MASTER THESIS:
Sustainable business model for off-grid PV electrification in developing country:
In the case of Sumba Island, Indonesia

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For my loving father.

As the greatest source of my inspiration to pursue a higher education.

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EXECUTIVE SUMMARY

The electrification ratio of Sumba Island has been increased in the past five years from about 24.5% in 2010 to about 43% 2015 in which 55% of the share supplied by renewable energy resources (Hivos, 2015). Despite the progress on electrification ratio, there are still about 238 out of 433 villages which do not have electricity access (PLN, 2017). It is because some of these villages are located in remote areas which have limited access to infrastructures, such as roads and grid access. Currently, the rural households in Sumba Island use fossil fuel to provide their electricity needs. However, the use of fossil fuel is considered polluting, noisy, and expensive. Thus, renewable energy based power generation needs to be introduced. While wind and hydropower could be very attractive for grid-connected options, off-grid solar Photovoltaic (PV) Systems stand out as the best solution for off-grid electrification because of Sumba's dispersed population and limited infrastructure. Several off-grid PV projects have been carried out by the government as well as private institutions. However, the adoption of off-grid PV technologies for Sumba's rural areas remains very slow.

From the literature, it is known that the role of business model to overcome challenges of the adoption of off-grid PV electrification in rural areas is considered important. However, there is still no literature which explains how a sustainable business model helps to overcome the barriers faced by PV projects in the rural energy market. Hence, the objective of this research is to understand how PV companies choose types of business models to address the challenges in the rural energy market. This insight will be used to develop advices on business models for PV companies who want to operate their business in the rural energy market in Sumba Island, Indonesia. The main research question of the research is: "***What is the most suitable business model for off-grid PV electrification in Sumba Island, Indonesia*?".** Thus, the expected output of this research is twofold: Firstly, a framework which explains the linkage between the barriers faced by PV companies and how business model could help the companies to overcome these barriers. Secondly, recommended business models for PV companies which operate in the rural energy market in Sumba Island.

This study is divided into four phases which are (1) the knowledge gap identification, (2) identification of barriers which influence the types of business models employed by the PVCs, (3) the framework construction and lastly, (4) framework validation phase. The first phase was done through a literature review. The second phase was done through literature review and case study. The case study was done through interviews with seven selected PV companies which meet the requirements set in this study. In the case study, a business canvas developed by Osterwalder & Pigneur (2010) is used as a data analysis tool to understand how elements of business model are generated based on the challenges that are faced by the PV Companies. Next, the third phase was done through cross cases analysis. Finally, field study and expert interviews were done to validate the framework

From this research, we found that only five out of ten barriers found in the existing literature influence the elements of business model employed by PV Companies. These barriers are (1) infrastructure, (2) financial, (3) market demand, (4) social, behavioral, and cultural, as well as (5) environmental aspects. Our analysis shows that the levels of these barriers influence the elements of business models employed by the PVCs, such as the key partnerships, key activities, key resources, customer relationships, channels, and revenue streams. Also, the types of business models employed by the PVCs are highly influenced by choice of the customer segmentation and its value proposition offered to the customers. On the other hand, the other four barriers which are faced by the PVCs do not play any roles in determining specific elements of business models employed by the PVCs. These barriers include (1) investments, (2) human resources, (3) governmental/institutional aspects, and (4) networks/partnerships, do not lead to specific elements of business model employed by the PVCs. Finally,

the technical barriers which faced by the PVCs should be addressed with specific elements of business model which are tailored based on the needs. Each of the technical barriers will lead to specific elements of business model.

Based on the framework and several data obtained from the field visit in Sumba Island, there are two recommended business models which could be employed by the PV Companies in Sumba Island. This choice of business model is influenced by the customer's segmentation which the PVCs want to cater. The first business model is the combination of the distributor and products-focused model. This model offers various products from a solar lantern with its mini solar panel, or rechargeable PV lamps up to bigger systems such as SHSs, followed by reliable after sales service at an affordable price by offering flexible payment scheme. The second business model is the combination of distributor and service provider model which offers the electricity services delivered by microgrid equipped with a smart meter to control the electricity usage. This model could also be used to serve the lower tier of BoP consumers by having the electricity service delivered through a much simpler microgrid technology. The use of simple technology enables a limited amount of electricity delivered to the customers in exchange for small fixed subscription fee which could be collected weekly or monthly.

The result of this study could be very useful for the practitioners and academia. From the practitioners' point of view, the framework developed from this study could help to developed suitable business model for off-grid PV companies which specialized in the rural energy market in the developing countries. From the academia's point of view, this study provides a new innovative insight on the linkage between the levels of barriers faced by the PVCs in the rural energy market and the business models employed by these companies. However, it would be wise to add more PV companies in this study to obtain more variations on the types of business model. Also, it is better to extend the regions where the PV Companies operate its business to obtain a greater generalizability of the framework. Given that this research only looks into seven PV companies which operate its business in the countries which are located on the continents, or operate only in specific regions in one country, there is much of a chance that the framework developed in this research might not be suitable for BoP market in the island or archipelago nations, when the operational areas are located on different islands from the companies' head-quarter. Thus, it would be wise to extend the regions and countries where the PVCs operate its business to obtain a greater generalizability of the framework. More case studies should be done in PV companies which operate its business in Archipelago or Island Nations, such as Maldives, The Philippines, and Fiji.

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1 CHAPTER 1: Introduction

1.1 Background

1.1.1 Indonesian rural communities and energy access

Like many other developing countries, Indonesia is facing several challenges in providing the energy services to rural areas and poor communities, reducing oil dependency as well as the greenhouse gasses emissions (Blum et al., 2013). As an archipelago country, Indonesia's population is dispersed in the most populated island, which are Java and Bali, as well as other outer islands. Currently, Indonesia's electrification rate is only at 71% (Blum et al., 2013). Of the remaining 29%, approximately 80% of them live in rural areas outside Java and Bali (Blum et al., 2013). The majority of those people who live in unelectrified rural areas are considered poor. They have very limited access to affordable and reliable electricity services because they live in the remote regions which are difficult to access (Blum et al., 2013). Despite its limited access to the electricity services, the demand for electricity is growing rapidly in the rural areas (Blum et al., 2013). Thus; additional power generation capacities need to be installed and distributed in rural areas.

Today, the responsibility for the access of electricity is owned by the state-owned utility or Perusahaan Listrik Negara (PLN). PLN owns and controls Indonesia's distribution and transmission network, as well as most of the generation plants (Blum et al., 2013). Although private companies are allowed to generate electricity, they need to sell their electricity to PLN at an agreed price through a Power Purchasing Agreements (PPA) which are licensed by the Central Government (PWC, 2013). As the main actor of the distribution of electricity, PLN faces several challenges in order to provide electricity services in rural areas. Firstly, the grid extension to rural areas requires an enormous amount of capital investment due to geographically challenging nature of the archipelago country. Secondly, the majority of PLN's budget is needed to maintain current or replacing aging infrastructure, leaving the only small amount of it for the expansion plan (Blum et al., 2013). Despite the fact that some of the rural areas are already electrified by PLN, this power generation is highly relying on a diesel generator (Sianipar, 2015). The use of diesel generator is not only considered as polluting and noisy, but also expensive. It is because the transportation cost and the availability of the fuel play a significant role in the cost of electricity generation (Veldhuis, 2015). Thirdly, Indonesia's electricity price is set by the Government of Indonesia (GOI) through the uniform national tariffs policy. High power production cost leads to significant challenges for the power utility, in this case, is PLN, to recover the operating and maintenance (O&M) cost because of this policy (Knuckles, 2016; Blum et al., 2013). Subsidy from the government is required to recover the O&M cost as well as to maintain the profitability of the utility companies. The amount of subsidy on the price of electricity will give enormous impacts on the Indonesian economy. Thus, power generation based on Renewable Energy (RE) needs to be introduced in rural areas in Indonesia to reduce the subsidy burden allocated by the GOI.

Recognizing the importance to increase the energy access in rural areas as well as to replace fossil fuels with renewable energy sources, The GOI has set an ambitious goal to increase electrification rate close to 100% by 2020 (Indonesia, 2014). The GOI also aims to increase the share of renewable energy in power generation from 10.5% in 2016 (PWC, 2016) to 38% in 2030 (IRENA, 2017). Thus, the GOI starts to implement policies which support the renewable energy technologies (RETs) (Blum et al., 2013). Several projects have been conducted by the GOI in collaboration with other stakeholders, such as non-governmental organizations (NGOs) and foreign institutions such as Banks and foreign governments, to increase the use of RE resources as the source of power generation in rural areas. One of the projects is Sumba Iconic Island (SII). The SII project is the most ambitious project initiated by Hivos (a Dutch NGO), supported by the GOI, Norwegian embassy, and the Asian Development Bank (ADB). The goal of SII project is to demonstrate that it is feasible to fulfill the energy needs of poor people in the isolated island by a 100% RE supplied with the combination of grid connected and off-grid systems (Hivos, 2012, 2014, 2015). Currently, SII program aims to provide 95% RE-generated electrification access in Sumba Island by 2020. Despite an ambitious goal set by the GOI, many

improvements are still needed in the SII project in order to be able to deliver the goal. It is because Sumba's RE-generated electrification was only contributing 10% out of the total of 37.4% of Sumba's electrification ratio in 2014 (Hivos, 2015).

Currently, the cost of power production in Sumba's main grid, which is powered by diesel generators, is around EUR 0.20-0.25/kWh (Hivos, 2012). However, due to the uniform electricity tariff's policy, the electricity price is heavily subsidized, resulting in sales price about EUR 0.06/kWh (Hivos, 2012). At this price, hydropower and wind energy could be very competitive. The selling price of electricity generated from hydropower is EUR ~0.06/kWh, while from wind power is EUR ~0.12/kWh without any subsidy (Hivos, 2012). If only a small part of the subsidy could be used for RE power generation, the price of RE-based power generation would be lower. Another RE resource in Sumba Island is solar energy. Although Sumba has high solar irradiation throughout the year, the application of solar energy for grid connected power generation is less attractive because of the profitability concern. However, according to the previous study, off-grid solar Photovoltaic (PV) Systems increase its competitiveness with the remoteness of the village (Blum et al., 2013). Sumba Island is characterized with a small and dispersed population who live far away from the main grids resulting to low electrification level (International, 2010; Ritter, 2011). Thus, off-grid solar PV Systems stand out as the single best option for off-grid electrification in the areas where the grid does not exist (Ritter, 2011).

Beside a huge technical potential of solar energy in Sumba Island which could reach up to 10 MW (Hivos, 2014), total installed capacity of PV systems in Sumba Island from the period of 2011-2014 is only 1351 kWp. This installed capacity is divided into 911.9 kWp grid connected system and 439.1 kWp off-grid system (Hivos, 2014). The amount of installed capacity of PV systems is still far away from its technical potential. It is because the adoption of PV technology in rural areas faces several challenges related to financing, distribution, operation, service, and maintenance. Thus, the GOI needs to be able to overcome the challenges which are emerged in the rural areas in order to achieve the goal of SII project.

1.1.2 Challenges to the adoption of off-grid PV technology in Sumba Island, Indonesia

Solar Home Systems (SHS) have been used for off-grid rural electrification in Sumba Island and other rural areas in Indonesia. The majority of SHS projects carried by the GOI or NGOs are donor-driven projects where the GOI or NGOs give the SHS for free. Donor-driven projects have led to several implications. Firstly, free SHSs have resulted in the lack of ownership of the system. From 2011 to 2014, roughly 25% of SHSs have stopped working in SII project (Hivos, 2014). From 14.829 units (439.1 kW) that have been installed, only 11.201 units (337.1 kW) that can work. Secondly, donor-driven projects depend heavily on the financial support from the donors or investors (Hivos, 2014). Thus, the project could be stopped whenever the funding is no longer available. This condition makes the sustainability of the donor-driven projects is highly questionable.

The implementation of off-grid PV technology in Sumba Island has to face not only several implications because of the donor-driven projects, but also several other challenges aligned with the challenges faced by other developing countries. Firstly, the rural communities in Sumba Island are characterized by low educational level. A low degree of education creates a vicious cycle with the degree of poverty. It means that low educational attainment could lead to low income. Sumba is one of the poorest regions in Indonesia. The average per capita income is less than EUR 200/year (International, 2010). It means that majority of people in Sumba live less than $2 per day per person. It makes the majority of people in Sumba is on the Bottom of the Pyramid (BOP) (Bharti, Sharma, Agrawal, & Sengar, 2014; Hart & Prahalad, 2008).

People with low income tend to have low purchasing power which means they buy anything cheap to provide their primary needs. In the case of electricity, the low-income people will only focus on the cheapest way to get electricity to support their living without paying attention to the sustainability. It could be a challenge for PV development since the first installation of off-grid PV system requires a significant amount of investment while people with low income tend to have limited access to formal financial institutions. Furthermore, low educational level makes the rural communities have limited knowledge on PV technology.

This condition makes the rural customers will be highly dependent on the PV technicians for the SHS services and maintenance or the after-sales service from the PV companies (Craine, 2013).

Secondly, rural areas in Sumba Island are characterized by a lack of infrastructure. Sufficient infrastructures, such as roads and transportation networks need to be provided to ensure the diffusion of off-grid PV technology in rural areas. One of the issues which hinder the development of infrastructures, especially in remote locations, is the land acquisition. A land acquisition is a problem due to a lack of coordination between the central and local government. This condition could lead to the delay of the infrastructures' constructions which will hinder the development of PV based electricity generation in remote areas. Moreover, based on the previous study, adequate infrastructures are required to facilitate the after-sales service from the PV companies to the villages (Palit, 2013).

While all the barriers that hinder the implementation of off-grid PV electrification in Sumba Island are available in the literature, there is no literature on how to overcome those barriers and to sustain the off-grid PV electrification projects in the long term.

