA**	**FUNDESER**
Agriculture credits	40.1%	29.1%	61.3%	84.6%	32.8%	15.8%	16.8%	12.9%	57.3%
Rural credits	78%	34%	99%	93%	56%	18%	83%	47%	74%
Interest rate annually	24%	24%	38%	38%	34.5%	45.6%	25%	48%	48%
Maturity >1 year	87%	95%	55%	51%	57%	72%	30%	61%	72%
Average loan in $	1’370	840	1’330	900	780	1’700	660	1’000	1’710
No. of clients in thous	70.9	5.1	4.2	7.9	26.8	7	4.9	43.3	30
No. of branches	41	14	4	8	19	11	9	17	27

Table 5: Microfinance Institutions
Source: ASOMIF, 2016; Larios, 2017; Inclusion Social Ratings, 2017, pp. 6-39

FDL and Fundeser (Foundation for Rural Socioeconomic Development) have already showed interest in a certain cooperation scheme regarding the sunlight pump.

FDL is a NGO founded by the Central America University (UCA) with the objective to provide financial services to small and medium entrepreneurs and families. 78% of their credits aim the rural area. In addition to credits, they provide non-financial services through the network of strategic partners. This way, FDL can provide technical assistance and training, support the marketing of agricultural products, and eventually secure the investments of their 70.9 thousand clients. The MFI has various financial products, amongst others, agricultural and ecological credits.

Within the latter product range, FDL promotes the product “ECOMICRO” which is designed for clients who adapt to sustainable technologies, including solar water pumps. The interest rate amounts to 24% and the maturity is due after a maximum of 60 months. Nitlapan (Research and Development Institute of the UCA) undertakes the technical assistance in order to achieve a greater development impact and visits the client four times to give technical training. (2C)
Conventional agriculture credits are provided with an interest rate of 33%. FDL operates throughout Nicaragua and runs 41 branches. The extensive network of branch offices facilitates the repayment process and guarantees a valuable and rapid service to the clients.

Similar to FDL, **Fundeser** provides technical assistance apart from their financial product range and focuses on long-term relationships, as 72% of their finance scheme last more than one year. Felix Diaz, executive director of Fundeser, states that the MFI could promote the sunlight pump to their pool of clients, provide credits and offer technical training. They have already implemented this procedure in cooperation with Tecnosol in the area of electrification systems (1C).

5.3.2 Educational institutions

Besides the possibility to include microfinance institutions to support the sales process of the sunlight pump, technical educational institutions can be integrated in order to raise awareness for the innovative sunlight pump and improve solar pump knowledge for future engineers and technicians. Several market players cooperate with universities in terms of sharing know-how or implementing projects. Examples are the postgraduate course in Energy Efficiency and Renewable Energy taught at the **Thomas More University** in cooperation with CpML-N or the prestigious agriculture university **Zamorano Pan-American Agriculture School** that supports SNV in a Cocoa & Coffee project in Nicaragua. (10B) Moreover, **INATEC** (National Technology Institute) offers technical courses in the area of renewable energy and assists blueEnergy in the training of technicians in remote areas. Generally, many educational institutions offer careers in renewable energy and educate students in practical applications. More universities in this field are the **UNA** (National Agrarian University), **ULSA** (Technological University La Salle) in León, **UNI** (National University of Engineering) and **UCA** (Central America University).

After introducing various market players in Nicaragua, we shall continue to the next section, namely potential add-on products for the sunlight pump and competitor products.

6 Availability of Bundling and Rival Products

This chapter shall provide an overview of existing products in the pump related market and is divided into add-on and competitor products.
Add-on options are products that can be offered in combination with the sunlight pump in order to fulfill particular needs of the client. They range from the indispensable solar panels to micro irrigation systems, water tanks and batteries. Furthermore, the possibility to combine the sunlight pump with water

purifiers or a biodigester is briefly discussed. Competitor products, on the other hand, are small-scale pumps that serve as potential substitutes and were offered at the time of the investigation.
The following data is based on point of sales visits and personal interviews conducted by the author as well as price offers from the respective companies.

6.1 Add-on products

Solar Panels

As there are various companies operating in the solar energy market, there is a wide variety of solar panels available. According to solar panel vendors, discounts can be given if large quantities are purchased. E-Cami, for instance, sold EGE panels for 0.78$ per watt to iDEal Tecnologías. Besides, modules from JinkoSolar cost 1$, from CanadianSolar 0.81$ and TrinaSolar 0.81$. The large majority of the solar panels are normally covered with a warranty of 20 years and come from China.

Batteries

Similar to the solar panels, system integrators sell a multitude of different kinds of batteries, which are specifically designed to store the solar energy. Deep cycle lead-acid batteries are by distance the most widespread for solar systems, followed by costly lithium batteries. Although, hardware stores offer cheap low quality or used batteries, it is crucial to add a solid product in order to sustain the overall quality of the sunlight pump system (6D). These batteries usually have a warranty of 1 year. Following, a range of suitable 12 volt deep cycle batteries is listed:

	Ampere-hour	Price
Yuasa	75	109$
Trojan	85 / 105	125$ / 135$
MaxSolar	105	115$
Ritar	100	160$
Koyama	150	291$
Power King	200	300$

Table 6: Available Batteries
Source: Own data

Accessories for the sunlight pump

If batteries are charged by solar panels, a controller is needed that costs approximately 30$ (10A). Moreover, a DC/AC inverter has to be added to the sunlight pump system when electrifying AC-devices. A 400 watt Samlex inverter, for instance, is equal to 39$.
Professional structures to place the solar panels in a more stable manner are available for approximately 200$ per module.
A 1 inch suction hose that bears 5 bars costs 1.21 dollars per feet[19] and one of 1 ¼ inch amounts to 1.46$ per feet in the “Casa de las Mangueras” in Managua.

[19] 1 feet = 30.48 centimeters

Micro irrigation systems

Micro-irrigation systems, especially drip irrigation, is an efficient technique of providing water to crops. It mitigates the costs of fertilizers and labor and increases food production. Furthermore, the drip irrigation method reduces the water need significantly, which is vital since 83% of the extracted water in Nicaragua is used for agriculture reasons and water scarcity is experienced in many regions throughout Nicaragua (Hurtado et al., 2013, p. 466). These advantages lead to an added value for the farmer in combination with the sunlight pump.

The prices of a drip irrigation system vary depending on the type of crops, the density of the drips as well as the overall design of the system. Therefore, it is difficult to determine a lump sum for drip irrigation kits. The most expensive system (usually for vegetables), offered by iDEal Tecnologías, is 192$ per 500 m^2 and 299$ per 1000m^2, whereas a kit for a 1 manzana (7000m^2) avocado field costs around 315$.

Water tanks

Water tanks facilitate an automated irrigation system and bridges times of no sun radiation. Apart from rather small tanks existing in the field, there are professional water tanks available, such as Plastitank or Tritank with a warranty of 1 year. The cost are as follows:

Liter	Price
750	161$
1100	195$
1850	311$
5'000	818$
10'000	1'805$

Table 7: Available Water Tanks
Source: Own data

Water purifiers

There are 1.1 million people in Nicaragua without access to clean water sources (WHO, 2015). Either the clean water is too far away or contaminated due to mining or agriculture activities. To improve the latter issue, the sunlight pump system can be combined with a small-scale ceramic water filter that eliminates around 99% of bacteria, eliminates turbidity and improves the taste of the water. One is able to filter around 36 liters per day and uses the filter for 2 years, until the ceramic part has to be replaced. The locally produced Filtron, for instance, costs 25 dollars.

Biodigester

A rather unconventional bundling possibility for the sunlight pump represents the biodigester. Three parties showed interest in this combination, namely Biobolsa, the company that produces the biogas plants, ASOGAMAT (Cattlemen's Association of Matagalpa) and SNV. A biodigester is a system that digests biomass, mostly animal waste and energy crops, in anaerobic conditions and produces biogas and organic liquid fertilizer as a result. Because of the generation of biogas, the sunlight pump could be connected to the small-scale biodigester through a suitable generator and put into operation. This

is applicable for periods in which no sun is shining. Besides providing water, the sunlight pump can move the liquid fertilizer to the crops which is usually done before sunrise when no solar energy is available. The sunlight pump is in particular suitable for this combination, since it runs with only 0.5 hp. The three mentioned parties have not been able to find such an efficient pump at the time of the investigation. Biobolsa sells the smallest biodigester system of 4m^3 for 1516$ and promises a lifespan up to 20 years. They received a subsidy from SNV at the time of the investigation, which results in a temporary price of 996$.

6.2 Competitor products

Apart from potential add-on products for the sunlight pump, the market is examined for similar water pumps. Within this analysis, the wide range of available electric, fuel and treadle pumps are not considered as direct competitor products since they fulfill other needs for end users and are considerably cheaper in the short-term, whereas the fuel and electric pumps require high operational costs, have a low lifespan, need to be shut down frequently to avoid overheating and require higher maintenance effort. Particularly fuel pumps are attractive to end users because of their large power range and availability of water when it is needed. However, they contaminate the environment and affect the health of end users at the same time. As a price reference, one common electric and fuel pump are compared subsequently including the Value Added Tax (VAT):

- Electric: Peripheral Toyo QB-70 (1"[20], 0.75hp, 40m total lift, 3450 rpm[21]); maximum water flow of 48 l/min and needs to be shut down every 50 minutes; Cost = 70$.
- Fuel: Koshin SEV-25 (1", 1.25hp, 30m total lift, 7500 rpm); maximum water flow of 110l/min and has to be shut down repeatedly; Costs = 320$.

It is apparent that the sunlight pump cannot compete with electric and fuel pumps in terms of initial price, but tackles other customer needs. For this reason, they will not be discussed in more detail.

On the other hand, small-scale solar pumps are direct competitor products of the sunlight pump. However, none of the numerous market players offered, at the time of investigation, surface solar pumps in Nicaragua. Therefore, the competitor products solely comprise submergible solar pumps. Several common products that are most similar to the sunlight pump and exist in Nicaragua are listed in the following table. The indicated retail prices only hold for the pump itself including the VAT of 15%, but without transportation, installation and solar panels. The data is aligned to a flow rate of 40 l/min (except Amarine-made) starting with the lowest price including the VAT:

	Model	HP	l/min	Total lift	Price
Amarine-made	MXS	0.13	6	30m	299$
Jintai	JCS4	1	40	50m	1'800$
Franklin	SDSP	1.5	40	40m	2'300$

[20] Outlet diameter in inches
[21] Revolutions per minute

Sun pumps	SCS	0.75	40	48m	2'400$
Grundfos	SQF	2	40	110m	2'500$
Lorentz	PS2 1800	2.5	40	105m	3'045$[22]

Table 8: Competitor products
Source: Own data and Jintai, n.d.; Franklin, n.d.; Sun Pumps, n.d; Grundfos, n.d. & Lorentz, n.d

The Amarine-made solar pump is added to the table, since it represents a cheap water supply alternative, which is offered in many point of sales. However, the pump is not considered as a principal competitor product because of the significantly lower water output.
Overall, the table above clearly shows that there are no comparable rival solar pumps available in Nicaragua. The products are costlier and designed for higher water flows and deeper ground water. The Chinese Jintai pump with its model JCS4-5.5-60 comes closest to the sunlight pump but is still approximately 1000$ more expensive. The 1hp solar pump accomplishes for instance: 40 l/min to a total head of 50 meters or 80 l/min up to 10 meters under perfect conditions. The 0.5 hp sunlight pump, in contrast, is able to lift maximum 40 l/min up to 28 meters. (ennos, n.d. a). Besides, all the existing competing products are submergible pumps and therefore not moveable like the sunlight pump and entail more maintenance. A benefit of the Grundfos and Franklin pump is the inclusion of a motor for DC and AC voltage. This makes pump sizing easier for end users and allows them to automatically switch to AC backup power if no solar energy is obtainable.