1.1.3 Overview on the Bottom of the Pyramid concept

The term the "bottom of the pyramid" (BoP) was first introduced in 1932 by the U.S, President Franklin D. Roosevelt through radio (Bharti et al., 2014). 70 years later, C.K. Prahalad and Stuart L. Hart defined the BOP as the largest but the poorest socioeconomic groups in the global income pyramid living less than $2 a day (Prahalad & Hart, 2002). However, there are other definitions of BoP proposed in the literature. Bharti et al. (2014) summarized the several BoP definitions in their work. The difference on BoP definitions is caused by the discrepancies on the size of the population living in the lowest tier of the pyramid (Bharti et al. 2014). The size of BOP population varies based on the criteria of income level chosen by the author ($1, $2, $8 per day) (Bharti et al. 2014).

The majority of people at the BoP live in developing and least developed countries. Collier (2007) stated that there are at least four billion people in developing countries and one billion people in the least developed countries living at the BOP (cited by (Pansera & Owen, 2015)). The people who live at the BOP have several characteristics such as low income with limited purchasing power and financial access (Bharti et al., 2014; Ramani, SadreGhazi, & Duysters, 2012; Schuster & Holtbrügge, 2012), lack of knowledge, information and skills, (Ramani et al., 2012), lack of education (Prahalad & Hart, 2002), inadequate institutional framework (Schuster & Holtbrügge, 2012), insufficient infrastructure with respect to transportation, media, and communication (Prahalad and Hart, 2002; Mason & Chakrabarti, 2016; Ramani et al., 2012; Schuster & Holtbrügge, 2012), low or lack of affordability (Prahalad, 2005), lack of availability (Vachani & Smith, 2008, cited in Ramani et al., 2012)). These characteristics of the BoP are close to the poverty. It is difficult for BoP population to find the way out of the poverty due to limited or lack of employment opportunities, technological deficits, and political instability (Hammond, Kramer, Katz, Tran, & Walker, 2007; UNDP, 2008, all cited in Schuster and Holtbrugge, 2012). Because of those reasons, a lot of private sectors demotivate or even avoid to enter the BoP markets (Bharti et al., 2014). On the other hand, one could see the BoP markets as the unmet social needs as well as untapped business potential (London & Hart, 2004; Prahalad & Hart, 2002).

Prahalad (2004) suggests that the multinational organizations could help to develop the BoP with the support from the government and the NGOs through inclusive capitalism (as cited in Bharti et al., 2014). Furthermore, he adds that the BoP customers are value conscious consumers. Thus, they should be provided with value-creating products and services that are beneficial in nature (Bharti et al., 2013). A study performed by Dey et al. (2016) supports the argument from Prahalad (2004) that the cost is not only the driving forces behind the BoP's market but also the value of the products or services offered by the enterprises (Dey et al., 2016).

Based on the characteristics of the BoP market, it is important for the private sectors to find the best way of doing business in the BoP market or low-income market with limited resources and infrastructure. For instance, due to insufficient physical infrastructure and financial access, traditional distribution channels and

payment systems could not be used in the BoP market. Moreover, Weidner et al. (2010) suggest that geographical spread and social relations influence the success of business activities at the BoP (as cited in Mason & Chakrabarti, 2016). Thus, the companies which aim to enter the BoP markets might need to find new innovative solutions in order to be able to run their businesses in a sustainable way (Schuster & Holtbrügge, 2012).

1.1.2 Role of Business model for off-grid PV projects

A business model plays a major role in the introduction and adoption of new technology. Chesbrough (2010) explains that the economic value of a new technology depends on the business model used to commercialize it. The same technology commercialized with different business models will result in different returns. In the case of off-grid PV electrification, it is believed that a business model has played an important role in the adoption of off-grid PV technology, especially to overcome the challenges that are faced in the early adoption phase of PV technology.

Richter (2013) argues that one important driver of the transformation of power industry towards RE-based power generation, which in this case is distributed solar PV (DSPV), is innovative business models. Business model innovation is required for the utilities or power companies to adapt the way they do the business towards the changing environment, such as policies, electricity generation, and demand in the future. If the power companies fail to adapt their business models towards the changing environments, their market share in electricity generation will continue to drop.

Balachandra et al. (2010) add, in the last three decades, the commercialization of Sustainable Energy Technologies (SETs), which include PV technologies, is government-sponsored or donor driven. The experiences of the government or donor-driven are not encouraging. Thus, the involvement of private sectors is needed in the commercialization effort of SET (Balachandra et al., 2010). The study found that a business model approach, where the involvement of private sectors is the key of SETs's commercialization. Participation from other stakeholders such as governments, international agencies, NGOs, and other communities as supporters, enablers, facilitators or guarantor is also required.

Huijben and Verbong (2013) examine the reason behind the rapid growth of PV technology in the Netherlands. They found that the main reason behind the PV technology breakthrough in the Netherlands is the development of new business models that are financially supported by both local and national government, such as tax deduction after investment.

Karakaya et al., (2016) investigate the business model of a local PV company in a city of 43,000 inhabitants, in Southern Germany. This study found that such business model innovation is essential to overcome the challenges of the changing environment in the future, such as declining feed-in tariff for PV installations, decreasing adoption rates as well as diminishing turnover per PV system installation due to saturated PV market in Germany. Overcoming such challenges will not only let the company survive but also help the diffusion of PV technology in the region.

In the case of developing countries, the majority of research on PV business model has been focused on the off-grid electrification and the BOP or low-income market (Tongsopit, Moungchareon, Aksornkij, & Potisat, 2016). The PV business model for off-grid electrification and the BoP market is a lot different from those employed in developed countries such as the Netherlands and Germany. Gabriel and Kirkwood (2016) explain that different areas might have different business model due to the various challenges they are faced, such as varying levels of government interest in RET, supporting policies, and the ease of doing business.

In addition, Tawney et al. (2014) explain the characteristics of rural customers are different with urban customers. The rural customers experience more challenges to energy access. This study found that business model innovation could help the adoption and diffusion of off-grid PV technology in rural areas. They believe that such business models might address several challenges associated with the rural areas such as limited financial access, lack of supply chains or infrastructure, as well as the lack of after-sale support.

Balachandra (2011) adds that a business model should be equipped with innovative institutional, regulatory, financing and delivery mechanisms to overcome the challenges faced during the implementation

of PV technology. Furthermore, Zhang (2016) adds that business model innovation is required to overcome the challenge in the high up-front capital of the installation of PV technology, especially in rural areas. The role of the business model in PV projects will be further explained in the next section.

Based on the previous research, the role of business model to overcome challenges of off-grid PV electrification in rural areas is considered important. However, there is still no literature which explains how a sustainable business model helps to overcome the barriers faced by PV projects in the rural energy market.

1.2 Problem Definition

1.2.1 Knowledge gaps

Based on the literature review on the previous studies and the current situation in Sumba Island, two knowledge gaps are identified. Firstly, although several barriers to PV technology for rural electrification in Sumba Island have been identified, there is no general framework from the previous studies which could be used to overcome all the challenges or barriers to the adoption of PV technologies in Sumba Island. Secondly, while previous studies revealed that innovative business models could support the adoption and dissemination of off-grid PV technology in BoP market as well as for the rural electrification (Gabriel & Kirkwood, 2016; Karakaya et al., 2016; Knuckles, 2016; Tongsopit et al., 2016; Zhang, 2016), it is still unclear how such companies develop or design types of business model to address the certain challenges in rural areas.

1.2.2 Problem statement

The problem raised from the knowledge gap is as follows:

There is no sufficient knowledge on how a business model for off-grid PV electrification is designed to address several barriers in the rural energy market in developing countries, especially in the case of Sumba Island, Indonesia

1.2.3 Research questions

The main research question following from the problem statement is:

"What is the most suitable business model for off-grid PV electrification in Sumba Island, Indonesia?"

To be able to answer this question the following sub-questions are formulated:

1. What are the different types of business models which implemented by the PV companies (PVCs) specialized in rural energy market?
2. What are the barriers faced by the PVCs which hinder the implementation of off-grid PV electrification in rural areas in other developing countries? Moreover, What types of business models employed by the PVCs to address the challenges they are faced?
3. How can characteristics of business models for off-grid PV electrification be derived from the barriers that are faced by PVCs in the rural energy market?
4. What is the potential off-grid PV electrification in Sumba? What are the barriers that impede the implementation of off-grid PV electrification in Sumba?
5. How could the existing business models help to address the barriers that impede the implementation of off-grid PV electrification in Sumba?

1.2.4 Research objectives

Based on the problem statement, the following research objective is formulated:

To understand how PV enterprises choose types of business models to address the challenges in the rural energy market. This insight will be used to develop advices on business models for PV companies who want to operate their business in the rural energy market in Sumba Island, Indonesia.

1.2.5 Scope of the study

In this section, the scope of the study will be defined. The scope is as follows:

- **Region:** The most appropriate regions for this study are rural areas which are part of the developing countries. It is because the majority of those areas have limited resources, especially financial and infrastructural resources. This study will look at some developing countries in Asia, such as India, Bangladesh, Indonesia, as well as some developing countries in Africa. The focus of this study will be Sumba Island in Indonesia as the GOI has set an ambitious goal for Sumba Island as an iconic island with 100% renewable energy despite the fact that it is one of the poorest regions in Indonesia which has very limited access to electricity.

- **Types of the market:** In this study, we will focus on the rural energy market and the BoP market where the financial access and grid infrastructure are limited as well as people earn less than $2 per day.

- **Cases:** This study will be concentrated in the renewable energy or PV companies which are registered as a profit organization and focus on the rural energy market in the developing countries

- **Products:** We essentially concentrate at off-grid or distributed PV technology such as solar lanterns, solar home systems, and mini/micro grid systems.

1.2.6 Relevancies of the study

The scientific relevance of this research lies in the understanding the role of business models to address barriers which are faced during the adoption of off-grid PV electrification in rural areas in developing countries. The outcome of this study will be a general framework that can be used to develop business models based on the different challenges that are faced in the rural areas in developing countries. The societal relevance of this research is to make recommendations on innovative business models for PV companies which operate in the rural energy market in Sumba Island and other parts of Indonesia.

1.3 Research approach

This study will be mainly qualitative and exploratory in nature since there is quite a gap in the literature. This study can be divided into four phases which are the knowledge gap identification, identification of barriers which influence the types of business models employed by the PVCs, the framework construction and lastly, framework validation phase. The overview of the research design is shown in Figure 1.1.

Phase 1: Knowledge gap identification phase

The goal of this phase is to narrow down the knowledge gaps which are found in the literature. This phase is dealt more in detail in Chapter 1. In this phase, we carry out a literature review on rural communities and energy access, specifically Indonesia, challenges to the adoption of off-grid PV technologies in Sumba Island, the concept of the bottom of the pyramid, and the role of business model for off-grid PV projects. In this phase, the problems definition as well as the research approach are also defined.

Phase 2: Identification of barriers and business models

In this phase, we will look deeper into the barriers or drivers in the rural energy market that influence the choice of specific types of business models employed by the PVCs in order to run their business. In this phase, we will perform a literature review and case study on the barriers to PV adoption for rural electrification, and the concept of business model and its role in off-grid PV electrification in the rural energy market. Furthermore, interviews will be performed with PV companies which operate in the rural energy market in developing countries to understand the real barriers they face during the adoption of PV technologies and how to deal with those problems. The result of this study will yield us sets of real barriers that the PVCs are facing in the rural energy market as well as sets of business models and business strategy that are used by the PVCs to overcome those barriers.

Phase 3: Initial framework construction

In this phase, the cross cases analysis will be conducted. We will use the sets of real barriers as well as business models used by the PVCs to overcome those barriers in rural areas to draw an initial general framework which explains the linkage between the barriers and the business model employed by the PVCs.

Phase 4: Framework validation

This phase aims to validate the initial framework and develop an initial business model for Sumba Island through expert interviews and cross analysis with the existing condition in Sumba Island. Thus, the outcome of this phase will be the final business model which is suitable for off-grid PV electrification in Sumba Island.

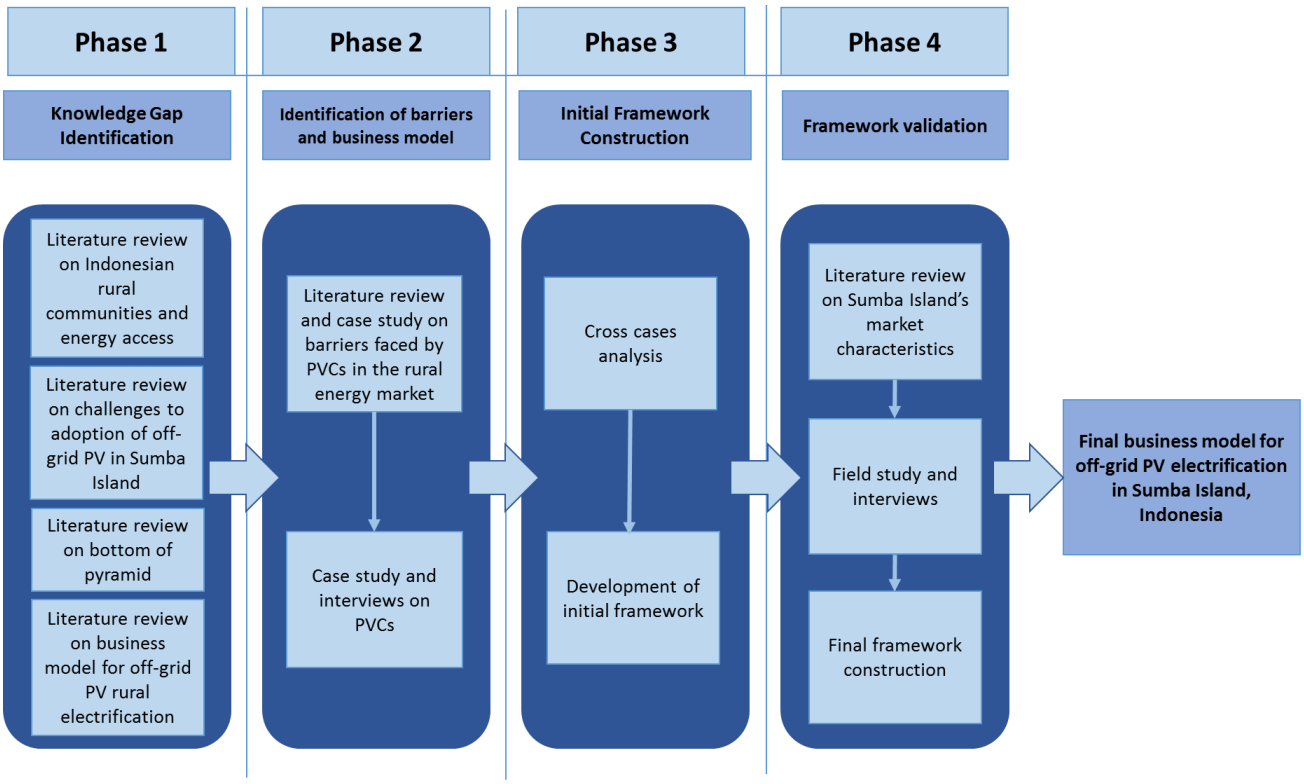

Figure 1.1. Overview of the research designs

1.4 Data collections

The data for this research will be collected through literature reviews as well as interviews which will be conducted during the cases and field studies. Cross cases study analysis will be done to develop the initial framework which explains the linkage between the barriers and the business model used by PV companies to address those barriers. In addition, expert interviews will be done to validate this initial framework. Finally,

the final framework could be used to develop suitable business models for PV companies which focus on the off-grid PV electrification in Sumba Island. The data collection methods of this study are summarized in Table 1.1.

Table 1.1. Research methods to answer research sub-questions

Research sub-questions	Methods	Report chapter
1. What are the different types of business models which implemented by the PV companies (PVCs) specialized in rural energy market?	Literature review	Chapter 2
2. What are the barriers faced by the PVCs which hinder the implementation of off-grid PV electrification in rural areas in other developing countries? Moreover, what types of business models employed by the PVCs to address the challenges they are faced?	Literature review, Case study analysis, Interview	Chapter 2 and Chapter 3
3. How can characteristics of business models for off-grid PV electrification be derived from the barriers or drivers that are faced by PVCs in the rural energy market?	Cross case study analysis	Chapter 4
4. What is the potential off-grid PV electrification in Sumba? What are the barriers that impede the implementation of off-grid PV electrification in Sumba?	Literature review, field study	Chapter 5
5. How do the existing business models could help to address the barriers that impede the implementation of off-grid PV electrification in Sumba?	Field study, Interview, Cross case analysis	Chapter 6

1.4.1 Literature review

A literature review will be performed in this research to gain knowledge and information that are important to this research. The literature review is conducted to answer the first, second, and fourth sub-questions. The literature review will consist of scientific articles from the previous works, books, websites, newspaper, and any other materials that are related to the research. The scientific articles and books are obtained from ScienceDirect, Scopus, Google Scholar, and TU Delft Library using specific keywords as shown in Table 1.2.

Table 1.2. Methods on literature review

No.	Literature review	Source	Keywords
1.	Barriers to PV adoption for rural electrification in developing countries	https://www.sciencedirect.com https://www.scopus.com https://www.tudelft.nl/en/library https://www.google.nl/	Barriers, off-grid, PV, rural, developing countries
			Challenges, barriers, PV, rural electrification.
2.	Business model	https://www.sciencedirect.com https://www.tudelft.nl/en/library https://www.google.nl/	Business model, definition, terminology, revenue model, comparison
3.	Business model for PV electrification in developing countries	https://www.sciencedirect.com https://www.tudelft.nl/en/library https://www.google.nl/	Business models, innovation, off-grid, PV, rural, and developing countries
			Business models, off-grid, PV, rural electrification, poor, and community

Next, the articles are selected based on the abstract which contains specific chosen keywords. Then, these selected articles are further analyzed by looking at the content. An additional search will be performed by looking at the references that the selected literature used. These specific articles cited in the chosen literature are searched in the databases of Science Direct and TU Delft Library.

The drawback of this method is that not all the literature needed for this research could be found in the database. Moreover, there is only a limited number of scientific literature related to PV in Sumba. Although some websites and reports are available, the data on those resources could be outdated or biased. One way to overcome the lack of available literature and outdated data on Sumba is by interviewing corresponding people from HIVOS who made the report and ran the projects.

1.4.2 Case study and cross cases analysis

Case study analysis is important for this study to gather information regarding barriers to PV the implementation of off-grid PV electrification in the rural energy market which are obtained from the literature earlier. Moreover, the case study is used to understand how the business model employed by the PVCs to overcome those barriers in the field. The cross cases analysis will be used to develop initial framework which explain the linkage between the barriers and the business model employed by PVCs.

1.4.2.1 Case selections

This section essentially explains the selection process of the industry, market, country, technology, and company. The industry we look at is the PV industries. Specifically, we look at electricity sector because one of the biggest problems living in rural areas in the developing countries is limited access to the grid. As this study focuses on the problems related to people who live in rural areas in developing countries, we selected PV companies which operate in the rural energy market and developing countries. Developing countries, which were selected for this study, are based on the classification made by the UN (Nations, 2014) as the developing economies as well as the World Bank (Bank, 2017) as low-middle income nations. The PV companies selected for this research are maintained to have diverse business model. One type of business models could be presented by minimum two PV companies. The companies that are selected for this study have to fulfill the requirements below:

1. PV companies should be a social enterprise and have to be a for-profit company
2. PV companies should offer PV technology as the primary products. Some companies offer solar thermal products which are different technologies from PV
3. PV companies must offer PV technology for electrification
4. Focus on PV companies which sell off-grid or distributed PV technologies, such as solar lanterns, solar home systems, and communal mini/micro grid systems
5. PV companies which focus to serve rural communities or households who live at the BOP

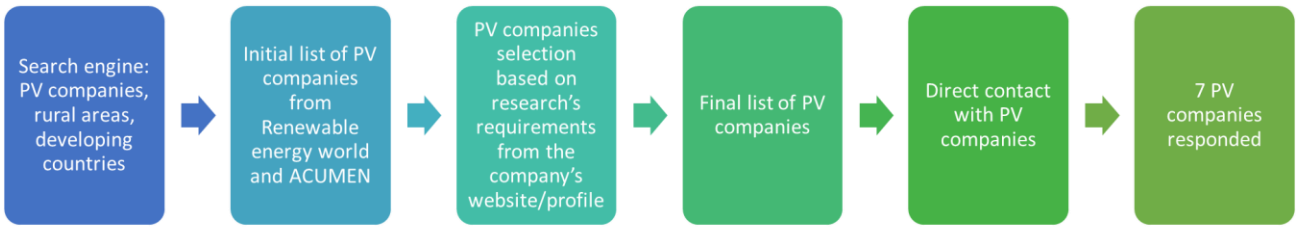

Figure 1.2 Case selection process

The selection of the companies was quite tough since there is no directory of PVCs who operate in the rural energy market. The search was conducted in Google with keywords: PV Company, rural areas, developing country. The list of companies and organizations which bring solar power to the developing world

was found in the website named Renewable Energy World and ACUMEN. We combined the lists from these two websites and looked into the company's profile in detail to make the final selection of the PVCs based on the requirements that we have made. The initial and final lists of PVCs is available in the Appendices.

After the final selection was made, we contacted the PVCs on the final list. Unfortunately, not all PVCs give positive feedback towards our study. Thus, our case study was performed to the PVCs from the final list which responded our invitation. Figure 1.2 shows the process of case selection used in this research and Table 1.3 shows the list of the seven PVCs which will be used in our case study.

Table 1.3. List of PV companies for case study analysis

No	Name of Company	Technology	Type of activities	Headquarter based	Operation based
1	SunnyMoney	Solar Home Systems and Solar Lantern	Sales, distribution, service	United Kingdom	Malawi
2	SunTransfer	Solar Home Systems and Solar Lantern	Sales, distribution, service	Ethiopia	Ethiopia
3	SunSawang	Solar Home Systems	Sales, distribution, service	Thailand	Thailand
4	Devergy	Micro grid	Service provider (utility company)	Netherland	Tanzania
5	Meragao Power	Micro grid	Service provider (utility company)	India	India
6	Mobisol	Solar Home Systems	Designs & production, sales, distribution, services	Germany	Kenya, Rwanda, Uganda, Tanzania
7	SELCO	Solar Home Systems	Designs & production, sales, distribution, services	India	India

1.4.2.2 Cross cases analysis

During the case study, several relevant barriers that are faced by the PVCs in the rural market will be obtained. Furthermore, various types of business models employed by the PVCs to address those challenges will be attained. In the cross-cases study analysis, the different challenges that are faced by the PVCs, as well as the types of business models to address those challenges, will be compared to develop the initial framework. This initial framework will explain the linkage between the barriers that are faced by PVCs in the rural energy market and characteristics of business models for off-grid PV electrification.

The second cross case analysis will be done to validate the initial framework. The cross case analysis will be done by comparing the initial framework which has been constructed with the existing condition in Sumba Island. The output of this part will be the final framework which could be used to develop suitable business models for PVCs in Sumba Island.

1.4.3 Field study

The field study was conducted in East Sumba where several projects from Hivos and the governments were already established. Two villages were chosen based on the recommendation of Hivos officials as well as the characteristics which were taken from the case study in Chapter 3. Below are the criteria of the chosen village:

1. Isolated from the main grid with the minimum distance of 10 km
2. Isolated from the nearest town with the minimum distance of 20 km or one hour ride
3. There are existing SHS(s) or a community solar power plant installed in the village
4. Most of the villagers live at the BOP level

Finally, two villages were selected based on those criteria and taking the recommendations from HIVOS team into considerations, which are Kadahang and Kataka village.

1.4.4 Interview

In this research, several interviews will be done during the case and field study to obtain necessary information from PV companies and other key stakeholders. Expert interviews will also be done to further validate the initial framework developed through cross cases analysis. Most of the interviews will be done through phone interviewes using English or Bahasa Indonesia as the main language. The interviews that will be used in this research is semi-structured and phone interviews based on the book from Willson (2013).

1.4.4.1 Case study interviews

The objective of the case study interview is to gather information about the barriers faced by the PV companies as well as the business model employed by the companies to overcome those barriers. The interviews will be carried out with the owner or a corresponding person of PVCs which are specialized in rural developing countries. The outcome of this interview would be a set of business strategies used by the PVCs to develop business models which aim to address several barriers faced in the rural energy market. This outcome will be used to answer the second sub question Based on this objective, the questionnaire was prepared. The questionnaire consists of two parts which divided into barriers and business model questions. The interview process was divided into two sections, namely: introduction and questionnaire. The interview lasts for one hour using English as the main language. Please refer to the Appendices for the detail of the questionnaire.

Introduction: The interview process started off with a short introduction of both the interviewer and the interviewee, a brief description of the project, as well as the goal and the expected outcome of the interview. Then, it is followed by a brief explanation of the interview procedure.

Questionnaire: After the introduction, the interviewee was asked the questions from the questionnaire. The interview procedure was divided into two sections: Open questions which involve the detail of business model employed by the PVCs and closed questions where the interviewee was asked to rate the relevant barriers which are faced by the PVCs on the scale of 1-5. The point is used to describe the barriers derived from the literature review to the PVCs to run the business. The higher the point means, the more significant the barriers for the PVCs to run the business.

Business model: In this section, the questions related to the company's business model were asked. Before asking the questions, a clarification regarding the definition of the business model and revenue model was made to avoid the further confusion. Questions related to the value proposition, customer segments, channels, customer relationship, key resources, key activities, key partners, and the financial aspects of the company were asked. The responses to this section are used to look into the company's business model in more structured and detail.

Barriers: In this section, the questions related to barriers to the implementation of PV technology for rural electrification faced by the PVCs were asked. A few relevant barriers were obtained from the literature review. Then, these barriers were explained to the interviewee based on the description gained from the literature. These barriers were scaled from one to five to describe the barriers' significances to the business. The higher the number means, the more significant the barriers to the business. After which, the interviewee was asked to rate how significant the barriers towards their business. For each of the barriers, the interviewee was asked how they overcome these barriers and how they incorporate this strategy into their business model. Following this process, the interview was again asked to think of any other barriers which influence the implementation of PV technology in rural areas and how they overcome those barriers using the company's business model.

This marks the end of the interview process.

1.4.4.2 *Field study interview*

The field study interview will be conducted with the village leader, the villagers and several key stakeholders of SII program, such as from HIVOS organization, PLN, the GOI officials. There are three different purposes of the interview. Firstly, it is to understand the profile of the off-grid PV market in Sumba Island as well as their point of view on the existing off-grid PV's programs. Secondly, the interview is conducted to understand the barriers of each of the key stakeholders face during the implementation of off-grid PV program in Sumba Island. Thirdly, it is to understand how these key stakeholders overcome these barriers in order to have successful off-grid PV projects on Sumba Island. Based on different proposes of the inte rviews, different questionnaires are made for the village leaders and the villagers which are both PV and non-PV users. The detail of the questionnaires could be seen in the Appendices. These interviews would help to develop, validate and improve the initial framework developed in Chapter 4, as well as to answer the fifth sub-question.

The interview was conducted through informal meetings using Bahasa Indonesia as the main language with the duration of the interview varies from twenty to sixty minutes. The interview correspondents are summarized in Table 1.4.