7 Import and Distribution

7.1 Importation process and tax exemptions

As a member of the Central American Common Market, Nicaragua harmonizes most commodities with a tariff of maximum 15%. There are three principal taxes that affect the importation, namely the Value Added Tax[23] of 15%, the Selective Consumption Tax[24] and the Customs Duties[25] (ProNicaragua, n.d.). Depending on the specific imported item, the three taxes are applied. However, there are several tax incentives which apply to the importation of solar and agriculture products.

Solar panel

Law 532 "Law on the Promotion of Electricity Generation from Renewable Energies", from May 27th, 2005, No. 102, forms the legal basis for the generation of electricity from renewable energies and facilitates the market access of renewable technologies. Article 7 ensures tax incentives for off-grid solar technology, including the reimbursement of the Value Added Tax, Customs Duties and further exemptions. As a result, solar panels and batteries can be imported tax free, which is confirmed and implemented by all interviewed market players. It is only required to apply for the exemption at the

[22] The price represents the ex-factory price of Lorentz. Because the pump was not sold temporarily at the time of the investigation, the author could not determine the retail price.
[23] Acronym in Nicaragua: IVA
[24] Acronym in Nicaragua: ISC
[25] Acronym in Nicaragua: DAI

Ministry of Energy and Mines (MEM) with the specifications of the respective solar panel (1A). In the near future, a reform of Law 532 is ought to be elaborated, which could entail changes in the current law (1D).

Sunlight Pump

Notwithstanding the above, solar pumps are not taken into account by this law. Consequently, VAT of 15% is owed for the importation of the sunlight pump[26], excluding all other taxes (Sistema Arancelario Centroamericano, 2017, p. 368). The 15% are paid on the CIF price and can be passed to the end user. Although the large majority of the importers in Nicaragua are not aware of water pump tax exemptions, there is a law that provides various tax benefits to certain productive sectors with the aim to foster their development. According to Article 274, in Law 822 "Tax Concertation Law", from April 10th, 2015, No.65, p. 3160 & 3171, small-scale water pumps that are operated by direct current and destined for agriculture producers, are excluded of the VAT and Selective Consumption Tax. As the VAT is the only tax relating the sunlight pump, it could be imported tax free.
According to Francisco Campos, freight consultant of Campos & Campos, this law is undisputable but it takes time to execute the tax exemption process as the importer has to register at the Ministry of Agriculture (MAGFOR) as well as at Ministry of Finance (MHCP) and submit a purchase plan, which has to be approved by the two parties. In addition, the end user is required to hand in a letter of exemption and his identity card number to the two ministries (Interview, 06.03.2017). Enicalsa is the only interviewed company that has implemented this procedure so far (2A).

Accessories

The third part of the importation is the accessories sent with the sunlight pump. If the tax exemption in accordance to Law 822 can be pushed through, the taxes on spare parts, cables, hoses and the associated accessories are omitted too. Otherwise, customs duties of 5% and VAT of 15%[27] have to be paid on the CIF price (Sistema Arancelario Centroamericano, 2017, p. 182). Other incurred expenses in the importation process are the fees for the customs agent, for instance JR World Cargo or Castellanos (2A).

Besides, exorbitant fines for minor administrative discrepancies and delays due to bureaucracy and arbitrary valuation of imported items can occur. Therefore, it is crucial to indicate the freight details with high accuracy and calculate enough time for the importation process. In terms of port of destination, Campos recommends importing at the biggest port in Nicaragua, namely Corinto located in Chinandega. From there to Managua he estimates transport costs of approximately 500$. If pumps are sent to Honduras and Nicaragua, the most feasible way represents the shipment to the duty-free warehouse in Port Cortés in Honduras wherefrom the pumps determined for Nicaragua are transferred to Port Corinto. (1D)

[26] The HS (Harmonized System) code of the sunlight pump is 84138.
[27] The HS code of the cables, hoses and accessories is 400942.

7.2 Last mile transportation

7.2.1 How does the products reach the end users?

It is generally recognized that the distribution infrastructure in developing countries is inadequate and formal distribution channels do not reach all consumers unlike in developed countries (Prahalad, 2004, pp. 43 - 45). These circumstances also apply to Nicaragua and therefore, affect the “last mile” transportation to the end users. For the sunlight pump several options are practical.

Firstly, venture-owned branch networks come into question (Dutt, 2012, p. 2). This distribution channel has been established by E-Cami and Tecnosol, the two system integrators with the highest financial capacity. A typical branch in a municipality of the latter enterprise comprises a manager, salesmen, technicians and promoters. As most of Tecnosol’s clients live in areas where no cars are able to drive through, each branch has motorcycle that can be used by the promoters and technicians. If this means of transport is not sufficient, they can rely on boats and horses rented from the respective municipality or hire an independent partner from the community to carry out the distribution, respectively installation. (1A)

The distribution through traditional distributors, such as small hardware stores, or NGOs and governmental programs is a second, more cost-efficient option (Dutt, 2012, p. 2). In particular, fuel pumps that are imported by one wholesaler in Nicaragua, are distributed through various hardware stores. The distribution via NGOs and governmental programs is certainly the simplest method and requires the least effort as they usually already have a selected beneficiary group and the needed budget. Especially, local NGOs are well integrated in their particular region and foster the creation of added value in the communities. All the interviewed system integrators make use of this sales channel. Also, IDE (International Development Enterprises), the responsible actor for the sunlight pump in Honduras, sells pump packages solely via those two channels for strategic reasons. In a second step, IDE Honduras attempts to involve end users in the supply chain which leads us to the third distribution option. (3D)

As solar off-grid technologies foremost serve rural or even isolated areas which are difficult to reach, , suppliers use micro entrepreneurs and technicians from the respective target regions to distribute their goods “in order to overcome the high cost of ‘last-mile’ delivery” (Sodhi & Tang, 2016, p. 128). The inclusive approach is reflected by the majority of interviewed market players in Nicaragua who have a pool of independent rural based technicians throughout the country. They are trained by the companies and hired for maintenance work in their communities. Apart from technicians and micro entrepreneurs, also micro retailers, and distributors are included in the supply of products to remote customer areas. iDEal Tecnologías, for instance, recruits micro retailers from their active client base, who are already successfully using the irrigation technology and have a wide personal network. They are contractually tied to visit two potential end users every week and receive training in order to advise the prospect as well as conduct the field diagnosis, which includes criteria such as field size, type of crops and use of

water quantity for the irrigation. After submitting the needed information, iDEal implements the installation of the technology. By means of this method, iDEal saves distribution and labor costs, and therefore pays a 12% commission to the micro retailer. If only the contact of the prospect is established by the micro retailer, he earns a 5% recommendation fee for every successful deal. (6A)

Tecnosol, on the other hand, collaborates with distributors by offering them a larger quantity of products with a discount. Afterwards they go “from door to door” and resell the products with a margin. If the distributors accomplish cross-selling results, they obtain a commission. Furthermore, Tecnosol involves micro entrepreneurs from rural areas in their supply chain. The micro entrepreneurs receive a continuous training in order that they are able to sell, install and maintain the products in their respective municipalities. They also buy the products from Tecnosol with a price reduction or work on commission. (1A)

All system integrators mention that the distribution to rural customers poses a challenge and the costs are high. On that account, efficient and innovative distribution strategies are crucial. In general, the costs for transport and labor depend on the extent of the solar pump system and the location of the end user. According to NicaSolar, Tecnosol and EraSolar, the transport of a solar pump system including the pump, solar modules and a metallic panel structure costs 100$ on average. In addition, labor costs are charged, which amount between 350 and 450$. (1A;7A)

7.2.2 The importance of providing training services

Besides the distribution of products to the end user, the delivery of extensive services is equally crucial (World Bank, 2015, p. 37). Regarding the sunlight pump Lacayo from E-Cami says that “even the best technology is worthless if the farmers do not know how to irrigate properly, how much water their crops need and how to use and maintain the technology” (3A) As seen in Chapter 4.3.1, of all the smallholder farms with less than 5 manzanas only 12.3% received technical and 12.9% agricultural support, which plays a significant role with respect to the low productivity of smallholder farmers (Lanza-Valdivia & Rojas-Meza, 2010, p. 185). Furthermore, the delivery of business knowledge has to be considered too, since many peasants do not apply basic accounting of their farm. During the investigation, no smallholder farmer was able to provide reliable information about their costs or sales figures. Danninger (5D), former Coordinator of Austrian Development Cooperation, compares the circumstance of Nicaragua to Costa Rica. He has managed various agriculture projects for small farmers in both countries and explains that in the latter country, he was astonished about the profound business knowledge of small peasants. They were able to calculate their overhead and variable costs, the market prices of their crops and how much profit they generate per harvest cycle. In Nicaragua, on the contrary, smallholder farmers know next to nothing about their business.
Also, IDE (3D), who has been promoting the sunlight pump since 2010, has realized that assistance to the customers is vital in order to use the pump efficiently. Therefore, the receipt of training is compulsory for the end users, otherwise IDE does not sell the pump.

The lack of technical, agricultural and business know-how of the Nicaraguan smallholder farmers show that the delivery of services is as important as the transportation of the physical sunlight pump system itself.

8 Insights from the sunlight pump Demonstrations

In order to test the sunlight pump in the field in Nicaragua and to raise awareness at the same time, ten pumps were installed on various demonstration sites. iDEal Tecnologías has selected progressive organizations and farmers with whom they have been working together in the field of agriculture for a long period. These organizations and farmers exert major influence in their area and the role as early adapters. The aim of this method is to present the installed pump to potential clients and to generate a pull effect with word of mouth recommendations (Prahalad, 2004, p. 15). Moreover, many rural farmers have no experience with solar pumps and only believe in the efficiency and reliability of a new technology if they see it with their own eyes.

The sunlight pump was installed with solar panels of 200 – 400 watts (depending on the required total lift of the water), suction hoses, electric cables and other needed accessories. The supply of batteries and water tanks was not comprised in the contract with the respective farmer or organization. After the

Figure 5: Example of a sunlight pump installation and a focus group
Source: Own illustration

setup seven demonstration events were organized in which the sunlight pump was introduced comprehensively and focus groups were realized with the participants. Below, two pictures of a demonstration site and a focus group are shown, which enables the reader to gain a picture of such an event. The first image presents a sunlight pump installation with a 200-watt panel and the water distribution from a basin to greenhouses. The image on the right demonstrates a focus group with a women's cooperative.