Table 1.4. List of interview correspondents

No.	Institution	Name	Position
1	Kadahang Village	• Kepala desa • Mr. Ahmad • Mr. Rudi • Mrs. Yohana • Mr. Baraeunjande	• Village leader • Villager • Villager • Villager • Villager
2	Kataka Village	• Kepala desa • Kepala sekolah • Mrs. Rambuhada • Mrs Yuli • Mrs. Yunita • Mr. Hunga	• Village leader • Headmaster of Kataka elementary school • Villager • Villager • Villager
3	Hivos	• Mrs. Sandra Winarsa • Mrs. Laily Himayati (Maya) • Mr. Dedy Haning • Mr. Rudi Nadapdap • Mr. Munawir S. • Mrs. Endah • Mr. Firman	• Project Manager • Stakeholder engagement officers • Project coordinator • Field project manager • Field project implementor • Training officer • Monitoring and evaluation officer
4	PLN	• Mr. Suharto	Installation assistant manager
5	Local government	• Mr. Daniel Lalupanda	Former head of the district's mining and energy department

1.4.4.3 *Expert interviews*

The expert interviews will be done to validate the framework developed from cross cases analysis. The interviews will be conducted with the experts who are experience in PV Companies which focus on the rural energy market in developing countries. Also, the objective of the expert interviews is to test the framework made in this research in practical environment. Based on this objective, a questionnaire is made. The detail of the expert interviews' questionnaire could be seen in the Appendices.

1.5 Research tool

In order to understand the barriers that might be faced by PVCs which operate in the rural energy market or at the BOP market, we need to understand the existing barriers which might be hinder the

implementation of PV projects in rural areas in developing countries. Thus, a literature review will be performed later in Chapter 2 to gain a deep understanding of the barriers to PV technology for rural electrification in developing countries. The set of existing barriers in the literature is summarized in Table 2.9. This set of barriers then will be used as a questionnaire during the interview with the PVCs.

The business model canvas from Osterwalder & Pigneur (2010) will be used as a data analysis tool to understand how a business model could be generated based on the challenges that are faced by the PVCs. This canvas-like framework from (Osterwalder & Pigneur, 2010) is chosen because of a couple of reasons. Firstly, it is because the framework has all the elements required for the entrepreneurs to create, deliver, and capture value or in short, to run the business. Secondly, for the purpose of this study, the business model canvas framework allows us to gather pieces of different business functions from the best practices to form a suitable business model for Sumba Island. Thirdly, not only that the business model canvas is simple and easy to construct (Leschk, 2013), but also it has been tested in practice and has been successfully applied in the field of renewable energies (Richter, 2013). The business model canvas consists of nine building blocks that show the companies' strategy in making money. These nine blocks cover four main pillars of business which are Infrastructure, product, customer, and financial viability, as indicated in Figure 1.3.

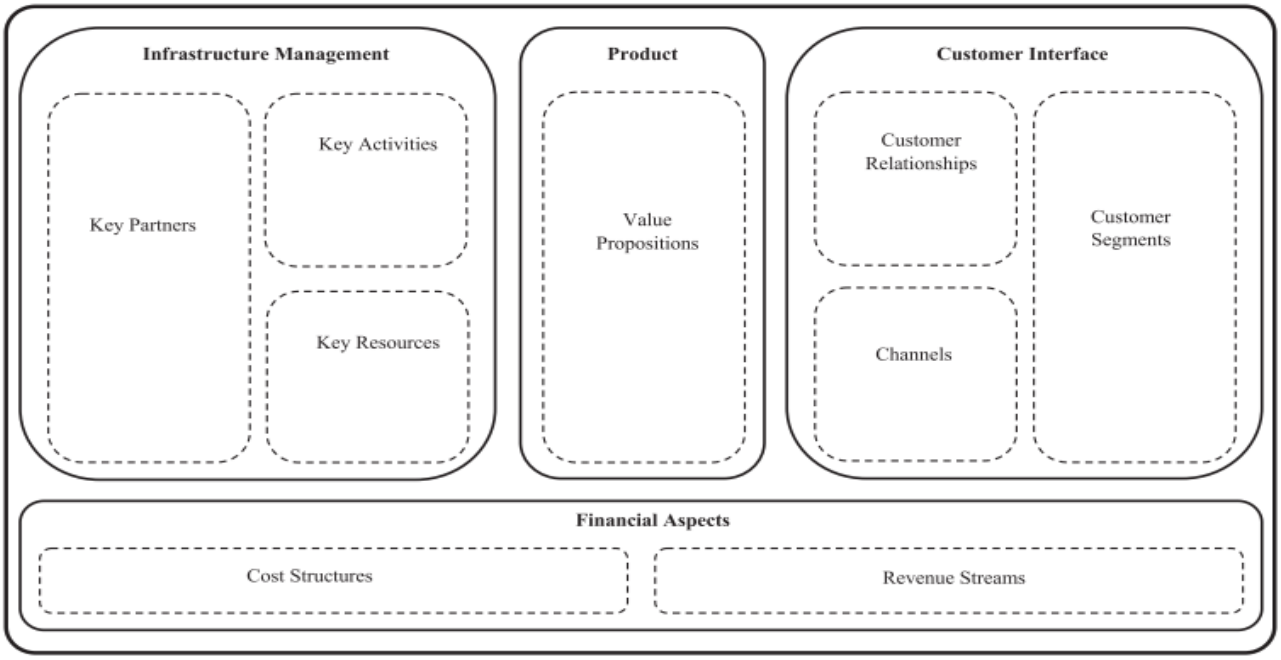

Figure 1.3. Business model canvas (Osterwalder & Pigneur, 2010)

1.6 Organization of the Thesis

This study is organized into seven chapters. In chapter 1, we present mainly the background of this study which includes the research questions. Then, the literature review will be performed in Chapter 2 to understand the barriers to the implementation of PV technology for rural electrification, the theory of business model, and tyeps of business employed by PVCs in the rural energy market in developing countries . In Chapter 3, several cases study will be performed and will be followed by cross cases analysis in Chapter 4. From Chapter 4, the initial framework to develop the initial business model for Sumba Island will be introduced. Chapter 5 will describe the current condition of off-grid PV market in Sumba Island, Indonesia. In Chapter 6, the initial framework will be validated and the proposed business model for off-grid PV in Sumba Island will be developed. Finally, the conclusion, discussion, recommendations, as well as the reflection will be presented in Chapter 7. The overview of the organization of the thesis shown in Figure 1.4.

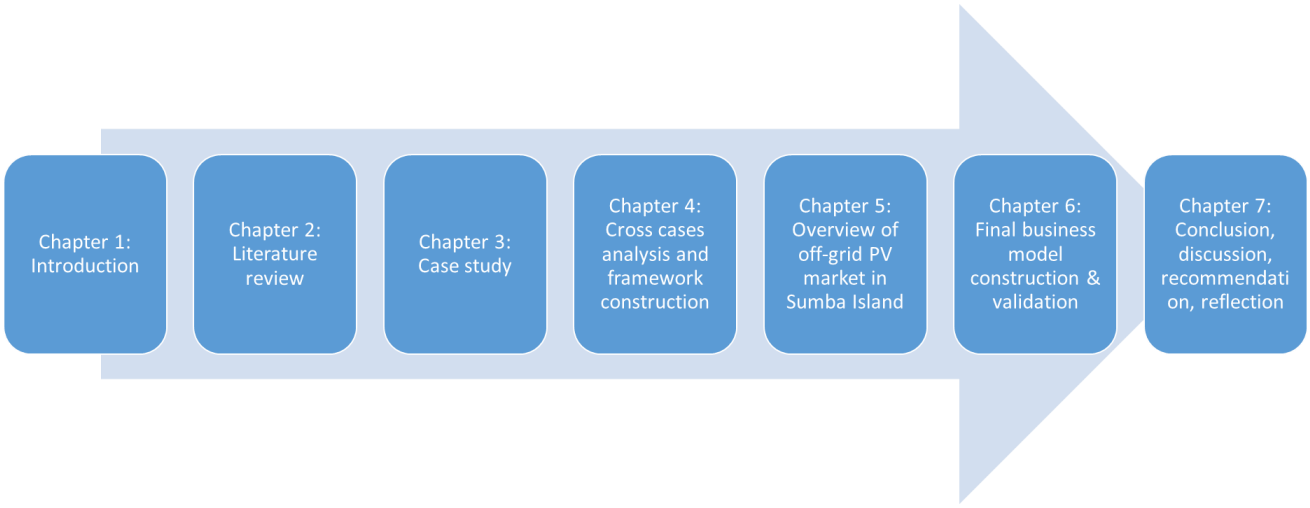

Figure 1.4. Overview of thesis organization

2 CHAPTER 2: Literature Review

2.1 Literature review on barriers to PV adoption for rural electrification in developing countries

2.1.1 Previous research on barriers to adoption of RETs or PV in developing countries

In this part, a literature review was performed in order to understand the barriers which influence PV adoption for rural electrification, especially in developing countries. In order to have a deep understanding on this particular issue, it is important to have a complete picture of the barriers to the adoption of PV systems for rural electrification from the previous research. The complete picture could be derived by looking at the barriers to the adoption of other RETs for rural electrification (Wade, 2003; Zerriffi, 2011), barriers to the adoption of PV systems in a broad context (Karakaya & Sriwannawit, 2015), general barriers to PV adoption for rural electrification (Chaurey & Kandpal, 2010), barriers to the adoption of PV systems in the specific regions or countries (Ansari, Kharb, Luthra, Shimmi, & Chatterji, 2013; Jeslin Drusila Nesamalar, Venkatesh, & Charles Raja, 2017; Ohunakin, Adaramola, Oyewola, & Fagbenle, 2014; Wamukonya, 2007), and barriers to the adoption of PV systems in rural areas in a specific country (Pascale, Urmee, Whale, & Kumar, 2016; Sharif & Mithila, 2013; Sindhu, Nehra, & Luthra, 2016).

Wade (2003) describes several factors which hinder the adoption of RETs for rural electrification. The author argues that the failure of RET to meet the expectations of rural users lies on the inadequate understanding of the rural needs. Other factors which influence the failure of RET adoption in rural areas are the high price of the system as well as high cost of the implementation of the project. Moreover, lack of innovative finance scheme and lack of resources such as infrastructure and well-trained human resources have influenced the success of RET adoption in rural areas. The author adds that inadequate maintenance, as well as ineffective project management and system integration, could influence the sustainability of the project. From the market perspective, unfamiliar technology and widespread issues of customer dissatisfaction from the previous technology might affect the demand for the technology. Support from the government and collaboration within key stakeholders also play an important role in the success of RET adoption in rural areas. Ineffective policies and lack of collaboration between the key stakeholders such as government, banks, and other institution involved in the project could have a significant role in the failure of RET adoption in rural areas.

Zerriffi (2011) describes three major challenges might be faced during the expansion of energy access to the poor or BOP customers. Firstly, the rural BOP customers are located in remote areas with low population densities. It means that the delivery and the maintenance cost required could be higher than those customers who live in the cities. Secondly, low or limited hours of power consumption of the poor leads to several difficulties for the company to regain capital investment. Lastly, the rural BOP poor has very limited financial access. It makes them very difficult to invest in new services or technologies. All of those challenges happen in many developing countries such as India (Balachandra, Kristle Nathan, & Reddy, 2010; Urpelainen & Yoon, 2016), Nepal (Mainali & Dhital, 2015) and Sub-Saharan Africa countries (Baurzhan & Jenkins, 2016).

Karakaya & Sriwannawit (2015) has conducted an extensive and systemic literature review to examine the barriers to the adoption of PV systems. The research was performed using selected 33 publications which cover 28 countries from Africa, Asia, Europe, and America. The authors argue that the barriers to the adoption of PV systems could be classified into four dimensions which are socio-technical, management, economic, and policy. The authors explain that the adoption of PV systems both in urban or rural areas is still a challenging process. Without a proper collaboration of the key stakeholders, effective marketing, dedicated government support, there will be challenges to overcome the barriers to the adoption of PV systems. The barriers to the adoption of PV systems from this paper are summarized below:

Table 2.1. Barriers to the adoption of PV systems (summarized from Krakaya & Sriwannawit (2015))

Sociotechnical	Management	Economic	Policy
• Poor quality of the products • No standardization process • Growing skepticism of the users • Customer mistrust • Lack of adequate knowledge among adopters and non-adopters • Lack of trust in the information that is widely and publicly available among adopters • Lack of technology awareness among users and stakeholders • Competition with other technology • Lack of entrepreneurial culture • Inadequate installation spaces • Lack of methodology to identify local needs • Lack of technical human and financial resources • Institutional reliability which discourages private sector to enter the market • Lack of demand and lack of customer base • Low purchasing power	• Inappropriate business model or strategies or the target market • Weak and neglected after-sales service • Lack of access to information, knowledge, communication channels, infrastructure, technical assistance • Ineffective marketing approach and education campaigns • Lack of collaboration and knowledge exchange between researchers and policy makers with adopters	• High cost of PV systems • In rural areas, it is not financially viable for low-income people • Low purchasing power • Low-income level hence low affordability • Lack of international donor funding • Lack of suitable financing mechanisms • High repair cost • Long payback period • Uncertainties in the funding process • Inadequate government subsidy • Mismatch between consumers demand and certification program • Mismatch between electrification cost and level that people can afford	• Insufficient and ineffective policy • Bureaucratic boundaries • Insufficient subsidies or lack of incentives to support adoption • Lack of cooperation and participation of stakeholders in energy development • Lack of innovation strategy

Chaurey & Kandpal (2010) has performed an assessment and evaluation of PV based decentralized rural electrification. The authors conducted a literature review to understand the challenges related to marketing, dissemination and the use of PV systems for the decentralized rural application. From this paper, several challenges which influence the success and the failure of PV based decentralized rural electrification are summarized below:

Table 2.2. Challenges which influence the success and the failure of PV based decentralized rural electrification (Summarized from Chaurey & Kandpal (2010)

• High cost of selling (marketing, delivery, and maintenance) • Lack of investment and financing • High transaction cost • Poor financial support • Lack of support to entrepreneur	• Unavailability of access to rural credit • Unavailability of skilled technicians for promotions and installation of the system • Inappropriate design • The use of unreliable components	• Poor maintenance • Lack of market infrastructure • Lack of PV awareness • Lack of government policies that support the project expansion • Lack of stakeholder participation • Improper installation

Several research on the barriers to the adoption of PV systems also have been done in the smaller scope from the level of a specific continents, countries, up to the specific regions. Wamukonya (2007) examines several key barriers of PV penetrations and the barrier removal options in Africa. The author argued that there are four main barriers of PV penetrations which are financial aspects, technical aspects, limited markets, and the quality of technology. This study reveals although SHSs might have financially and technologically improved at the global level, those improvements still insufficient to influence the SHSs

diffusion rate at the African level. A collaboration with the key stakeholders is needed to overcome all the challenges in the PV adoption in Africa.

Table 2.3. Four main barriers of PV penetrations (summarized from Wamukonya (2007))

Financial	Technical	Limited market	Quality of technology
High upfront capital cost	• Lack of trained technicians • Lack of knowledge of the users	• Lack of supporting policies • Lack of awareness of the technology	• No standards • No government regulation

Ansari et al. (2013) have developed a structural model of the barriers to the implementation of solar power in India. The authors identified thirteen relevant barriers which influence the implementation of solar power installation in India from literature and discussion with experts from industries and academia. Not only that this paper provides insights for a better understanding of the barriers to the implementation of solar power in India, but it also suggests several ways of removal of those barriers. This insight would be useful for the organizations or government bodies to manage the resources in the most optimum way in order to have the maximum number of solar power projects installed in India. The barriers to implementing solar power installation in India as reported in this paper are summarized below:

Table 2.4. Barriers to the implementation of solar power in India (Ansari et al., 2013)

• High initial capital cost • High payback period • Less efficiency • Need for backup or storage • Unavailability of solar radiation data • Lack of consumer awareness of the technology	• Lack of trained people and training institutes • Lack of financing mechanism • Lack of sufficient market base • Lack of local infrastructure • Lack of political commitment • Lack of adequate government policies • Lack of R&D work

Nesamalar et al. (2017) provide a comprehensive review of the achievement of Tamilnadu, the southernmost state of India, in extracting renewable energy, which includes wind, biomass, small hydro, and solar energy. The authors analyze various challenges faced on the exploitation of the renewable energy as well as the prospects of renewable energy in Tamilnadu. From this paper, the authors explain that there are several barriers in promoting solar energy in Tamilnadu state. Those barriers are summarized below:

Table 2.5 Challenges face on the exploitation of renewable energy, in the case of Solar energy, in Tamilnadu (Nesamalar et al., 2107)

• Ignorant customers towards the durability of PV systems and the overall efficiency of installing solar power plants • Lack of stability of incentives. The incentive could be discontinued without prior notice • Poor customer service and lack of marketing campaigns • Lack of cooperation and collaboration between the PV industries and the users • High investment cost of the system • No dedicated governmental support

Ohunakin et al. (2014) investigate the status of solar energy development, which includes the drivers and barriers of the use of PV technology in Nigeria. This is an interesting paper since Nigeria is famous for its production of crude oil and natural gas, yet at the same time, the country possesses an abundant amount of renewable energy resources, especially solar energy. Despite a huge availability of solar radiation throughout the country, market opportunities created by the inhabitants who have limited access to electricity, and the drivers or motivation of the country to shift towards renewable energy, Nigeria faces various barriers to the development of solar energy. The authors identified nine barriers which are variability and intermittency of radiation, grid reliability in the case of grid-connected applications, lack of awareness and information, high initial investment cost, high operation and maintenance cost, lack of supporting policies as well as subsidies for conventional fuel, ineffective quality control of the products, insecurity of solar power plant infrastructure

which influence the future investments, and the competition of land uses, especially with the agricultural sector.

Finally, various barriers to the adoption of PV systems in rural areas in a specific country were also investigated by academia. Sharif & Mithila (2013), Pascale et al. (2016) and Sindhu et al. (2016) examine the barriers to the adoption of PV systems in rural Bangladesh, rural Myanmar, and rural India. Sharif & Mithila (2013) investigate the prospects, constraints and the solutions of PV market growth in rural Bangladesh through literature review, case studies and success stories of the implementation of PV systems in the rural energy market. This paper explains that the challenges of the implementation of PV in rural Bangladesh are a lack of resources and capacity, lack of tailored financing package, high initial cost of solar equipment, and lack of business model.

Pascale et al. (2016) summarize their findings on barriers to the adoption of PV systems in rural Myanmar from the literature review. Those barriers are summarized below:

Table 2.6. Barriers to the adoption of PV systems in rural Myanmar (Pascale et al., 2016)

• High upfront cost • Lack of financing access • Knowledge gap • Lack of human resources capacity • Poor technical and management skills • Poor quality of the systems and poor track records	• Lack of standards and quality enforcement • End user training gap • Lack of diffusion of solar PV market • Lack of awareness of resources and technology • Poverty	• Bureaucratic complexity • Lack of supporting policies on technology transfer and development of RE in rural electrification • Lack of institutional transparency • Lack of coordination • Lack of networking

Sindhu et al. (2016) have conducted an exploratory study to investigate the barriers which hinder the implementation of solar energy in Indian rural sector. The authors identified five barriers which influence the success of solar energy's implementation in Indian rural energy market. Those barriers are classified into investment barriers, technical barriers, financial barriers, social and environmental barriers, marketing and policy barriers. The barriers examined by Sindhu et al. (2016) are summarized below:

Table 2.7. Barriers which influence the success of solar energy's implementation in Indian rural energy market (summarized from Sindhu et al. (2016))

Investment	Technical	Financial	Social and Environmental	Marketing and Policy
• High initial capital cost • Long payback period	• Efficiency • Reliability • Requirement of storage device • Unavailability of proper solar radiation data • Lack of R&D focus	• Lack of local facilities and infrastructure issues • Lack of proper financing facilities because of high risk	• Environmental implication: the use of storage device • Reluctance of people to new technology • Safety concern during the production or gathering of crystalline silica	• Market uncertainties • Institutional issues • Policy and regulatory barriers

Based on the studied literature, the barriers to the adoption of PV systems or other RETs were already discussed by scholars, both in general and specific rural areas in the developing countries. However, those barriers could overlap each other. Thus, those barriers need to be categorized in order to understand the barriers to the adoption of PV systems for rural electrification in developing country. Based on the literature, this research categorized those barriers into ten different sections which are an (1) investment; (2) financial; (3) human resource; (4) infrastructure; (5) technical; (6) market demand; (7) social, behavioral, and cultural; (8) governmental/institutional; (9) network/partnership; and (10) environmental. The descriptions of those ten barriers are summarized in Table 2.8, and the categorization of the barriers is summarized in Table 2.9.

Table 2.8. Barriers categorization

Classification of Barriers	Description of Barriers
Infrastructure	The unavailability of infrastructure or access that are required for the distribution and the usage of the services or technologies. Such as lack of access to information, knowledge, communication, channels, infrastructure, and technical assistance
Investment	Issues related to company's access to funding (loan or grants). This includes issues related to the uncertainties of the funding process, the requirement of high investment cost and long payback period.
Financial	Issues related to the absence or limited financial access for the end users. This includes issues inappropriate business models or strategies for the targeted market, lack of access to rural credit and financial support for the poor
Human resource	The unavailability of skilled and trained people or training institutes which could cause ineffective quality control as well as poor technical and management skills
Technical	Issues related to the technology and services. This could occur due to lack of standardization of the technology, lack of R&D focus, unavailability of proper solar radiation data, ineffective project management as well as the system integration which resulting in poor customer services and poor quality of the products
Market demand	The issues related to the potential customers for the products/services. This could occur due to the situation where there is a lack of consumer awareness and information of the technology, ineffective marketing approach, and education campaigns, as well as a widespread issue on customer dissatisfaction or customer mistrust leading to unwillingness to buy the products/services or when the price of the product/service offered is considered too high
Social, Behavioral, Cultural	Different norms and culture in regards to the use of the product. For instance different consumption pattern of the poor, growing skepticism of the technology's users, reluctance and ignorance of people to the new technology. All of these issues could occur due to poverty and low-income level as well as a lack of trust to the 'outsiders'.
Governmental/Institutional	Laws, policies, and regulations that hamper the diffusion of the product. Lack of supporting policies or incentives, subsidies on the conventional fuel, bureaucratic complexity, lack of institutional transparency, lack of innovation strategy, no political commitment on rural electrification, lack of support for the entrepreneurial and R&D activities
Network/Partnerships	The absence of actors which are directly involved to supply or distribute necessary product/service as well as lack of collaboration and cooperation within key stakeholders such as government, industries, users, financial institutions (banks), and academia
Environmental	The issues related to the production process as well as the afterlife cycle of the technology, especially those technologies which contain harmful or toxic material such as storage device

Table 2.9. Barriers categorization from the literature

Researchers	Wade (2007)	Wamukonya (2007)	Chaurey & Kandpal (2010)	Zerriffi (2011)	Ansari et al. (2013)	Sharif (2013)	Ohunakin et al. (2014)	Karakaya & Sriwannawit (2015)	Pascale et al. (2016)	Sindhu et al. (2016)	Nesamalar et al. (2017)
Scope	**Rural electrification**	**SHS in Africa**	**Decentralized PV for rural electrification**	**Energy access for the poor**	**PV in India**	**PV in Rural Bangladesh**	**PV in Nigeria**	**Barriers to PV adoption**	**PV in Rural Myanmar**	**PV in rural India**	**PV in Tamilnadu, India**
Infrastructure	lack of local infrastructure				lack of local infrastructure			lack of access to information, knowledge, communication channels, infrastructure, technical assistance		lack of local facilities and infrastructural issues	
Investment	• the high price of the system • the high cost of project implement ation	High upfront cost	• the high cost of selling (marketing delivery and maintenance) • lack of investments and financing • high transaction costs • subsidies to conventional fuel	High cost of logistics and maintenance due to rural areas with low population densities	• the high cost of the system • the high payback period	high initial cost of solar equipment	• High initial investment cost • High O&M cost	• the high cost of PV systems • lack of international donor funding • high repair cost • the long payback period • uncertainties in the funding process	High upfront cost	• high initial cost • the long payback period	high investment cost
Financial	lack of innovative finance scheme		• poor financial support • access to rural credit	• lack of tailored financing package • lack of a business model	lack of financing mechanism	people in rural areas are financially poor		• inappropriate business model or strategies or the target market • the technology is not financially viable for low-income people • lack of suitable financing mechanisms	lack of financing access	lack of proper financing facilities because of high risk	
Human Resource	lack of trained local technicians	lack of trained technicians	unavailability of skilled technicians for promotions and installation of the system		lack of trained people or training institutes		ineffective quality control due to lack of trained personnel	lack of human and financial resources	• knowledge gap • lack of human resource capacity • poor technical and management skills		
Technical	• inadequate maintenance of capital intensive equipment • ineffective project management • ineffective system integration	Lack of standardizati on of the technology	• Inappropriate design • use of unreliable components • improper installation • poor maintenance		• less efficiency • the need for backup storage • unavailability of solar radiation data		• variability and intermittency of radiation • grid unreliability • insecurity of solar plant infrastructure • competition with land uses	• poor quality of the products • no standardization process • competition with other technology • inadequate installation spaces • weak and neglected after-sales service	• poor quality system and poor track record • lack of standards and quality enforcement	• technology efficiency • reliability • the requirement of the storage device • unavailability of proper solar radiation data • lack of R&D focus	poor customer service

cont. Barriers categorization from the literature

Researchers	Wade (2007)	Wamukonya (2007)	Chaurey & Kandpal (2010)	Zerriffi (2011)	Ansari et al. (2013)	Sharrif (2013)	Ohunakin et al. (2014)	Karakaya & Sriwannawit (2015)	Pascale et al. (2016)	Sindhu et al. (2016)	Nesamalar et al. (2017)
Scope	**Rural electrification**	**SHS in Africa**	**Decentralized PV for rural electrification**	**Energy access for the poor**	**PV in India**	**PV in Rural Bangladesh**	**PV in Nigeria**	**Barriers to PV adoption**	**PV in Rural Myanmar**	**PV in rural India**	**PV in Tamilnadu, India**
Market demand	• inadequate understanding of rural needs • widespread customer dissatisfaction • unfamiliar technology	• lack of knowledge of the users • lack of awareness of the technology	• lack of market infrastructure • lack of awareness about PV	lack of capacity	• lack of consumer awareness of technology • lack of sufficient market base		lack of awareness and information	• lack of technology awareness among users and stakeholders • lack of adequate knowledge among adopters and non-adopters • ineffective marketing approach and education campaigns • customer mistrust • lack of methodology to identify local needs	• end user training gap • lack of diffusion of solar PV market • lack of awareness of resources & technology	market uncertainties	Lack of marketing campaigns
Social, Behavioral, Cultural						the consumption pattern of the poor		• Low-income level hence low affordability and low purchasing power • lack of trust in the information that is widely and publicly available among adopters • growing skepticism of the users	poverty	the reluctance of people to new technology	Customer are ignorant of the durability and the overall efficiency of installing of PV
Governmental / Institutional	• inefficiencies of local government • ineffective subsidy	lack of supporting policies	• lack of government policies that support the project expansion • lack of support to entrepreneurs		• lack of political commitment • lack of adequate government policies • lack of support for R&D culture		• lack of supportive governmen t policies and incentives • subsidies in convention al fuel	• inadequate government subsidy • insufficient and ineffective policy • bureaucratic boundaries • insufficient subsidies or lack of incentives to support adoption • lack of an innovation strategy • lack of entrepreneurial culture	• bureaucratic complexity • lack of supporting policies in technology transfer and development of RE in rural electrification • lack of institutional transparency	• institutional issues • policy and regulatory barriers	• Lack of stability incentives from the government • No dedicated government -al support
Network / Partnership	• lack of stakeholders participation to tailor the technology base don user needs • lack of cooperation between stakeholders (government, banks, and other institutions involve in the project)	• lack of collaboration within the key stakeholders	lack of stakeholder participation					• lack of cooperation and participation of stakeholders in energy development • lack of collaboration and knowledge exchange between researchers and policy makers with adopters	• lack of coordination • lack of networking		Lack of collaboration between the owners and solar panel industries
Environmental										• after the life cycle • safety in production process	

2.2 Literature review on business model

2.2.1 Clarification on the ambiguity exist on business model terminology

Over time, the term "business model" has been misused by both scholars and practitioners. It has suffered into unclear ideas such as the overlapping meaning with other management terms, for instance, the term "business strategy", "business concept", "revenue model", and "economic model". A study conducted by DaSilva and Trkman (2014) explained the ambiguity that exists on business model terminology.