8.1 Interviews with Focus Groups

93 persons were divided into 11 focus groups on the occasion of seven demonstration events.

Brief characterization of the participants

In total, 60 smallholder farmers and 33 representatives of organizations (mostly technicians or agriculturists) between the age of 18 and 82 joined the event, whereas women accounted for 20%.
None of the participants has ever used a solar pump. The most used type of pump is the fuel pump with a share of 55%, followed by the electric pump with 42% and the mechanic pump with 24%. Many participants have already utilized various types of pumps. Only 30% have never used a single water pump on their farm.
Of all the focus group participants who run a farm, 64% are subsistence farmers, since they possess less than 5 manzanas (around 3.5 hectares) of agricultural land. Moreover, every fourth of the participants have no access to electricity in their farm, whereby the rate for subsistence farmers is even higher with 31% who have no electricity source.[28]

8.1.1 Evaluation results

The insights of the focus groups are outlined on the basis of the summarizing content analysis. The direct quotations are translated in English and the statements that are assigned to a specific focus group are marked with the respective section in appendix I.

Problems and customer needs

The participants agree that the absence of financing to make investments (for instance for new technologies), the lack of access to or scarcity of water, the repercussions of climate change and the high costs of fuel and electricity are their major problems. Even if the farmers are covered by the national electricity grid, its failure rate is high which complicates the planning on their farm. A peasant justifies:

> *"I have electricity on my farm, but it is very unstable. There are periods of time when there is no electricity for 4 days." (7I)*

Furthermore, the commercialization of agriculture products is impeded to farmers due to absent or costly means of transport, insufficient road infrastructure and the lack of farmers' network, such as commercial cooperatives or product buyers (food processing companies, local and municipal markets or supermarkets). Also, the long distance they have to walk in order to obtain water from a source or to carry the irrigation water from a basin to the field poses a problem for the peasants.

Sunlight pump as a problem solver for farmers

The results of the focus groups clearly show that the sunlight pump could solve various problems of potential end users. Some farmers do not irrigate their crops and others irrigate their fields manually by hoses, buckets or gravity instead of automatic systems such as sprinklers or drip systems. They

[28] Information is based on the quantitative data gained at the event, saved in a separate Excel database

admit that the manual methods increase the workload in the field significantly. A farmer, who uses a fuel pump and irrigates his field by hand with a hose, explains:

> *"I have to check what amount of fuel I need, check the system whether it is working well, maintain and control the pump, refill the fuel, irrigate by myself and stay in the field all along. That takes a lot of time. With an automatic system, let's say this pump with drip irrigation and a tank, I could save time for this job [irrigation]." (1I)*

Some farmers also recognize that they could use the sunlight pump for the supply of domestic and drinking water in their farm, without physical and time-consuming effort. With the additional time, thanks to less manual work in the irrigation process and the domestic and drinking water procurement, the farmers are able to undertake other tasks on their farm, whereas different aspects were mentioned: Fumigate and rake their fields, cut weeds or sick plants, review the water distribution and tube system, invest effort in their crops diversification and expansion of their farm, tend their cattle and improve their sales channels and commercialization strategy. Also, they realized that they can save labor costs. Besides matters regarding their business, they would increasingly visit markets and stores, spend time with their families, bring their kids to school and renovate or tidy up their home. However, it stands out that, when farmers are asked on what other tasks they would focus in their farm with the additional free time, they usually do not know what to answer. Only with hints and clarifications of the focus group moderator, a few farmers are able to give a response. It is therefore plausible to assume that the majority of farmers do not have the mentality to change anything in their "businesses*",* unless inputs are given from outside.

A further participant, who has difficulties extracting water from his well, complements that *"the water problem does not allow to produce efficiently. The sunlight pump could change that. It would contribute to increase income, we can save by not paying fuel or electricity (1I)."*

One representative of a cooperative in Chinandega, that uses the sunlight pump already, feels the same:

> *"I am convinced that the solar pump is a good investment that can improve my daily productive activity on the farm because I can get water with less physical strain. The best thing that has happened to me is not spending on fuel." (3I)*

The consequence of the high price of fuel leads to an inadequate usage of the respective pump: *"I do not use my pump often because of the fuel costs. Even when I irrigate for only 4h, I need minimum 1 gallon of diesel",* claims a farmer in San Dionisio (7I). In all the focus groups, the participants show confidence that the sunlight pump can enhance their irrigation process and reduce their concerns and distress.

Scope of application

The focus groups state that the sunlight pump could generate added value in the areas of irrigation, , domestic and drinking water supply and electricity generation. Some representatives of organizations

identify a possible application in the domestic water supply for interlinked households. Moreover, stock-breeding is often mentioned as a high potential business opportunity for the sunlight pump. A representative of a slaughterhouse elucidates:

> *"This solar pump could be useful to some of our producers They often do not have good water systems but require much water. They could use the pump to bring drinking water to the cows and irrigate small parts of pasture. Sometimes the water trough of the cattle is higher up, and this pump can lift the water up there." (4I)*

In terms of electricity the farmers would be glad to use electricity produced by the solar panels for illumination and different devices. Ranchers highlight that they could electrify small pasture choppers as well as electric fences, refrigerate medicine for cattle (5I) and illuminate the farm during the night for their employees (4I). Another cattle breeder explains that, besides using the sunlight pump for irrigation, he would add a battery and apply the electricity to a milk refrigeration system on his farm. By means of this method, he is able to store the milk for a short time on the spot and avoids the additional costs and workload to transport the dairy to another location. (4I)

Other scopes of application frequently discussed in the focus groups are related to the regions of Nicaragua without access to electricity. A cooperative in Sébaco says, for instance: "*It [the sunlight pump] is needed for everyone, but most of us are farmers here. It is good that this technology reaches areas where electrical power has not yet arrived. Ciudad Darío for example has problems with remote towns*." (1I)
Some bigger farmers, on the other hand, express an interest in the possibility to implement an entire home solar and domestic water system if they had enough solar panels and batteries together with the pump.

Product evaluation – advantages & disadvantages

Many participants recognize the environmental and economic benefits of the sunlight pump. They support clean technologies and mention frequently that they live in close touch with nature. Two attendees say:

> *"The technology that uses solar energy is good, that energy does not have to be paid […]. The most important thing is to know that the sunlight pump uses renewable energy and that we can save a lot of money and think about a better future." (1I)*

> *"Because this technology is about to reinforce a resource option that we do not have to pay for: The sun! This technology is a technology of opportunity." (5I)*

The participants perceive the quality, design and reliability of the sunlight pump as high because of its simple handling, physical appearance (the display in particular), origin and the professional presentation of the demonstration team. It is striking that the attendees in each group express their high trust in products from Switzerland and Germany. Moreover, they associate the quality of the demonstration event and the competence of the organizers with the quality of the product. The long life span of the sunlight pump is judged as an essential advantage. One peasant explains *"I have to repair my pump*

every year for small wear and tear. Sometimes I can do it myself, but sometimes I need help from a hardware store. This always costs (2I).”

In general, the attendees appreciate the possibility of moving the sunlight pump to different water sources, which allows them to share the pump with others and use various water sources. A coffee farmer in San Ramón says that he also would be able to shift the pump between his two scattered wells on the farm, which facilitates his irrigation process (6I). A younger woman adds:

> *“I am responsible for my farm and every day I have to carry heavy tools. I am skinny as you can see. That's why it's good that the pump does not weigh much. Because of its weight the pump is very practical and easy to transport (3I)"*

Various participants, however, fear the instability of the sunlight pump performance due to the weather. Especially, at the demonstration events where the weather was unsettled or overcast permanently, and as a result the sunlight pump did not run well, they insisted on requiring a battery. A representative of a cooperative explains: *“The disadvantage is when it is cloudy*[29]*. We think that, in order for water to be available 24 hours a day, we need a tank and a battery (1I).*" Another focus group participant in Matagalpa adds: *“there are periods in which 2-3 weeks no sun is visible (5I)."*

Besides, the attendees worry about theft of the sunlight pump. Cables, pumps, motors and other tools have already been stolen from farmers. Because of that experience they would not leave the sunlight pump outside without supervision and bring back the pump into the house during the night. A few focus groups even propose to install an alarm system to prevent robbery. A peasant in Tipitapa explains *“submersible pumps are not exposed to this danger [theft]. That's why I like this type of pump more (2I)."*

Another drawback of the surface sunlight pump is the limited water lift, as many farmers’ wells are profound. The majority of the attendees, however, appeal to the possibility to drop the sunlight pump into a well with an adequate installation in order to make the pump applicable to deep ground water. However, “one would not see the performance symbols on the display when the pump is inside a well (3I)”, identifies an attendee.

The participants all agree that in order to use the potential application possibilities of the sunlight pump, they require training to fully understand this unfamiliar technology. Most of the farmers and representatives of organizations state that they are more accustomed to submergible pumps.

Willingness and ability to pay

To estimate the consumer price preferences and the ability to pay for the sunlight pump system, the participants of the different focus groups were asked to individually write down an amount of money to four different price questions[30]. However, many of the participants did not understand the questions, felt uncomfortable answering them, were biased by others or were illiterate. As a consequence, the statistical representativeness of the quantitative analysis was flawed and the questions were simplified

[29] Author’s note: The sunlight pump did not work at that demonstration event because of the cloudy weather.
[30] The methodology is based on Van Westendorp’s Price Sensitivity Meter (1976), a popular price technique for market research.

and shortened after two demonstration events. One question is related to the willingness to pay for a sunlight pump system (considering their own current budget), whereas the other question aims to determine at which price the attendees think the system is too expensive (regardless of their current budget). Also, by means of the adapted questions, there are many statistical outliers since the participants have not had any experience with solar pumps and hence, had difficulties valuing the sunlight pump in connection with a price. Therefore, the following price indications of an installed sunlight pump system including a 200-watt panel and fittings, are considered as an estimate:

	Mean	**Median**	Net sample
Willingness to pay	608$	600$	62
Perceived excessive price	1306$	1055$	53

Table 9: Willingness to pay and excessive price
Source: Own data

After the two questions, the moderator announced a not binding retail price, estimated by iDEal at that time of the investigation, of 1'200$. The table shows that the average willingness to pay for a sunlight pump system is approximately 608$, which is half of the actual price given. The second row illustrates the perceived excessive price. Compared to the mean of 1306$ the median is only 1055$. It can therefore be concluded that there were several outliers who valued the excessive price much higher.

In the subsequent discussions, the participants stated several times that fuel and electric pumps are more affordable to them because of the lower purchase price. A farmer summarizes: *"We are small producers. For me, that price is too high. Although the pump is cheaper after a while because I do not have to pay for fuel, traditional pumps are more accessible to us (2I)."* In spite of the higher price, several farmers affirm that reliance on the vendor of the sunlight pump is more important. A rancher in Managua explains: *"I would buy the pump (sunlight pump] because although the pump is expensive there is no doubt about the quality because I trust Ideal Technologies and ennos. Besides Switzerland is a reliable country (4I)."* In general it is noticeable, that ranchers usually are wealthier and rather willing to pay a higher price.

Financing experience

Several farmers have made use of loans provided by microfinance institutions, mostly in form of individual credits with a maturity of 3, 6 or 12 months. Within this credit schemes they have provided various collaterals, for instance an electric motor, a part of the agriculture land, the produced crops, cattle or a guarantor, whereas a flawless credit record is crucial to obtain a financing. However, all of the participants raise concerns about micro-credits because of the high interest rates and would prefer to receive credits with a maturity of one year in the minimum.

A part of peasants has also received group loans. The participants highlight that the members of such a borrower group need to have a close relationship as it is about "trust and honesty" (1I). Otherwise, reimbursement problems can occur. Although a large proportion of participants have already been clients of microfinance institutions, they would prefer to receive financial support directly from ennos or

iDEal Tecnologías since they acknowledge their competence and professionality after the demonstration event. Moreover, one farmer says: *“It is more convenient when I get the product and the financial support from a single source” (1I).*

Possibilities for additional income by means of the sunlight pump

Similar to the topic about the usage of the extra time in the farm, the end users do not know, with a few exceptions, what to respond to the question about additional income possibilities by means of the sunlight pump system (with the possibility to electrify devices). One could argue that many of the farmers lack of an entrepreneurial mindset. Another reason could be the traditional circumstance within a community of rather sharing products and services than to charge for it. One old participant explains: *"I would not charge the farmers I know, for water or other services. I would do it for free since it is common among us. Maybe we could do an exchange but without money.” (7I)*

Not until the moderator gives stimulations to possible ideas, the dialog proceeds between the participants. All of them endorse the business ideas of the moderator, which are

- refrigeration of beverages, vegetables, fruits, fish and meat,
- entertainment such as offering movie screening or music nights,
- offering charging services of cell phones, batteries or lamps and
- providing services such as irrigation as well as technical support and transportation of the sunlight pump.

The business suggestion of a water kiosk and a charging station fascinates the participants in particular. Only the stimulus of a pay-as-you go system encounters confusion among the farmers as no one has experience with this method.

In addition to the mentioned business ideas, a few participants propose to commercially lend the pump, utilize the remaining electricity for food mills to produce fruit and vegetable concentrates (3I) and attempt to enhance their crops’ quality in order to raise their profit. A representative of a cooperative mentions: *“What we have been working on is always in the commercialization of agricultural products. With the sunlight pump we could improve the crops quality and sell it [crops] at a good price, which we could not do before.” (1I)*

8.1.2 Technical review and feedback

After the installation and commissioning of the sunlight pump on the demonstration sites, it was possible to get a better understanding of the technical advantages and opportunities for improvement of the sunlight pump system. Moreover, the responsible farmers on the demonstration sites gave feedback regarding their experience with the new technology.

Advantages of the sunlight pump system:

+ The farmers embrace the fact that the sunlight pump is able to lift water to an outstanding height. In Matagalpa the pump reaches 40 meters and in San Ramón 35 meters, whereas the pressure of a 10hp fuel pump in the respective farm is not sufficient.

+ Peasants are happy to apply the pump for multiple uses: As an example, one farmer in Managua used it for sprinklers, drip irrigation including a tank, domestic water and drinking water for cattle. A sunlight pump user in Chinandega even fills a small swimming pool with the pump.
+ The overflow sensor in the tank in order to automate the water system is appreciated.
+ The farmers welcome the possibility to connect the pump to a battery or the national grid by adding a charge controller, respectively a switching power supply. Especially in the demonstration spots around Matagalpa the need aroused due to frequently emerging cloudy skies. Moreover, peasants require this extension to sustain a steady pressure level, without interruptions, for their sprinkler system. Thus, it is not necessary to use a second electric pump (occurred in San Dionisio).

Drawbacks and Improvement possibilities:

- The farmers particularly worry about the water output as well as the suction depth and suggest introducing two further sunlight pump models: One pump with a larger water flow and a submergible pump.
- The end users propose providing a manual or even adequate material for the assembly of a construction to descend the pump into a well.
- Some farmers require a professional solar panel structure to reduce dirt and leaves on panels (especially in forested areas) and increase stability.
- As the electronics of the sunlight pump are difficult to maintain, enough spare parts have to be available in Nicaragua.
- The hose hardly withstands 5 bars if total lift is high, which leads to cracks (experienced in Matagalpa and San Ramón). A horizontal valve (approximately 12$), stronger hoses or hoses in one peace (not various assembled hoses) would reduce this problem.
- The distance between solar panels and pump is limited to maximum 15 meters due to transmission losses. This restricts farmers to find shadow-free and well visible installations spots for the sunlight pump.
- Because of theft-risks ennos could integrate a GPS-chip in the pump and connect it with a smartphone application. Hence, one would always know the location of the pump. Moreover, farmers would appreciate to turn the pump on and off and to switch between solar and battery mode remotely.
- The solar connector Y was not available at the time of the investigation. The rest of the needed accessories for the sunlight system can be purchased in Nicaragua.

9 The Marketing of the sunlight pump

After the in-depth research, this chapter discusses the marketing of the sunlight pump by means of the customer value approach. Within this extensive model the critical success variables are used exclusively, relating to the creation of customer advantage. Customer advantage consists of the end users perceived benefit for the product and service. From this it follows that a company has to direct its service towards the needs of the respective end users. (Belz & Bieger, 2006, pp. 84-95)

Customer advantages not only cause an increase in sales and earnings. The customer identifies itself with advantageous providers, builds trust and commits to them. The five critical success variables facilitate to provide accurate solutions to the end user (Belz, 2006, pp. 47-49). On that account, they are oriented towards the customer, as depicted in the following figure. Before elaborating the marketing of the sunlight pump by means of the 5 Cs, the customer target groups are discussed in more detail.

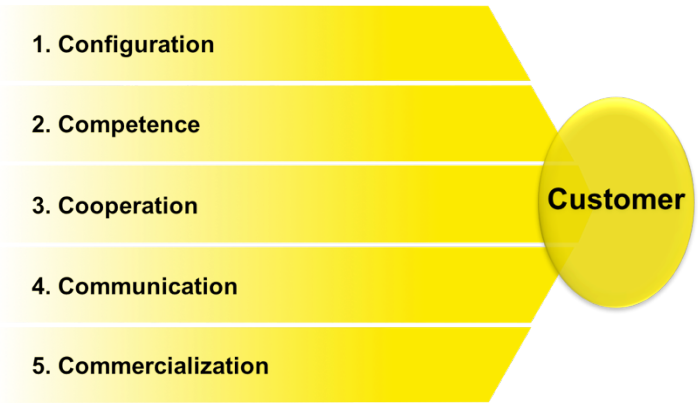


Figure 6: Critical success variables (5Cs)
Source: Own figure, adopted from Belz & Bieger, 2006, p. 117

9.1 Customer – Differentiation of end users

Based on the market context of Nicaragua and the findings of the case study research, it emerges that the exact differentiation between target groups is not possible, since creating value with the sunlight pump depends highly on the specific individual. For example, the target groups cannot only be segmented according to land ownership, since a farmer who cultivates 1mz of beans is less suitable than a farmer with 1mz of tomatoes. Moreover, one farmer might have several manzanas of land but only irrigates a small plot during the dry season. Or even if the sunlight pump cannot create value for a rancher in terms of solely irrigating pasture, he could use the sunlight pump to supply drinking water for his cattle at the paddock and simultaneously obtains domestic water for his family and electrifies milk skimmers and livestock fences. Another farmer might only need 2'000 liters of water per day but since he establishes a water supply service within his community, the sunlight pump can create great value for him. In conclusion, too many factors prevent the clear differentiation between target groups. Without drawing specific lines, the main focus of the marketing should lie on smallholder farmers in general, and subsistence farmers in particular, since both have the need for a technology like the sunlight pump.

With regard to irrigation, a smallholder farmer who owns between 5-50mz might not be able to water all of his land, but only small plots. One farmer, for instance, already uses the sunlight pump to deliver water from one of his basins to a small part of his cultivated land. The rest of his land is either irrigated by an industrial pump or is not watered at all. In this set-up, the farmer benefits from the mobility of the sunlight pump as he can move it from one water source to the other. Generally, these farmers have a

higher ability to pay. Subsistence farmers, on the other hand, are more likely to be able to irrigate all of their land.

Nevertheless, due to the insights from field observations and countless unofficial conversations, other possible end users should also be considered and are following briefly discussed.
Hydroponic farmers are another possible target group. Simply explained, this method allows to grow plants without the use of soil, but only by water, including the necessary nutrition. Hydroponic farming requires water throughout the year and has already been applied by various organizations in Nicaragua. Consequently, it is an interesting option for the sunlight pump.
Besides target groups in the area of agriculture, aquaculture poses a niche application for the sunlight pump. In this sector, a water pump is needed to fill tanks or ponds, to aerate and circulate the water therein or to lift water from groundwater sources. Mauricio Morales, a small-scale fish farmer based in Las Peñitas, explained that he could deploy the sunlight pump for his aquaculture activities in order to save electricity costs. Since he possesses minor cropland on the same site, he would be able to use the pump for irrigation additionally (12B). In 2015, it was estimated that 60% of the total domestic production volume of fishery products originated from aquaculture. The government, through the Nicaraguan Institute of Fisheries and Aquaculture (INPESCA), aims to promote aquaculture diversification in order to reduce poverty and boost economic growth in the country. They mainly emphasis on small-scale aquaculture and attempt to assure food security for vulnerable households. In this process, INPESCA aims to integrate environmentally friendly aquaculture (FAO, 2016, pp. 1-2). As a result, small scale fish farmers should be considered as a possible segment.

As many projects from the government or other NGOs deal with the supply of drinking water or sanitation, *rural communities* represent a further niche target group (2D). This means that several nearby family houses can be supplied with water or important buildings within a community, such as rural schools, churches and medical facilities.
Moreover, *wealthier people*, who do not possess a farm, is a realistic end user, as they generally think more long-term and environmentally conscious than the poorer population and can utilize the sunlight pump in their garden, for a swimming pool or in emergency situations to ensure drinking and domestic water, for instance when the water grid fails. (5D)

Tourist accommodations represent another target opportunity where the sunlight pump could create value. Many rural hotel owners (amongst others in Masaya, Rivas and Matagalpa), who promote ecotourism in rural areas showed interest in the sunlight pump. Many of these establishments are involved in environmental and social projects where they could apply the sunlight pump as well. Nicaragua has experienced a significant growth in tourism in terms of visitors as well as hotel offers (1’177 establishments in 2016), while the government supports the industry with tax exemptions (INTUR, 2017, p. 9 & 58).

9.2 Critical Success Variables - The 5 Cs

9.2.1 Configuration

The first “C” comprises the suggestion of a suitable value chain and the bundling of possible sunlight pump packages.
Aiming at delivering a suitable offer that fits the needs of the customer, it is important to structure an efficient value chain. Thereby, ennos has to choose the right partners, train them and provide the necessary marketing material to eventually create customer advantage.