DaSilva and Trkman (2014) argue that the term "business model" is different with "business strategy." They believe that business model differs from business strategy in two ways. Firstly, the authors argue that the strategy influences the development of capabilities to respond any contingencies in the future through the changes of a business model. Secondly, the authors explain that a business model describes what a company today while business strategy reflects what a company aims to become in the future. The differences between the business model and business strategy are summarized by the authors in a framework which can be seen in Figure 2.1.

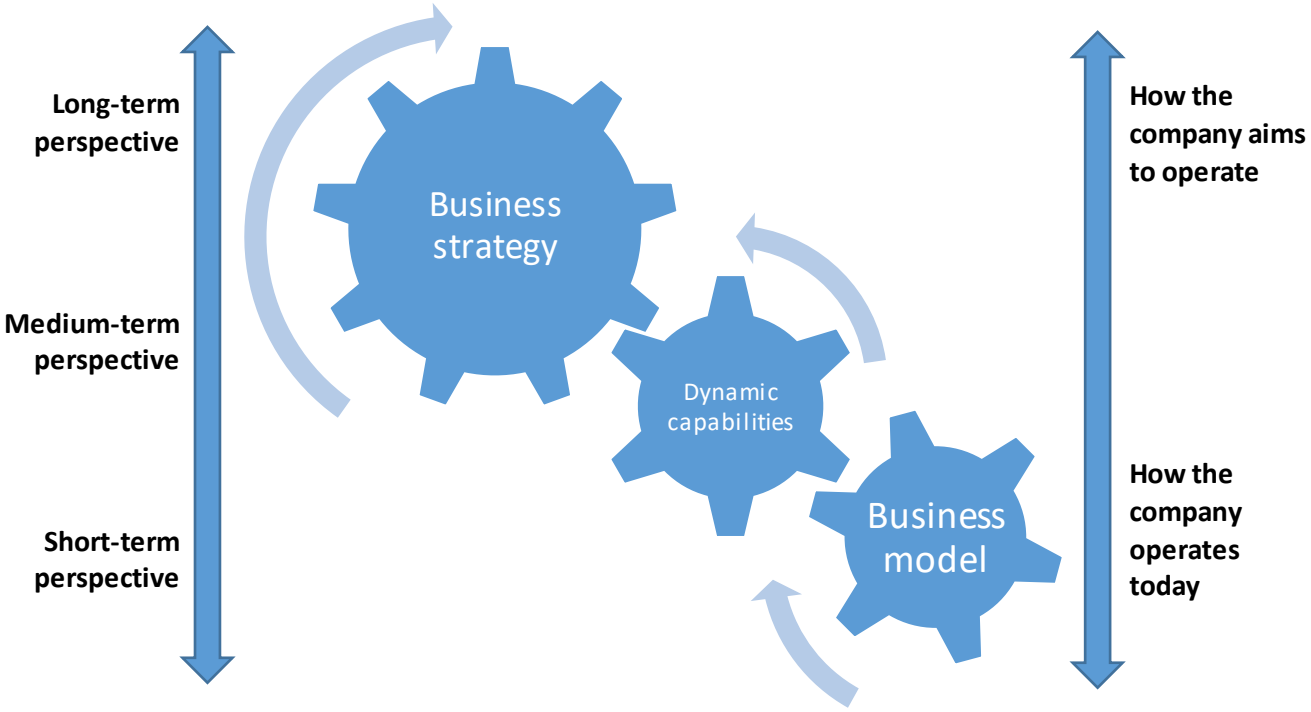

Figure 2.1. A framework of business model vs. business strategy (DaSilva & Trkman, 2014)

The term "business model" and "business concept" have several similarities. In fact, previous studies have used both terms as synonyms without having any clarification on their terminology. For instance, Voelpel et al., (2005) described a business model as "the way of doing business" or a "business concept" as cited in (DaSilva & Trkman, 2014). However, a study performed by DaSilva and Trkman (2014) argue that the business concept terminology differs from the business model. According to the authors, the business concept is "the conceptualization of business reality, which is the business itself along with business model with the company's strategy."

The term "business model" and "revenue model" have led to confusion (George & Bock, 2011) and have frequently been used interchangeably in the literature. Thus, it is important to clarify the difference between the revenue model and business model. Zott and Amit (2010) explain that a business model describes how the revenue is generated while a revenue model describes the sources of the revenue, the volume, and distribution. A revenue model is seen as one of the essential elements in a business model, defined as the value captured by a company (Zott and Amitt, 2006 cited in DaSilva and Trkman, 2014).

Another term which has been misused with the term "business model" is the "economic model". Historically, the term "economic model" was used by the economics to describe what is nowadays referred as a "business model" (DaSilva & Trkman, 2014). However, the term "business model has replaced some of the economic models in the recent literature. Currently, the term "business model" has a different definition from the "economic model". While business model describes the logic of the company on how it operates within the industries or economy, the economic model provides a mathematical and economic rationale to a company, industry, or an economy as a whole (DaSilva & Trkman, 2014). For instance, in the case of Ryanair (the low-cost airline), this company uses economic model to set the flight prices through an analysis of the elasticity of flight demand and the business model of this firm can be referred as a combination of sources and the way they manage the transactions in order to generate value for both customers (low prices) and the company (low variable costs) (DaSilva & Trkman, 2014).

As the term "business model" has been clarified from the ambiguity with other management terms, such as "business strategy", "business concept", "revenue model", and "economic model". In this study, it is important to have a deep understanding of the definition and elements of a business model which exist in the literature. Thus, the definition and elements of business model will be discussed further in the next section.

2.2.2 The definition and elements of business model

The term "business model" was first introduced in the academic article in 1957 (Bellman et al., 1957, cited by DaSilva & Trkman (2014)). However, the term of business model was hardly used in the academic article until the mid-1990s when the concept of e-business became so common with the emergence of internet (Knuckles, 2016; Osterwalder, Pigneur, & Tucci, 2005; Saebi & Foss, 2015; Zott, Amit, & Massa, 2011). Since then, different concepts of the business model have been developed by the scholars as well as the business practitioners (Saebi & Foss, 2015; Tongsopit et al., 2016; Zott et al., 2011). At a general level, scholars referred business model as a statement (Stewart & Zhao, 2000), a representation (Morris, Schindehutte, & Allen, 2005; Shafer, Smith, & Linder, 2005), a description (Applegate, 2000; Weill & Vitale, 2001), an architecture (Dubosson-Torbay, Osterwalder, & Pigneur, 2002; Timmers, 1998), a structural template (Amit & Zott, 2001), a conceptual model or tool (George & Bock, 2009; Osterwalder, 2004; Osterwalder, Pigneur, & Tucci, 2005), a framework (Afuah, 2004), a method (Afuah & Tucci, 2001), a set (Seelos & Mair, 2007)., a pattern (Brousseau & Penard, 2006) all cited in Zott et al., (2011). An extensive literature review on business model conducted by Saebi & Foss, (2015) and Zott et al., (2011) have summarized various definitions of business model from the existing literature. This different definition on business model leads to different elements of the business model proposed by the scholars as summarized in Table 2.10.

The business model could be simply defined as the way the company making money (Bienstock, Gillenson, and Sanders, 2002, p. 174) cited by Saebi & Foss, 2015)). Teece (2010) describes business model as *"in defining manner where the enterprise delivers value to the customers, entices customers to pay for value, and converts those payments to profit*." Baden-Fuller & Morgan (2010) also argues that one role of business models is to provide a set of general guideline on how a company manages itself to create and deliver value in a profitable way. A good business model should have beneficial cost and risk structures, value propositions that are attractive to customers, and allow the business that generates products and services to have significant value capture or profit (Teece, 2010). The business model could also be understood as a coherent framework that mediates between economic value creation and technology development (Chesbrough and Rosenbloom, 2002, cited by Saebi & Foss, 2015).

Despite different definitions and elements of the business model proposed in the academic literature, most of the publications seem to converge on the basic definition of the business model. It is the way the companies creating and capturing value by defining their target market, attractive value propositions, the key resources to deliver the value to the customers, and the mechanism of value capture to be able to generate profits (Saebi & Foss, 2015). Several common characteristics of business models are also summarize by Zott et al. (2011) which are (1) business model is a logic of how value is not only captured by the local firms but also created for all stakeholders, (2) business model is a set of activities which are done by partners, suppliers, or

even customers, (3) business model is a holistic view of how a company 'do business', (4) business model is emerging as a new level and unit of analysis. For the purpose of this study, the definition of business model and elements proposed by Osterwalder and Pigneur (2009) is chosen. It is due to the fact the definition and elements of the business model proposed by Osterwalder and Pigneur (2009) represent the convergence of general characteristics of the business model proposed by most of the publications. Osterwalder and Pigneur (2009) defined a business model as "the rationale of how an organization creates, delivers, and captures value" (Osterwalder and Pigneur, 2009, cited by Richter, 2013).

Table 2.10. Elements of business models

Authors (year)	**Business model elements**
(Amit & Zott, 2001)	• Content of transaction • Structure of transaction • Governance of transaction • Value creation design
(Chesbrough & Rosenbloom, 2002)	• Value proposition • Market segment • Structure of value chain • Cost structure and profit potential • Position within value network • Competitive strategy
(Magretta, 2002)	• Customer definition • Value to customer • Revenue logic • Economic logic
(Shafer, Smith, & Linder, 2005)	• Strategic choices • Value network • Capture value • Create value
(Tikkanen, Lamberg, Parvinen, & Kallunki, 2005)	• Material aspects: strategy and structure, network, operations, finance and accounting • Belief system: reputational rankings, industry recipe, boundary beliefs, products
(Voelpel et al., 2005)	• Customer value propositions • Value network configuration • Sustainable returns for stakeholders
(Chesbrough, 2007)	• Value proposition • Target market • Value chain • Revenue mechanism • Value network or ecosystem • Competitive strategy
(Osterwalder & Pigneur, 2010)	• Value proposition • Customer segments • Channels • Customer relationship • Key activities • Key resources • Key partners • Revenue streams • Cost structure
(Zott & Amit, 2010)	• Structure of transactions • Content of transactions • Governance of transactions

(Santos, Spector, & van der Heyden, 2009)	• A set of elemental activities • A set of organizational units performing the activities • A set of linkages between the activities • A set of governance mechanisms for controlling the • organizational units and the linkages between the units
(Baden-fuller & Haefliger, 2013)	• Customer identification • Customer engagement • Value chain linkages • Monetization

Source: Adapted from Saebi & Foss (2015), Baden-fuller & Haefliger (2013), and Osterwalder & Pigneur (2010)

2.2.3 Business model generation

The generation of a flexible and sustainable business model is important for any start-up companies. The generation process of a business model consists of two phase (Blank, 2006, as cited in (Trimi & Berbegal-Mirabent, 2012). The first phase is the designing step which has a trial-error dynamics. This step is an iterative process which aims to help to set the boundaries of the structure of the organization by testing several hypotheses regarding the products or services being offered by the firm. Once a robust business model is developed, the next phase is the application of the business model. It is the phase where the business model should prove its characters to be reproducible and scalable. It means that the business model should accommodate the small changes that drive a better performance of the firm. The following section will describe three different practices of business model generation using the trial-error testing.

2.2.3.1 Open business model

The concept of open business model was originated from the notion of Open Innovation introduced by Chesbrough (2003). The concept of Open Innovation explains that the best way to develop new and fresh ideas that might lead to innovation is by expanding the company's boundaries and opening the company to the market (Trimi & Berbegal-Mirabent, 2012). In relation to the business model, Open Innovation could be seen as a new way to capture new or additional ideas which might lead to a better business model and a better business' performance. Chesbrough (2007, 2010) explains that the use of Open Innovation in the business model requires open designs which mean the business model should be made in such a way that allow open licenses or sharing for new technology. This condition will allow the entrepreneurs to take advantages from the market to improve their business model.

2.2.3.2 Customer development model

The customer development model consists of four iterative processes which include customer discovery, customer validation, customer creation, learning, and company building which can be seen in Figure 2.2 (Trimi & Berbegal-Mirabent, 2012). This model is very useful for the entrepreneurs to face the challenges in discovering the markets, identifying their customers, and validating their assumptions from the very initial stages (Trimi & Berbegal-Mirabent, 2012). The customer model development is the complementary of the product development model. This approach enables the entrepreneurs simultaneously explore the product developments as well as the market.

From Figure 2.2, it can be seen that the process of customer development model is divided into two steps which are the search and the execution steps. The searching period is an iterative process which aims to develop the right value propositions which can be converted into sales later. This process has a loop back to the customer discovery just in case the firm fails to validate the real targeted market or fail to provide the right products/services for the targeted customers. The execution period is the period when the firm has a real proof of the viability of their business. They know their market and their customers in such way that they are able to capitalize the market opportunities and generate profits from the market.