As already described in Chapter 5.1, there are six companies interested in retailing the sunlight pump in Nicaragua. However, the individual shipping to the respective system integrator would increase the price of the pump and makes it less affordable for the end users. Hence, it would be appropriate that one of the system integrators takes care of the import, operates a consignment stock and delivers the sunlight pumps, if possible on behalf of ennos, to the other system integrators. The consignment stock is necessary since all of the system integrators stated that they are not able to afford the value of goods for a large number of pumps. In the initial phase of the market entry, ennos should limit the number of system integrators to three with the objective to maintain trust and establish an atmosphere of collaboration instead of competition between the system integrators.
For example, each of the three should stick to a given or recommended pump retail price so that customers recognize the homogenous cost, regardless of where they buy the product. As a consequence, competition only arises in the area of the offered service, more precisely transportation, installation, labor, training, maintenance and add-on products.

This leads to a next vital point regarding the system integrators. Many potential end users have never seen or used a solar powered technology, and hence require comprehensive explanation and education. On that account, the system integrators have to include training in the package offer in order to maintain the reputation and to exploit the maximum potential of the sunlight pump. The pump should not be sold as a stand-alone product because the possible failure due to the insufficient installation will be traced back to the product, despite this not being the case. In the initial sales phase, it is recommended to provide two core packages, both including training:

1. Water Package:	Sunlight pump, solar panels, hose & other needed accessories *Optional: Water tank with sensor, irrigation system & panel structure*
2. Extended Package:	Sunlight pump, solar panels, hose, battery, controller & accessories *Optional: Water tank with sensor, irrigation system, panel structure & inverter*

The first package is a pure water offer suitable for irrigation, domestic and drinking water. The second package is enlarged with a battery and the necessary accessories in order to extend the customer benefits. By means of this offer, the end user is able to increase the daily water output of the sunlight pump and to electrify devices such as lamps, cooling systems and livestock fences. Within the two

packages, the end user should decide what products he desires to fulfill his personal needs (Belz, 2006, p. 49).

In order to better reach the end user, intermediaries have to be included in the value chain. This is an important strategic step in order to speed up the last mile transportation. The intermediaries act between the system integrator and the end user, and serve as indirect customers. They consist of different actors and thus, add value in various facets. NGOs or government institutions might include the sunlight pump packages within projects. Some of them could even support with technical assistance in the respective rural areas. Agriculture hardware stores in municipalities could include the sunlight pump in their product range or conduct maintenance work. Besides, rural service providers from the communities, such as technicians, micro entrepreneurs and micro retailers contribute value through the implementation of technical, logistical or sales tasks. Each system integrator should steadily extend their network of service providers in order to enter new regions and enhance the customer service.

To sum up, the proposed structure of the value chain is shown in the following diagram:

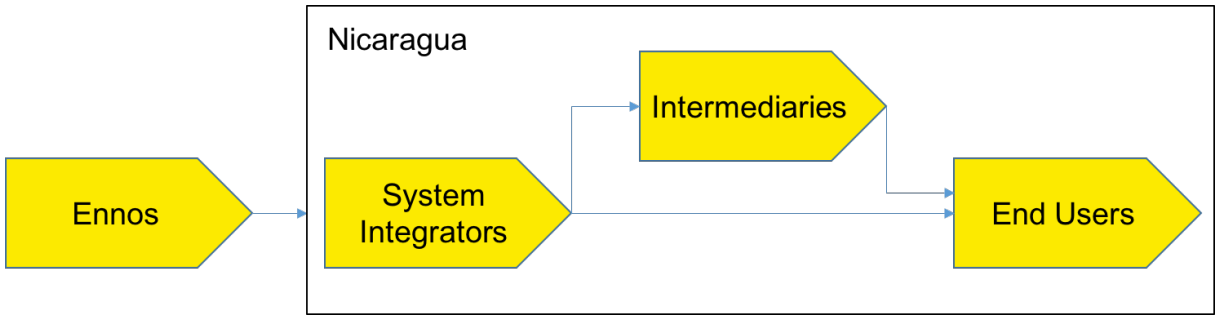


Figure 7: The value chain of the sunlight pump
Source: Own figure

9.2.2 Competence

After structuring the value chain, we have to determine the core competencies along the value chain. First of all, the main competence of ennos is the development of a reliable product as well as their know-how, which is delivered to the system integrators in a way that they understand ennos' vision and the performance components of the sunlight pump. An in-depth technical training and further negotiations in the initial phase of the market entry is therefore vital. Besides, ennos should take note and react to given feedback from market players and end users in order to quickly react to market changes and extend services or product features or even launch new pump models.

The system integrators, on the other hand, should exhibit certain competencies to retail the sunlight pump in accordance with the strategy of ennos. Hence, professionality, reliability and a suitable network are core competencies. Eventually, they are the "faces" who are associated with the quality of the sunlight pump by the customers. Since the end users are mostly rural farmers, whose main problems, in simple terms, are the lack of water, electricity and business knowledge, the system integrators require available resources in the three areas. First, they have to be able to consult end users in terms

of exploiting the full potential of the sunlight pump, calculating the needed energy supply of the panels and assisting in the agriculture productivity enhancement. Otherwise, the customers are not able to generate an additional income, in particular in the dry season, as they do not know how to use the technology adequately. Second, a certain innovative power might help to motivate end users in their opportunities to create an added value when the pump is not needed for irrigation reasons. In other words, end users should be fostered in launching their own business by means of the sunlight pump. As an example, an end user might provide neighboring houses with water by setting up a central located water tank as well as installing decentral water meters with the aim that his customers only pay what they consume. Moreover, he could establish a drinking water or mobile phone charging kiosk and offer irrigation services within his area. Lead users can even be integrated in the value chain as intermediaries by implementing various services, such as customer acquisition, maintenance work or organizing demonstration events.
In consideration of these core competencies, three system integrators are suggested and other possible partnerships are discussed in the following chapter.

9.2.3 Cooperation

In the short term, it is essential to choose the adequate system integrators in order to enter the market. As mentioned above, on the basis of the competencies the author suggests partnering up with iDEal Tecnologías, Enicalsa and Tecnosol, since they complement each other according to their area of expertise. All of them have a broad network of intermediaries and strive the same objectives as ennos, namely offering small scale, high-end products that are affordable and are equipped with extensive services. iDEal is an expert in irrigation, Enicalsa has an in-depth technical know-how and Tecnosol, as the solar company with the highest awareness, operates 16 sales points throughout Nicaragua and is a leader in electrification. The three proposed system integrators could even harness synergies in their areas of expertise.
The system integrators should then try to integrate the sunlight pump system in projects of NGOs, such as ANF, SNV, blueEnergy or CPmL-N, and governmental programs like Agriadapta - realized by INTA. Moreover, they might extend their current network in order to penetrate the high potential regions in terms of agriculture (Mataglapa, Jinotega, Estelí, León, Chinandega, Masaya and Rivas) and low accessibility to electricity (RAACN and RAACS). The livestock sector in particular comprises strong organizations that could serve as intermediaries for their ranchers. Moreover, micro finance institutions should be involved in the value chain to facilitate the initial investment for the end users.
In a longer term, the partnerships should be extended - on the one hand with educational institutions in order to spread the awareness and know-how of the sunlight pump. On the other hand, the supply channel for the sunlight pump could eventually be enlarged by means of partnerships with companies that offer possible add-on products, such as biodigesters or water purifiers.
Overall, functioning partnerships along the value chain are decisive in order to create advantages for the customers.

9.2.4 Commercialization

After discussing the possibilities of partnerships along the value chain, this chapter focuses on the commercialization of the sunlight pump.

After the various interviews with possible system integrators, it is apparent that, besides the sale of the actual product, intangible services account for a large part of the retail price. The sales process requires additional labor cost since it has to be organized proactively to gain a foothold in Nicaragua, in particular in the initial phase. Moreover, the service in terms of convincing, distributing, installing, training and maintaining the system causes further expenses. In the light of the above mentioned "Water Package", without the optional add-on products, the retail price amounts to 1200 – 1500$ including VAT. The "Extended Package" with the addition of a Trojan 85 Ampere hour-battery, a controller and another 200-watt panel[31] would cost between 1500 – 1850$ including VAT and the same service expenses as in the first package. These retail prices might sound excessively but are necessary to cover the expenses of the system integrators and allow them to add an adequate margin.

From the perspective of subsistence farmers, both packages are not affordable without financial help. The gross value added per year of their farm and their willingness to pay is lower than the offered retail price. It follows that this target group can only be reached through subsidies from intermediaries, such as NGOs or governmental institutions, or by financial support of MFIs. The annual interest rates of the MFIs vary between 24 – 48%, which is difficult to reimburse for a subsistence farmer within a short period. Therefore, it is important to provide this target group with a long-term finance scheme and technical assistance. The two microfinance institutions FDL and Fundeser meet both criteria. Especially FDL offers with "ECOMICRO", a finance scheme that is suitable for the sunlight pump, as it exclusively finances farmers who adapt to sustainable technologies. Also, smallholder farmers with more land, could be integrated in such a finance scheme since they rather fulfill the legal and collateral requirements of a MFI. In general, the interest rates in Nicaragua are high, which poses an investment barrier for many smallholder farmers.

As a result, the other mentioned target groups should not be ignored by the system integrators. Selling the sunlight pump through the direct channel is more probable for wealthier farmers or players in the tourism sector.

9.2.5 Communication

Commercialization only succeeds once the customer is convinced of the sunlight pump system and recognizes his benefits. Therefore, it is important to use the right messages and communication paths (Belz & Bieger, 2006, pp. 268-272). The greatest effort for communication activities should be carried out shortly before the end of the rainy season.

[31] Additional costs of: 125$ (Trojan battery) + 30$ (controller) + 156$ (200-watt solar panel) = 311$

Messages

The messages of the sunlight pump system should match the needs of the end users or address their potential benefits.

As a result of the focus groups, the operational costs of fuel or electric pumps in the long term pose a problem to them. Others complained about the droughts they experienced and how these weather changes cause crop failures. These problems should be used to create powerful messages that are easy to understand.

Moreover, the messages could target the possibilities to increase productivity and income by means of the sunlight pump system. If the farmers would have an automated irrigations system, they were able to conduct other task in their business, such as raking their fields or spending more time in investigating new sales channels and crop diversification.

Then, explicit benefits can be addressed, for example in terms of multiple applications of the pump system, for instance irrigation, domestic water and illumination in the evening, so that the children can do their homework and the farmer the monthly accounting.

Finally, the brand “Switzerland” was seen as a high-quality feature from the focus groups and might lead to a premium being paid from end users. Moreover, it causes an emotional value.

Paths

Even more importantly, especially in the market entry of the sunlight pump, are the channels of communication. Several possible channels are listed below:

- Fairs: To raise awareness and network with other market players (Expica and Euroferia are potential events)
- Field demonstrations: Prepare presentations on flipcharts and try to reach as many people in the community as possible (involving lead users)
- Direct visits: Using a communication manual to convince potential clients and maintain customer relationship (involving rural technicians, micro entrepreneurs and micro retailers)
- Radio and Television: Spreading a message through a rural influencer, such as Aniceto Prieto, through these two canals that reach the most rural people (4D)
- Online: Make use of the growing internet access and social media users, particularly for the younger generation

10 Conclusion

The purpose of this thesis was to analyze if there is market potential for the sunlight pump in Nicaragua and under which conditions the marketing can successfully be implemented. At the beginning the thesis outlined the specific features of the Base of the Pyramid market, which served as a basis for the second part - the case study. After introducing the sunlight pump a wide range of literature was reviewed in order to provide an extensive overview of the relevant market context in Nicaragua, namely the solar and agriculture sector. It has been pointed out that the Nicaraguan energy policies and trends are clearly in line with the intended market entry of the sunlight pump. A closer look at the agriculture context unveiled that the large majority of farmers are smallholders. On average, however, they own significantly more land than smallholder farmers in other developing countries do, which poses a problem for the irrigation by the sunlight pump due to the limited water output. On the other hand, data showed that smallholder farmers who own less than 5 manzanas of agriculture land are most probably not able to pay the initial investment of the sunlight pump. Regardless of the available financial means, the need for the sunlight pump exists, amongst other factors, because of droughts and the fact that only 5.5% of the cultivated areas are irrigated.

Subsequent to the secondary research, individual interviews with key market players and focus groups with potential end users as well as representatives of organizations were conducted. The in-depth primary research revealed that there are many possible cooperation partners for ennos along the value chain. Yet the companies offering solar systems highlighted that the distribution to rural customers is challenging and costly. Moreover, it was detected that, although a large variety of solar pumps are offered in Nicaragua, there is no competitor product to the sunlight pump.

The findings from the various focus groups helped to understand if there is a need for the sunlight pump from the perspective of smallholder farmers and to determine what problems can be solved by means of such a small-scale solar technology. The focus groups clarified that smallholder farmers recognize the benefits of the sunlight pump. They appreciate the possibility to use the pump for multiple applications and the advantage of not paying for fuel or electricity. However, it was revealed that the smallholder farmers' ability and willingness to pay is much lower than the estimated price of a sunlight pump system.

The results from the study were afterwards used to develop a possible implementation of the marketing in Nicaragua according to Belz & Bieger's (2006) five critical success variables.

The thesis outlined that there is potential for the sunlight pump in Nicaragua but the successful implementation depends on several conditions: First, a functioning partner network along the value chain has to be established, involving service providers from high potential areas who give support in maintenance issues and promotion of the sunlight pump. Second, financial support, either from NGOs, MFIs

or directly from system integrators, needs to be provided in order that end users, in particular subsistence farmers, are able to afford the initial investment. And third, end users require technical, agriculture and business training so that they exploit the full potential of the sunlight pump, increase the productivity of their farm and hence raise income.

There are still a number of aspects not discussed in the successful marketing of the sunlight pump. One interesting topic for further research would be an analysis of more efficient sales channels for smallholder farmers. The reason is, even if farmers achieve a higher yield, the question remains whether they can integrate their output in a more profitable sales channel. Other research could be dedicated to innovative and long-term finance schemes with the aim to facilitate the initial investment of the sunlight pump. Due to the limited scope of this study, these questions have to be left for the future.

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Lorentz: https://www.lorentz.de

Appendices

Appendix A: System Integrator Interviewees

Code	Name	Function	**Interview Date**
1A	Vladimir Delagneau	General Manager (Tecnosol)	04.04.2017
2A	José Benito Rodríguez	General Manager (Enicalsa)	22.03.2017
3A	Max Lacayo	General Manager (E-Cami)	07.03.2017
4A	Jürgen Kulke	General Manager (Altertec)	05.04.2017
5A	Douglas González Martínez	Operational Manager (SuniSolar)	07.04.2017
6A	Stefan Schäfli	Sales Manager (iDEal Tecnologías)	04.04.2017
7A	Lester Cortez	Sales Manager (NicaSolar)	27.03.2017

Appendix B: Organization and Small Enterprises Interviewees

Code	**Name**	**Organization and Companies**	**Interview Date**
1B	Keith Poe	American Nicaraguan Foundation	28.03.2017
2B	José Rolando Reyes Leiva	Biobolsa	08.04.2017
3B	María Teresa Fernández	Coordinadora de Mujeres Rurales	07.04.2017
4B	Mercedes Alvarez	Fuprosomunic	08.03.2017
5B	Hermogenes Zelaya	IDEAS (TecAp)	22.03.2017
6B	Jorge Lopez	Grupo Fenix	21.03.2017
7B	Javier Espinoza	blueEnergy	08.03.2017
8B	Peter Coleman	Peace & Hope Frontier Mission	23.02.2017
9B	Bayardo Alonzo	Agrofor (Cooperative)	14.04.2017

10B	Ronald Fonseca	CpmL-N	05.04.2017
11B	Luis Cuadra	Agrofor (Company)	12.04.2017
12B	Mauricio Morales	Criadero Pargo Rojo Nicaragua S.A.	27.03.2017

Appendix C: Microfinance Institution Interviewees

Code	Name	Microfinance Institution	Interview Date
1C	Felix Diaz	Financiera Fundeser	24.03.2017
2C	Elke Rivas	Financiera FDL	22.03.2017

Appendix D: Expert Interviewees

Code	Name	Function	Interview Date
1D	Francisco Campos Conrado	Shipment Consultant (Campos & Campos CIA. LTDA.)	06.03.2017
2D	Maria Antonia Zelaya	Representative of the Consulate of Switzerland in Nicaragua (COSUDE)	28.02.2017
3D	Carlos Urmeneta	Country Director (IDE Honduras)	06.03.2017
4D	Juan Francisco Rodríguez	Communication Manager (ICOM)	13.04.2017
5D	Hans Danninger	Coordinator of Austrian Development Cooperation in Nicaragua (ÖEZA)	13.03.2017
6D	Alois Müller	Senior Consultant (ennos)	07.03.2017

Appendix E: Sunlight Pump Product Shot

Appendix F: Global Horizontal Irradiance in Nicaragua

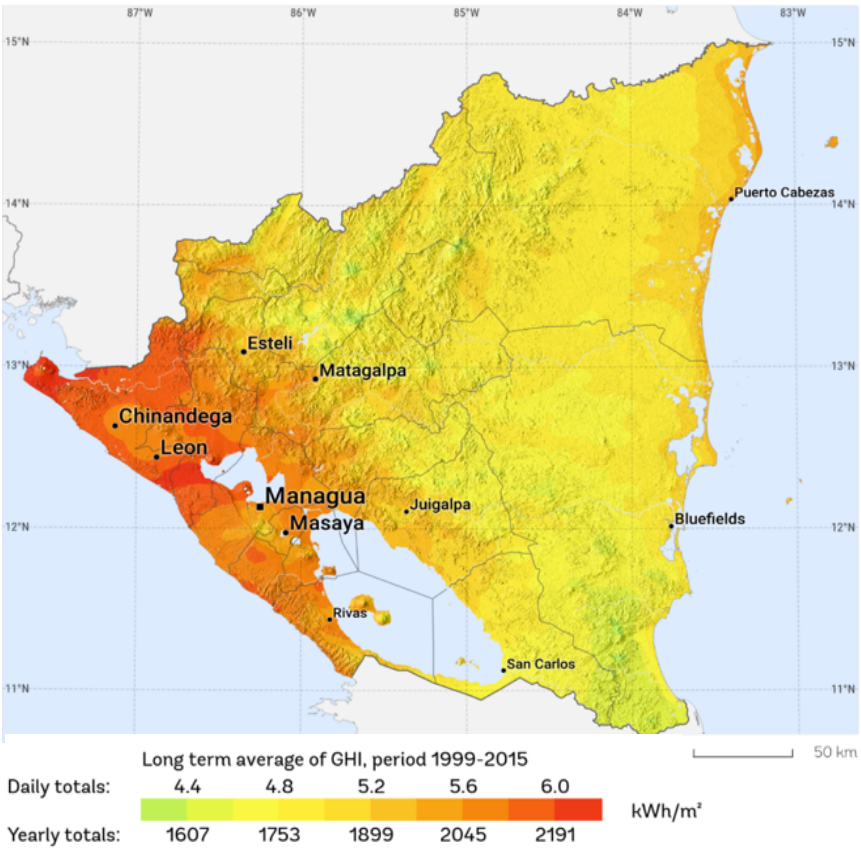

Figure 3: Global Horizontal Irradiance in Nicaragua

Appendix G: Complete List of System Integrators

NAME	DESCRIPTION *(WHO, WHERE)*	OFFER *(PRODUCTS/SERVICES, BRANDS)*	CONTACT	AUTHOR'S EVALUATION
iDEal Tecnologías	▪ Social Business that aims to increase the income of small-scale farmers by low-pressure irrigation Consists of 9 employers and 20 external service providers https://www.ideglobal.org/country/nicaragua ▪ Operates nationally (except of Raan and Raas) with an office in Managua	▪ Micro- and drip irrigation system, pedal pump ▪ Focus on research, consulting services and monitoring ▪ Irritec, Ennos etc.	StefanSchäfli Sales- and Logistics Manager (505) 2223 4300 sschaefli@idealbtecnologias.com	+ Comprehensive agricultural know-how + Emphasis on personal relationship with customers + Already known and reliable partner of Ennos - Little technical expertise in the range of pumps and solar energy
Tecnosol	▪ Works in the field of renewable energies (especially solar) since 1998 Offers a great range of products mainly for rural areas, employs more than 100 collaborators and has installed approximately 70'000 photovoltaic systems http://www.tecnosolsa.com.ni/ ▪ Headquarter in Managua, comprises 16 branches in Nicaragua and has a foothold in Panamá, Honduras and El Salvador	▪ Solarpanel, pump, battery, inverter, biodigestor, lamp, electric fence, refrigeration system ▪ Franklin, Sunpower, Koyama, Amarine, Shurflo, Mastersolar, Trojan etc.	Vladimir Delagneau General Manager (505) 2251 5152 vdelagneau@tecnosolsa.com.ni	+ Extensive experience in the solar market + Highest company awareness in Nicaragua in this sector + Wide network of cooperation partners, such as financial institutions
Enicalsa	▪ Founded in 2003, emphasizes on research, training and installations in the area of photovoltaic-, water supply-, thermic- and water purifications systems 70 % of his project are financed from Germany http://enicalsa.com/ ▪ Located in Léon, but operates nationally with around 100 independent technicians Has already installed systems in Mexico and Guatemala	▪ Photovoltaic-, irrigation-, pump-, wind power- and water purification system ▪ Grundfos, Lorentz, Comet, Exide etc.	José Benito Rodríguez General Manager (505) 8893 7464 benito@enicalsa.com	+ Long experience with pumps and solar energy + Studied and lived in Germany for 20 years (speaks German) + Is the president of the chamber of commerce (Germany/Nicaragua) and cooperates with many universities in Nicaragua
E-Cami	▪ Company which works in the field of photovoltaic energy and radio communication for more than 25 years	▪ Solar panel, lamp, pump, refrigeration, inverter, battery	Max Lacayo General Manager	+ Extensive network and experience in the solar market + High profile in Nicaragua