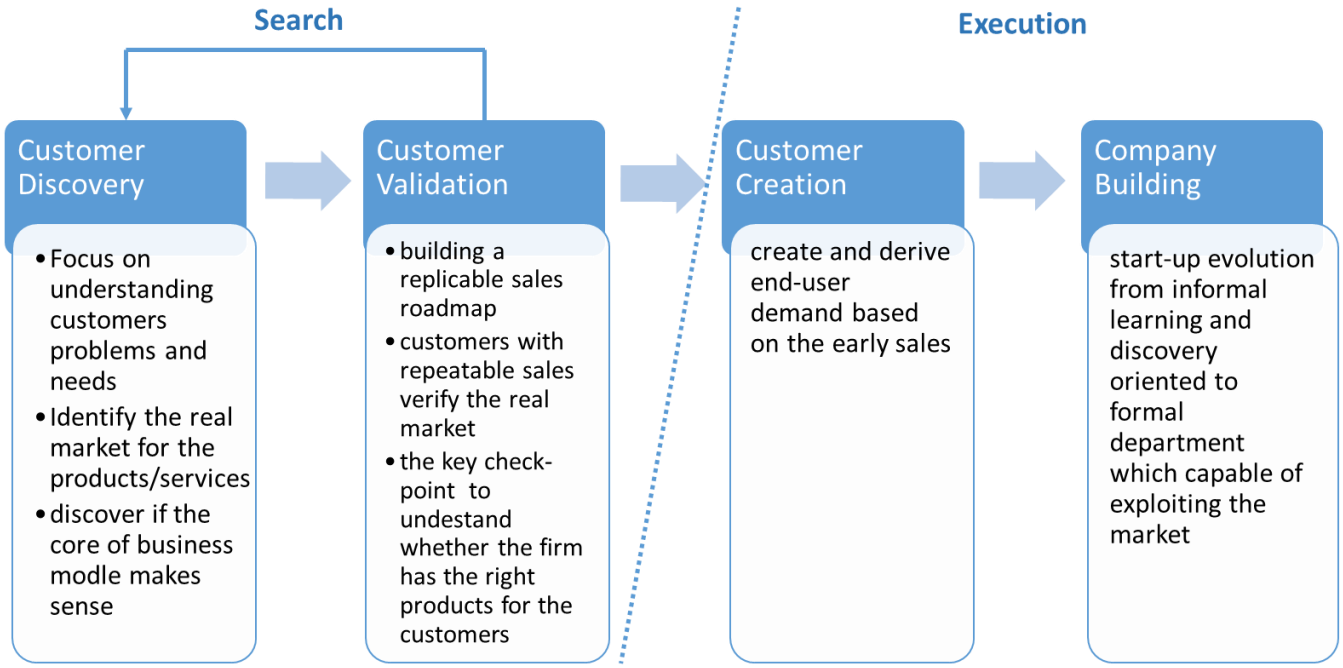

Figure 2.2. Customer development model (Trimi & Berbegal-Mirabent, 2012)

2.2.3.3 Business model canvas

The business model canvas was first proposed by Osterwalder & Pigneur (2010). It is a conceptual tool which visualizes how the enterprises function. The business model canvas consists of nine building blocks which can be grouped into four areas as summarized in Table 2.11. In this way, the business model canvas helps to visualize different issues and enable the users to map, discuss, design and invent a new business model (Ching & Fauvel, 2013).

Several studies of the business model canvas have been performed by previous scholars. Hulme (2011) as cited in (Trimi & Berbegal-Mirabent, 2012) believes that the business model canvas is an essential tool for the entrepreneurs. The canvas could be used as a useful instrument in four ways. Firstly, it helps the entrepreneurs to have a constant evaluation and reflection on their business model by using the canvas which the components are related to each other providing an overall view of the business model. Secondly, it facilitates the key stakeholders such as entrepreneurs, employees, executives, and customers, to have a creative discussion about risk and failure identification, new business opportunities, and the company's vision and mission alignment. Thirdly, the canvas helps the entrepreneurs to look at the business model as a whole not on each of the elements individually. This is an important feature because the entrepreneurs tend to focus on the specific part of the business model neglecting the other key elements. Lastly, the use of the graphical tool in business model canvas help to enhance creative and innovative thinking.

However, another research conducted by Joyce & Paquin (2015) explained that although the business model canvas proposed by Osterwalder and Pigneur (2010) might help the users to create and deliver value for the customers as well as to make profits for the company, it only emphasizes the "profit-only" of economic value orientation. It is considered to be neglecting the "sustainability-oriented value creation" which integrate the economic, environmental, and social value into a holistic view of the business model.

Despite the pros and cons on the business model canvas, this canvas-like framework from Osterwalder et al. (2010) is chosen as the business model generation method because of a couple of reasons. Firstly, it is because the framework has complete elements which enable the users to create, deliver and capture value. Secondly, for the purpose of this study, the business model canvas framework allows us to visualize different business models employed by the PVC. Thirdly, the plug-and-play model from the canvas model allows the users to mix-and-match various elements of business model from the best practices to form a suitable business model for Sumba Island, which is the goal of the study. Lastly, not only that the business

model canvas is simple and easy to construct (Leschk, 2013), but also it has been tested in practice and has been successfully applied in the field of renewable energies (Richter, 2013).

Table 2.11. Elements of business model canvass (Osterwalder & Pigneur, 2010)

Main areas	Pillars	Description
Customer interface	• Customer segments • Customer relationship • Channel	The overall interactions between the firm and the customers
Product	Value proposition	The products or services that create value for the customers and allows the company make revenue
Infrastructure management	• Key activities • Key partners • Key resources	Explains the company's function of logistics, productions, assets, partnerships to create value
Financial viability	• Revenue stream • Cost structure	It represents the financial sustainability of the company. It describes the cost to create value and the revenue generated by offering value to the customers

2.3 Literature review on business model for PV electrification in developing countries

2.3.1 Previous research on business models for PV electrification in developing countries

This chapter presents all the business model for PV in developing countries that currently exist in the literature. Due to a limited amount of literature, this article will be focused on the business models in developing countries in Asia such as India, Nepal, Bangladesh, Sri Lanka, and Thailand, as well as Africa such as Ghana.

Singh (2016) provided a comprehensive classification of PV business models that operate in India. This study distinguished various types of business models based on the market, distribution method, and payment systems. Singh (2016) classified the business models for off-grid PV electrification in rural India into eleven different models which are formal, informal, retail, direct marketing, sell-only, sell and service, full payment, rental, pay-as-you-go, community-managed, and entrepreneur-based. This study found that one of the drivers of PV technology diffusion is the need of products more than lighting, such as television. Nevertheless, the companies which focus on fewer products are more likely to achieve unit scaling. Thus, PV companies need to find the balance of providing the products based on the customers' needs and achieving unit scaling. However, the author failed to give an explanation on how the types of business models help to achieve the unit of scaling in the rural energy market.

Another study performed by Palit (2013) provided a comparative analysis based on the lessons and experiences of PV programs for rural electrification across South Asia, such as Nepal, India, Bangladesh, and Sri Lanka. This study found that the development of infrastructure and technical capacity is important to provide the after-sales service. The after-sales service is a critical element in the diffusion process of PV technology in rural areas since it is a key to gain trust from the villagers, especially those who have had experiences with bad-quality PV products. This study also added that the fee-for-service model could be the best business model for the poor. However, it fails to answer what are the key elements that influence the big success of fee-for-service and make it the most suitable model for the poor.

Tongsopit et al. (2016) presented not only the existing business models but also financing mechanisms for PV in Thailand. However, due to the scope of this study, we will only look at the current business model for PV electrification in Thailand. This study described four different business models which are roof rental,

solar-shared saving, solar leasing, and community solar. This study found that the success of PV business models is influenced by not only the current policies but also the government actions or supports. This study also examined the drivers, barriers, and the risks each of the existing PV business models in Thailand to provide a deep understanding of current PV business models as well as to provide policy recommendations for the government of Thailand.

A study in a Sub-Saharan country such as Ghana is presented by Steel et al. (2016). This study assessed market development as a sustainable approach to increasing the use of PV technology in Ghana, based on Ghana's Solar Projects. It also examines the weakness of donor-driven and fee-for-service business model to ensure its sustainability after the end of the project. This study showed that in order to sustain the use of PV technology in rural areas, the PV companies, and financial institutions need to develop a market-based strategy addressing the demand, supply, financing, quality, and facilitation problems. This study provided a good understanding of how business model could influence the success of a project. However, this study was very project and country-specific that could not be generalized for other developing countries.

2.3.2 Business models for off-grid PV electrification in rural areas in developing countries

In this section, the description of existing types of business models for off-grid PV electrification in the rural energy market is presented. The typology of business models for PV electrification in developing countries from the literature is summarized in Table 2.12. They can be divided based on the market where the PVCs operate the business, the channels used by the PVCs to sell the product, the value proposition offered by the PVCs, the payment system, and the ownership of the system.

Based on the description of the business models found in the literature, not all business models that currently exist in developing countries are suitable for the rural energy market. Some of them require grid connections and feed-in-tariffs policy to sell back the electricity to gain profit from feed-in-tariffs, while some others require access to financial institutions to provide high upfront capital. In this section, types of business models which might be suitable for rural energy market will be further discussed.

The first type of PV business models that might be used in rural areas is the informal business model. As presented in Table 2.12, the informal business enterprises operate within the informal market. The goal of this type of business is to provide clean energy with affordable price. Thus, it makes this type of companies operate on the margins. The informal PV business could be run by an individual in the village, which is similar to the entrepreneur based model. This model could work in the rural areas since a customized solar home systems or the other solar products could be made at decent prices. This condition is very different if we compare the informal business model with the formal one. The majority of trade players who operate in the formal market are registered and established companies. This type of business models works under the formal regimes where most of the clients are the institutions, governments, NGOs, or the other well-established industries/companies. This model is rather hard to operate in the rural energy market since most of the people who live in rural areas most likely could not afford the high upfront cost of the PV and still have a lack of access to the formal banking. Nevertheless, the company which operate in the formal market could still offer its products or services to the rural customers as long as they could provide suitable business model for the rural customers.

The next type of business models is distinguished based on the distribution method or the channels used by the PVCs to sell the product. These business models are retail and direct marketing approach. Both of these distribution methods might be suitable for rural energy market for a couple of reasons. First, both of these business models could work based on the individuals in the village. Second, both distribution methods could start on low or almost no investment while at the same time leading to more job creations and additional income to rural communities. The retail model lets local entrepreneurs own a franchise of a specific PV brand or own an independent store which sells many types of PV components. While a direct marketing method

with its Village-level entrepreneurs leads to more job creation and additional income from PV companies that give commissions on every PV products sold.

Table 2.12. Typology of PV enterprises business models in developing countries (Singh, 2016; Steel et al., 2016; Tongsopit et al., 2016) *compiled by the author.*

Differentiated by	Types	Description	Customers
Market	Formal	• Registered enterprises • Start-ups/established business • Operating in formal market with headquarters in cities	Industry, Institutions, Households
	Informal	• Operating in informal market • Operate on the margins • Customized solar home systems with reliable price	Households
Channels	Retail	• Operate based on a network of a company or owned a franchise • A portion of profit goes to the retailer of the product	Households, Industry, Institutions
	Direct marketing	• Operating through an independent sales agents (Village-level entrepreneur or VLE) • Target the "Last mile" of services needs in rural areas • A commission is paid to VLE for every product sold	Households
Value proposition	Sell only	• Maintenance is done not by the solar company yet by an authorized service center • Worst case: there is no service supports or warranty	Households
	Sell & Service	• After sales support/warranty is available • Maintenance/services are done by solar company's technicians or third party's technicians	Households, Industry, Institutions
Revenue model	Full payment	• Customers own the product • High up-front cost • Financing may /may not be available	Industry, Institutions, Households
	Fee-for-services or Pay-as-you-go	• Payments to be matched with customers' consumption • Could be a Pay-to-own: a progressive purchase	Household
	Rental or Solar leasing	• Customers do not own the PV system • Small payments • Weekly/monthly fee is paid to the entrepreneur/company • For solar leasing, the electricity could be sold to receive Feed-in-Tariffs	Households
	Solar loans	• Customers own the PV system • Payment is made with an interest rate at an agreed period between the financial institution and the customer • Specific target groups depending on the policy of the financial institutions	Households, Commercials
	Solar-shared saving	• The customer, who wants to reduce electricity costs, agree on the contract with the PVCs, which typically lasts 20-25 years • Solar company own and operate PV system and sell the electricity at a discount, typically 5-10% lower than the grid tariffs	Energy intensive building, Industry
Ownership	Community owned	• Shared ownership • Agreement on governance structure, tariffs, shared of operation & maintenance costs or possible profits from Feed-in Tariffs	Household
	Third-party owned	• Customers do not own the system • Customers pay a fixed price based on the contract with the energy company or PVCs	Household
	Customer-owned or Entrepreneur based	• Individual ownership • Relies on capital, social standing, and networks	Households

The other typology of business models is distinguished based on the value proposition offered by the PVCs to the end users. The "sell-only" business model is rather hard to be developed in rural areas since it will not provide any after sales support. In "sell-only" business model, the customers need to go to the service centers, which most likely located in the cities or far from the village, if any faults happen to the products. Moreover, in the worst case, any warranty will not be provided by the "sell-only" company. It is important for rural communities to have the after-sales support for PV technology they bought because of the characteristics of rural communities who have limited knowledge of PV technology. This condition makes the rural customers will be highly dependent on the PV technicians for the system's services and maintenance. Thus, it makes an after-sales support is one of the important factors which define the success of PV adoption in rural areas.