NAME	DESCRIPTION *(WHO, WHERE)*	OFFER *(PRODUCTS/SERVICES, BRANDS)*	CONTACT	AUTHOR'S EVALUATION
	http://ecami.com.ni ▪ Head office in Managua, consists of 12 branches and 40% of customers come from rural areas	▪ Trojan, Simpliphi, Ritar, Sunpumps, Samlex, Studer, Ege, SolarWorld, Kyocera, Sma, Solis, Schneider, Shurflo etc.	(505) 2276 0925 max.lacayo@ecami.com.ni	- Rather a shift from BoP-market to a financially stronger clientel (could also be an advantage)
Altertec	▪ Enterprise (no S.A.) that aims to develop the rural market with renewable energies and consulting services since 1984 Collaborates often with Germany and has created his own technical cooperative http://altertec.com ▪ Operates nationally with an office in Estelí	▪ Projects in the field of photovoltaic as well as wind power systems, pumps and biomass ▪ Lorentz, Sunpumps, Shurflo, Kyocera, Phocos, Sundanzer, Fosera etc.	Jürgen Kulke General Manager (505) 8406 5440 altertec@ibw.com.ni	+ Comprehensive technical know-how (has different training programs) + Speaks German + Dynamic person and a doer - Location and business approach not optimal as a wholesaler or principal system integrator
SuniSolar	▪ Since 1999, offers solutions for sustainable energy (especially solar systems) Has conducted various projects in the rural area http://www.sunisolar.com/ ▪ Works in whole Nicaragua with an office in Managua	▪ Pump, battery, solar panel, inverter ▪ NaturaLight, Trojan, Lorentz, Sunpump, CanadianSolar, Solartec, Zebra Energy	Douglas González Martínez Operational Manager (505) 2278 2630 douglas.gonzalez@sunisolar.com	+ Has different business partners, mainly with various microfinance institutions + Rather small and flexible enterprise - Not as professional and well-structured as the rest of the other system integrators

Further Alternatives

EraSolar	▪ Operates in the renewable energy market since 2008 http://www.erasolar.com.ni ▪ Office is in Managua but works nationally	▪ Panel, wind turbine, battery, inversor, pump, lamps, electric fence, ▪ Franklin, Shurflo, Isofotón	Roberto Muñoz General Manager (505) 2270 5666 roberto.munoz@erasolar.com.ni	+ Rather small and flexible enterprise - Did not show great interest in the SunlightPump
NicaSolar	▪ Company with seven years of experience in the renewable energy market http://www.nicasolar.com.ni	▪ Pump, lamp, solar panel, refrigeration, household appliance	Jorge Rivera General Manager	+ Professional sales points

NAME	DESCRIPTION *(WHO, WHERE)*	OFFER *(PRODUCTS/SERVICES, BRANDS)*	CONTACT	AUTHOR'S EVALUATION
	Work in both urban and remote rural areas ▪ Headquarter in Managua, have 7 branches	▪ MaxSolar, Amarine, Jinko, Jintai, PowerKing, Ritar, Magnum	(505) 2252 5896 info@nicasolar.com.ni Lester Cortez Sales Manager Tipitapa (505) 2224 3982 ventas.tipitapa@nicasolar.com.ni	- Does not answer requests and did not show great interest in the SunlightPump
Aquatec	▪ Large enterprise that operates in the water and pump sector since 1991 (part of AquaCorp) Conducts mainly projects for the industrial sector, hotels, institutions, government and private customers http://aquatec.com.ni ▪ Headquarter in Managua, consists of various branches	▪ Pump system, water heater, filter, irrigation product, pool accessory ▪ Sta-Rite, Koshin, Subdrive, Aquapro, Aft, Franklin etc.	Juan Santos Bonilla Sales Manager (505) 2255 9797 jsantos@aquatec.com.si servicioalcliente@aquacorp.com	+ Would offer a different sales network and opportunities to expand to different countries - Not primarily in the renewable energy market
Sinter	▪ Large company in the field of infrastructure http://www.sinter.com.ni ▪ Head office in Managua with various branches	▪ Wide product range in the field of infrastructure (indoor/outdoor) ▪ Countless brands	Karen Sánchez Irrigation and Pumps Manager (505) 2255 7900 mercadeo@sinter.com.ni	+ Huge company with comprehensive technical know-how - Would probably not push our product proactively - Has mainly extensive projects and don't collaborate with end customers directly

Appendix H: System Integrators' assessment regarding sunlight pump and possible collaboration with ennos

Tecnosol does not have much experience with surface pumps as they only sell submergible solar pumps, but they consider the sunlight pump as inexpensive compared to their present product range. Based on a first estimation, they could sell a small-scale sunlight pump water supply system (with 120 watt panels and the needed accessory) for approximately 1300 – 1500$. After seeing the sunlight pump running in the field, Tecnosol is interested in playing a system integrator role in the value chain.

E-Cami views the sunlight pump as an option for the irrigation in small rural farms, since the price is reasonable, the pump looks esthetic and the screen is a simple adequate tool to monitor. The low maintenance effort is a key advantage due to the instable distribution channels in rural zones. Lacayo is willing to purchase three several pumps and distributes them to the 12 branches. After testing the pump and assessing the demand for 4 -6 months, E-Cami would start promoting the pump proactively. However, the process of promoting the pump takes time since Nicaraguans are difficult to convince and usually want to see the technology in action.

Douglas Gonzalez of **Sunisolar** states that he is interested in marketing the sunlight pump since it is convenient to install and use. He considers mainly smallholder peasants with approximately one manzana and farmers who live near to surface water as the main target group. Sunisolar estimates to sell 2 – 10 sunlight pumps per month but is not able to have an extensive stock as they do not have a storage.

Rodríguez of **Enicalsa** states that the sunlight pump is an excellent option for small-scale farmers; particularly who live near surface water, cheaper than Grundfos and straightforward to install since one can connect the solar panels directly to the pump. However, he fears robberies in the field if the end user does not secure the pump accordingly. Enicalsa is available for further proceedings but would like to test the pump primarily. He could store the pumps in his stock, distribute them to further system integrators and is willing to give technical consulting service to its cooperation partners.

Kulke of **Altertec** figures that the sunlight pump is efficient and suitable for smallholder farmers. However, the water level has generally decreased in Nicaragua, which limits the application possibilities of the sunlight pump. He possesses a stock and considers the availability of the pumps as enormously important since his customers usually buy immediately and do not want to wait. Kulke states that he would buy 15 – 20 pumps and already has interested customers.

As a player in the supply chain, **iDEal** would demand technical support from ennos and sufficient spare & wear parts. Especially the electronics of the sunlight pump are technical sophisticated and vulnerable. A supply chain with various system integrators, which could evoke internal competition and freerider problems, does not pose a problem for iDEal. Schäfli mentions that ennos could fix or propose

the retail price of the pump in Nicaragua so that the system integrators only compete in service operations. However, he would rather let the free market forces play. Generally, Schäfli assumes to sell around 50 pumps in the first year.

Appendix I: Demonstration Events

1 **Sébaco** Matagalpa	• 12 participants divided into 2 groups • Organizations: Comusol, Agrofor & Central America University (UCA)
2 **Tipitapa** Managua	• 11 participants in 1 group of individual end users • No organizations present
3 **San Juan de las Pencas** Chinandega	• 7 participants (twelve women) divided into 2 groups of individual end users and a cooperative • Organization: Mujeres en acción
4 **Managua**	• 15 participants (mostly ranchers) divided into 2 groups • Organizations: blueEnergy, FAGANIC, ECOTER, Nuevo Carnic & Coop. Pedro Joaquin Chamorro
5 **Matagalpa**	• 17 participants divided into 2 groups • Organizations: ADDAC, Caritas Jinotega, ASOGAMAT & Agrofor (company)
6 **San Ramón** Matagalpa	• 8 participants in 1 group • Organizations: SNV / Zamorano & CECOSEMAC
7 **San Dionisio** Matagalpa	• 13 participants in 1 group • Organizations: Movimiento Comunal Nicaragüense & Coop. La Campesina

Appendix J: Focus Group Questionnaire

Grupo Focal: Consumidores Finales

INTRODUCCIÓN

En el inicio del grupo focal, decir buenos días/tardes. Mi nombre es..... y explicar quiénes somos, a qué organización pertenecemos y mencionar que estamos realizando un estudio sobre una nueva bomba solar que puede apoyarles en diferentes aspectos.

La idea es poder conocer sus distintas opiniones para colaborar con el desarrollo futuro e implementación de la bomba y proyectos correspondientes. En este sentido, siéntanse libres de compartir sus ideas en este espacio. Aquí no hay respuestas correctas o incorrectas; lo que importa es justamente su opinión sincera. Cabe aclarar que la información es sólo para nuestro trabajo, sus comentarios serán confidenciales y con otras opiniones de manera anónima y en ningún momento se identificará que dijo cada participante. Para agilizar la toma de la información, resulta de mucha utilidad grabar la conversación. ¿Existe algún inconveniente en que grabemos la conversación? El uso de la grabación es sólo para los fines de análisis. También tenemos sus datos de contacto (por el cuestionario) para compartir los resultados del estudio con ustedes, si tengan interés.
¡Desde ya muchas gracias por su tiempo!

PREGUNTA DE ENTRADA

Presentación: nombre y domicilio → más personal y para romper el hielo

- ¿Cuáles son los principales "problemas" que están enfrentando en su vida cotidiana (independientemente de la Sunlight Pump)?

PREGUNTAS DE ANÁLISIS

- Ahora, piensen en la última vez que ustedes regaron su parcela. Por favor, describan sus pasos de trabajo? *(no aplica para consumidores finales que no riegan su tierra)*
    - ¿Cómo se sentían mientras regaron su parcela (Cultivo)? *(")*
    - ¿En qué otras tareas podrían ocuparse, si el proceso de la irrigación sería automático?
- ¿Después de haber visto esta bomba solar en acción; qué ventajas y desventajas encontramos *(análisis interno y externo/ evaluación subjetiva)*? -> *uso del pizarrón*
    - Cuáles son las diferencias a las otras bombas que ya conocen (nombres de los vendedores)? *(aplica especialmente para los consumidores que ya conocen o usan bombas solares)*
- ¿Qué tipo de "problemas" ustedes pueden resolver con la Sunlight Pump en su vida diaria? -> *uso de tarjetas de colores*
    - Enfoque:
        - Cosecha aumenta (mayor productividad y más ingreso)
        - Agua potable
        - Agua domestica (cocina, ducha, lavar, limpiar etc.)
        - Electricidad (cargar celulares, luz, refrigerador, TV, radio, máquina corta pelo, licuadora, picadora de pastos, molino / mezcladora para hacer concentrado de alimentos etc.)
- ¿Cuál es la inversión que usted está dispuesto a pagar por la bomba? -> *al principio todos la anotan independiente*
- ¿A qué precio piensa usted que la bomba está demasiada cara?

  ¿Qué precio piensa usted que un precio óptimo?

Resumen de las ventajas y demostrar una ilustración (hoja de cálculo) sobre los ahorros (mano de obra, combustible, coste de mantenimiento) y el punto de equilibrio comparado con una bomba combustible); les decimos que esta pregunta es sin importar de su capital propio
Van Westendorp método – Rangos de Precios: Cada persona escribe los precios en un pedazo de papel y después lo discutimos

- ¿A qué precio dejaría de comprar esta bomba por considerar que es demasiado caro? *(demasiado caro)*
- ¿A qué precio dejaría de comprar este producto por considerar que es tan barato, así que dudaría de su calidad? *(demasiado barato)*
- ¿A qué precio usted considera que este producto empieza a ser caro y tiene que pensar mucho, pero aún así lo compraría? *(caro/parte alta)*
- ¿A qué precio usted considera que este producto es barato y lo compraría? *(barato/buen precio)*

- ¿Qué métodos de pago usted ya conoce?
  - ¿Qué método de pago usted prefiere?
    - Financiamiento de préstamo con un período determinado (individual)
    - Formación de grupos o grupo solidario (responsabilidad compartida)
    - ¿Qué tipo de garantías usted ofrecería a cambio de obtener un crédito?
- ¿Usted compartiría la bomba solar / el agua generada con otras personas?
  - En caso afirmativo, ¿con quién (familia, comunidad, amigos, contratantes) y por qué?
- ¿Qué ideas tiene usted para ganar un ingreso adicional con la bomba (agua) y la electricidad generada? -> uso de tarjetas de colores
  - Enfoque:
    - Kiosco de agua (agua potable, agua doméstica etc.)
    - Entretenimiento (cine, música etc.)
    - Estación de carga (celulares, baterías, luz etc.)
    - “Pay-as-you-go” sistema (en una comunidad)
    - Refrigeración (sodas, mantenedor de carne / pescado / fruta / vegetal)
    - Proveedor de servicios (transportación, apoyo técnico, servicio de regadío etc.)

PREGUNTA DE SALIDA

- Si puedan adquirir una bomba de agua hoy; ¿cuál compraría (electrónica, combustible, solar)?
  - ¿Por qué usted tomó esta decisión?
- (¿De todos los temas que hemos discutido; cuál (en su opinión) es lo más significante o que ha llamado la atención?)

Gracias por su tiempo y esfuerzo. ¡Nos ayudaron mucho!

Grupo Focal: Organizaciones

INTRODUCCIÓN

En el inicio del grupo focal, decir buenos días/tardes. Mi nombre es..... y explicar quiénes somos, de que organismos pertenecemos y que estamos realizando un estudio sobre una nueva bomba solar que puede apoyarles en varios proyectos.

La idea es poder conocer sus distintas opiniones para colaborar con el desarrollo futuro e implementación de la bomba y proyectos correspondientes. En este sentido, siéntanse libres de compartir sus ideas en este espacio. Aquí no hay respuestas correctas o incorrectas; lo que importa es justamente su opinión sincera. Cabe aclarar que la información es sólo para nuestro trabajo, sus comentarios serán confidenciales y con otras opiniones de manera anónima y en ningún momento se identificará que dijo cada participante. Para agilizar la toma de la información, resulta de mucha utilidad grabar la conversación. ¿Existe algún inconveniente en que grabemos la conversación? El uso de la grabación es sólo para los fines de análisis. También tenemos sus datos de contacto (por el cuestionario) para compartir los resultados del estudio con ustedes, si tengan interés.

¡Desde ya muchas gracias por su tiempo!

PREGUNTA DE ENTRADA

Presentación: nombre, nombre de la organización y enfoque de la organización → más personal y para romper el hielo

1. Por favor, breve describa un proyecto realizado de su organización en el campo de electricidad, agua o bombas.

PREGUNTAS DE ANÁLISIS

2. ¿Cuáles son las principales necesidades de sus beneficiarios?
3. ¿Después de haber visto esta bomba solar en acción; qué ventajas y desventajas encontramos *(análisis interno y externo / evaluación subjetiva)*? *-> uso del pizarrón*
    - Cuáles son las diferencias a las otras bombas que ya conocen (nombres de los vendedores)? *(aplica especialmente para las organizaciones que ya conocen o usan bombas solares)*
4. ¿Qué tipo de “problemas” de sus beneficiarios ustedes pueden resolver con la Sunlight Pump (de acuerdo con pregunta 2)? *-> uso de tarjetas de colores*
    - Enfoque:
        - Cosecha aumenta (mayor productividad y más ingreso)
        - Agua potable
        - Agua domestica (cocina, ducha, lavar, limpiar etc.)
        - Electricidad (cargar celulares, luz, refrigerador, TV, radio, maquina corta pelo, licuadora, picadora de pastos, molino / mezcladora para hacer concentrado de alimentos etc.)
5. ¿Cuáles son los principales obstáculos del sector rural para su desarrollo?
    - Enfoque:
        - Distribución y acceso a suministro tecnológico
        - Recursos financieros de los beneficiarios
            a) Describe experiencias con instituciones micro financieras

- Educación (conocimiento del negocio, falta de capacitación técnica etc.)
- El rompimiento de tradiciones (cambio a un nuevo procedimiento o tecnología)
- Incentivos insuficientes
- Falta de tenencia de la tierra

6. ¿Cómo usted organiza, dentro de la cadena de distribución, la última entrega? *(la entrega de última milla)*
    - ¿Cómo usted maneja el mantenimiento con respecto a las largas distancias y a la mano de obra limitada?
7. ¿Qué grupos objetivos podrían imaginarse para el Sunlight Pump? -> *uso del pizarrón*
    - Enfoque:
        - Agricultor pequeño/mediano
        - Ganaderos
        - Criaderos de peces
        - Comunidades (compartir la bomba, el agua generada o la electricidad)
            a) ¿Ya conocen mecanismos / sistemas para compartir máquinas, herramientas u otros bienes?
        - Otras instituciones (escuelas, hospitales etc.)
        - Turismo
    - ¿En qué zonas de Nicaragua usted ve el potencial más grande para la bomba?
8. *Resumen de las ventajas y demostrar una ilustración (hoja de cálculo) sobre los ahorros (mano de obra, combustible, coste de mantenimiento) y el punto de equilibrio comparado con una bomba combustible); les decimos que esta pregunta es sin importar de su capital propio Van Westendorp método – Rangos de Precios: Cada persona escribe los precios en un pedazo de papel y después lo discutimos*
    - ¿Qué precio dejaría de comprar esta bomba por considerar que es demasiado caro? *(demasiado caro)*
    - ¿A qué precio dejaría de comprar este producto por considerar que es tan barato, así que dudaría de su calidad? *(demasiado barato)*
    - ¿A qué precio usted considera que este producto empieza a ser caro y tiene que pensar mucho, pero aún así lo compraría? *(caro/parte alta)*
    - ¿A qué precio usted considera que este producto es barato y lo compraría? *(barato/buen precio)*
9. ¿Su organización combina sus productos / servicios como una iniciativa económica? En caso afirmativo; ¿cómo?
    - Enfoque:
        - Quiosco de agua (agua potable, agua domestica etc.)

- Entretenimiento (cine, música etc.)
- Estación de carga (celulares, baterías, luz etc.)
- "Pay-as-you-go" sistema (en una comunidad)
- Refrigeración (sodas, mantenedor de carne/ pescado/ fruta/ vegetal)
- Proveedor de servicios (transportación, apoyo técnico, servicio de regadío etc.)

PREGUNTA DE SALIDA

- Si quisieran adquirir una bomba de agua hoy para un proyecto; ¿cuál compraría (electrónica, combustible, solar)?
  - ¿Por qué usted tomó esta decisión?
- (¿De todos los temas que hemos discutido; cuál (en su opinión) es lo más significante o que ha llamado la atención?)

¡Gracias por su tiempo y esfuerzo. Nos ayudaron mucho!

Appendix K: Example of a Narrative Interview

ennos INNOVATIVE SWISS TECHNOLOGY University of St.Gallen iDEal Tecnologías

Entrevista con
un Mayorista
- Michael Sinniger -

Introducción

- *Estudiante de Urs (escribiendo mi tesis de maestría) y al mismo tiempo trabajo para Ennos (la empresa que diseñó la bomba); Urs me dijo que debo ponerme en contacto con usted porque Tecnosol es una empresa muy progresiva y innovadora.*
- *Plan de análisis que incluye la cadena de suministro, la fijación del precio, la necesidades de los clientes y de buscar potenciales socios de negocios*

Sección narrativa

- ¿Cómo describiría el mercado de la energía solar y de la bombas de agua en Nicaragua? ¿Ha sucedido un desarrollo significante de combustibles fósiles hacia energía renovable (especialmente energía solar)?
- ¿Qué segmentos de clientes ECami sirve (también productores pequeños)?

Parte estructurada

NECESIDADES DEL CLIENTE

- Cuáles son las principales necesidades de los consumidores finales (en todos segmentos de clientes)?
- ¿Cuáles son los principales obstáculos del sector rural para su desarrollo? (distribución, financiamiento, educación, tenencia de la tierra, falta de capacitación técnica, el cambio a una nueva tecnología / procedimiento, etc.)?
- ¿En qué regiones de Nicaragua usted trabaja?

DISTRIBUCIÓN Y SERVICIO AL CLIENTE

- ¿Cómo usted organiza el mantenimiento y "la entrega de última milla" con respecto a las largas distancias y a la mano de obra limitada?
    - Cuales son las maneras mas eficientes de traer productos / servicios hasta la puerta de personas que viven muy rural?
- Cuál es un margen común en Nicaragua para empresas (mayoristas, minoristas)?

PRODUCTO

- Usted tiene productos (especialmente bombas) para productores pequeños, casas unifamiliar (para agua domestica etc.)?
    - Me podrías mandar proformas de sus: baterías (12V/24V con 60-200 amperio-hora; e.j. Trojan etc., de litio y de plomo), paneles solares (100-400W) y bombas (11 GPM), calentadores de agua (con especificaciones y rendimientos =bomba)
    - También de sus servicios: instalación, diagnostico, transporte?
- (show pump) Dónde usted ve el potencial más grande para la SunlightPump?
    - En combinación con electricidad (refrigeración, luz, entretenimiento), agua potable, agua domestico, in combinación con Biodigestión

COMUNICACIÓN

- ¿Normalmente, cuál es la mejor forma de comunicarse en Nicaragua?
    - Promover un producto
    - Servicio al cliente

COMERCIALIZACIÓN

- ¿Usted colabora con instituciones microfinancieras?
    - ¿En su opinión, piensa que las microfinancieras pueden ofrecer términos resp. tasas de interés adecuadas para permitir una inversión facilitada?
- ¿Qué segmentos de clientes potenciales para el Sunlight Pump vienen a su mente (Productores, Escuelas, Hogares familiares etc.)?

Conclusión

- Qué piensa de la bomba? Tendría interés en desempeñar un rol en el lanzamiento de la bomba?
    - Precio: 1200$ -> para el consumidor
    - Disponibilidad: Junio / Julio
- La directora executiva de la empresa y Urs van a llegar a Managua el 20,21,22 de april. Tienes tiempo para discutir el tema más?
- Tarjeta de presentación!
- ¿Tiene alguna pregunta? ¿Hay algo que no he sacado el tema y que quisiera señalar?
- ¿Hay alguna otra persona con quien pueda contactarme?

Declaration of Authorship

"I hereby declare

- that I have written this thesis without any help from others and without the use of documents and aids other than those stated above,
- that I have mentioned all used sources and that I have cited them correctly according to established academic citation rules,
- do not pass any information from the company to unauthorized third parties; not even beyond the project work."

Tägerwilen, 19.11.2017

Michael Sinniger