In the sell and service model, some companies have their technicians who could go to the customer's house to repair the solar systems based upon requests, yet some other companies use a clustering approach. The clustering method was done by CREDA (Chhattisgarh Renewable Energy Development Agency) in India (Palit, 2013). CREDA appoints a village operator in every solar powered village to clean the PV modules on a daily basis and report any faults or breakdown to a cluster technician who works for 10 to 15 villages. In this model, the technicians and the operators are paid a fixed monthly fee, and for this service, the solar owner is charged for a monthly fee. The after sales support could also help to prevent the low-cost and low-quality products sold in the rural energy market. These cheap and low-quality products could be dangerous for future implementation and adoption of off-grid PV technology since it could lead to the negative public perception of PV technology as an unreliable energy option (Steel et al., 2016). Thus, the "sell & service" business model is the right type for a company who wish to expand their business to reach rural customers.

PV technology in the rural energy market is known as its high upfront capital. The full payment business model could face many challenges since government subsidies, or financing mechanisms are not always available for rural customers. This condition leads to the emergence of monthly installment business models. The monthly installment business model could be distinguished into four types of payments which are fee-for-service, rental/solar leasing, solar loans and solar-shared shaving. However, the solar leasing and the solar-shared saving are rather hard to reach the rural customers because these types of business models rely heavily on the feed in tariffs. Thus, solar leasing and the solar-shared saving models will be only beneficial for urban and industrial customers where the grid exists. Fee-for-service and rental business models could work in rural areas since they operate based on a small monthly service fee or lantern rental fee. These models could be very suitable for rural customers since they could pay the electricity based on their needs to avoid the high upfront cost and complicated financing system. In addition, solar loans could also be used as financing model in rural areas since the customers could own the PV technologies by paying installments at agreed period and interest rate with financial institutions.

The last types of business models that will be discussed are a community, third party, and customer owned. All of those business models might work for rural customers. People who live in rural areas, usually live together with their community in the village. This community could own solar systems by forming a governance body to organize the monthly/weekly installment as well as responsible for operation and maintenance of the PV systems. In this way, the adoption of off-grid PV technology in rural areas could be encouraged. The third party owned business model could be very suitable for people who live in rural areas where they have very limited financial resources. Through this business model, the customer does not have to pay the initial cost of the system since the system is owned by the PVCs. In exchange, the customers will need to pay a down payment and small monthly or even weekly fee for the system. Another way to help the adoption of off-grid PV technology is to encourage individuals to own their PV system or even their own solar business in the village. It is important to promote local entrepreneurs since local companies are one of the important factors in the success of the diffusion of off-grid PV technology (Dewald & Truffer, 2012; Fabrizio &

Hawn, 2013; Karakaya et al., 2016). It is because local companies have better visibility than other companies lead by individual outside their communities (Karakaya et al., 2016). Moreover, the local entrepreneurs have known the local culture, traditions, and lifestyle for a long time that makes the local businesses get a higher chance to be successful in the local communities

Finally, all the business models that might be suitable for rural energy markets have been discussed. There are fourteen types of business models that have been used to support the adoption of PV electrification in developing countries. Nevertheless, only eleven of those business models are suitable for the rural energy market. They are informal, formal, retail, direct marketing, sell & service, monthly installment in the form of fee-for-service, solar loans, and solar rental, community, third party and customers-owned or entrepreneur managed.

3 CHAPTER 3: Business models employed by PVCs to overcome barriers to the implementation of off-grid PV electrification in the rural energy market (Case study)

3.1 Case study 1: SunnyMoney

In this section, we present the case study from SunnyMoney. Data from this section was essentially gathered from different sources. Firstly, the interview was conducted with Mr. Brave Mhonie, who is the National Sales Manager of Sunny Money in Malawi. Secondly, the information was gathered through the official company's report and website. The details of the results of SunnyMoney's case study could be seen in the Appendices.

3.1.1 SunnyMoney's company profile

SunnyMoney is a social enterprise which was created in 2008 by SolarAid, a London-based international charity. SunnyMoney operates in Africa, which currently focuses on five African countries namely Malawi, Uganda, Kenya, Tanzania, and Zambia. Together with SolarAid, SunnyMoney aims to eliminate the use of kerosene lamp in Africa by 2020 by applying an innovative distribution model to sell affordable solar lights to the rural off-grid communities and building a sustainable market for solar products. SunnyMoney offers a wide variation of solar products starting from a solar lantern with the price from $5 to $10 to a bigger solar home system with the price range of $87 to $141.

By the end of 2015, the company together with SolarAid have reached ten million people to have better access to clean, safe, and affordable light by successfully selling more than 1.7 million solar lights. In the near future, SunnyMoney intends to share the benefit of their products to over 60 million people by selling over 10 million solar lights in 14 countries.

3.1.2 SunnyMoney's business model

In this section, we look into the business model and its elements applied in SunnyMoney's business. The elements of SunnyMoney's business model is divided into four main areas which are customer interface, value proposition, infrastructure management, and financial aspects. Figure 3.1 shows the overview of SunnyMoney's business model. The detail of SunnyMoney's business model and its elements are discussed in the Appendices.

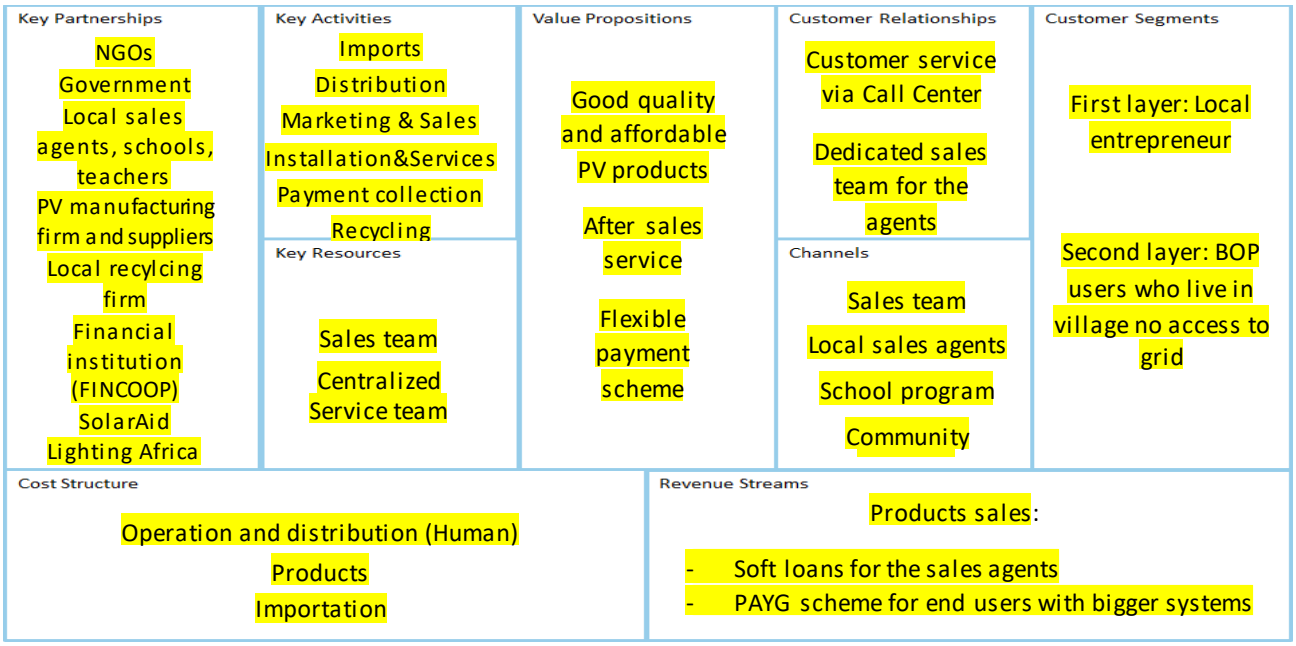

Figure 3.1. SunnyMoney's business model

3.1.3 Summary

SunnyMoney's case is summarized in a flowchart which is shown in Figure 3.2. It explains that the company starts choosing its customer segments and defining what to offer to those group of customers, which is referred to its value proposition. From the interview, it could be concluded that the SunnyMoney focuses on selling and distributing the technology to the end users through partnerships with the third party which is through the local sales agents. Based on the company's choices on the customer segment and its value proposition, there are several barriers which emerge that could influence the elements of business models employed by the company. The barriers which are faced by SunnyMoney are summarized in Table 3.1 with different colors which represent how significant the barriers towards SunnyMoney's business. Red means that a certain barrier is extremely significant towards the company business. Orange explains that the barriers are very significant towards the company's business. Yellow and Green represent barriers that are moderately and slightly significant towards the company's business. Lastly, Blue represents that the barriers are insignificant towards the company's business. In the same table, several elements of business models that are influenced by the levels of barriers faced by SunnyMoney also summarized. From Table 3.1, we could see that each of the barriers influence different elements of business models. This phenomenon will be further explained in Chapter 4. Finally, the choice SunnyMoney's business model will give impact to the cost structure of the company, as shown in Figure 3.2.

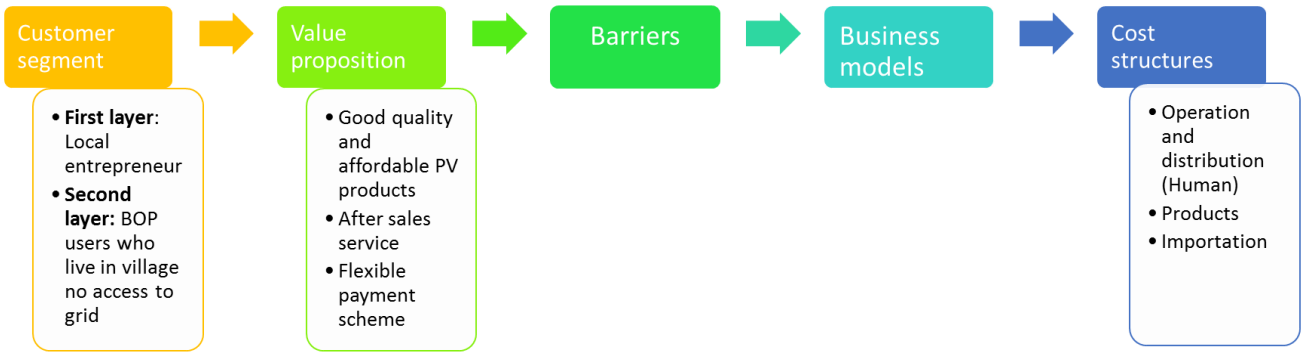

Figure 3.2. SunnyMoney's flow chart

Table 3.1. SunnyMoney's barriers representation and elements of business model

No	Barriers	Element of business model to overcome barriers					
		Customer relationship	**Channels**	**Key partners**	**Key activities**	**Key resources**	**Revenue streams**
1.	Infrastructure		Local agents	Local agents	• Distribution • Sales	Sales team	
2.	Investment			SolarAid			
3.	Financial			• Local agents • FINCOOP			Products sales in cash from FINCOOP
4.	Human resources			Foreign PV Manufacturing	Importations		
5.	Technical			• Lighting Africa • Foreign PV Manufacturing			
6.	Market demand		• Sales team • School program	• Ministry of education • Local schools	Sales and marketing	Sales team	

			• Community meetings	• Local marketing firm • NGOs			
7.	Social, Behavioral, Cultural	• Customer service via Call Center • Dedicated sales team for the agents		• Trusted teachers from local schools • Village leader • NGOs		• Sales team • Centralized service team in HQ	
8.	Governmental /Institutional				Direct lobbying activities		
9.	Network/ Partnerships			• Strategic partnerships • Criteria for selecting favorable partners			
10.	Environmental			Local recycling company			

insignificant sightly significant moderately significant very significant extremely significant

3.2 Case study 2: SunTransfer (Ethiopia)

In this section, we present the case study from SunTransfer Ethiopia. Data from this section was essentially gathered from different sources. Firstly, the interview was conducted with Mr. Yonas Workie, who is the Managing Director of SunTransfer in Ethiopia. Secondly, the information was gathered through the official company's report, interviews, and websites. The details of the results of SunTransfer's case study could be seen in the Appendices.

3.2.1 SunTransfer (Ethiopia)'s company profile

SunTransfer GmbH is a social enterprise which was established in 2009 by a Solar Foundation, a German-based NGO. Currently, SunTransfer GmbH operates in three different countries with different entities which act as local companies in Kenya, Ethiopia, and The Philippines. For this case study, we are focusing on SunTransfer Ethiopia, which later in this section will be written as SunTransfer. SunTransfer Ethiopia was established in 2012. The company aims to provide the best service for sustainable off-grid solutions through a holistic approach which includes top-quality PV products, flexible payment via PAYG systems, technical installation, and after-sales services. SunTransfer offers a wide variation of solar products starting from a solar lantern with the price from $12 to $40 to a bigger solar home system with the price up to $650. Not only that SunTransfer has solar products as the source of lighting, but it also provides other solar products for the community such as PV water pump, PV street-lights, PV water disinfection.

By the end of 2016, SunTransfer Ethiopia has reached the break-even point, which means the company has become profitable. In the future, in order to have a sustainable business, SunTransfer Ethiopia aims to offer more variation of products for any customers in rural areas, independent of size, types, and way of finance the solar systems. The company aims to be a one-stop energy access company who provides the full range of products to rural customers starting from small lantern to big solar systems on project-based for the institutions and companies.

3.2.2 SunTransfer (Ethiopia)'s business model

In this section, we look into the business model and its elements applied in SunTransfer's business. The elements of SunTransfer's business model is divided into four main areas which are customer interface, value proposition, infrastructure management, and financial aspects. Figure 3.3 shows the overview of SunTransfer's business model. The detail of SunTransfer's business model and its elements are discussed in the Appendices.

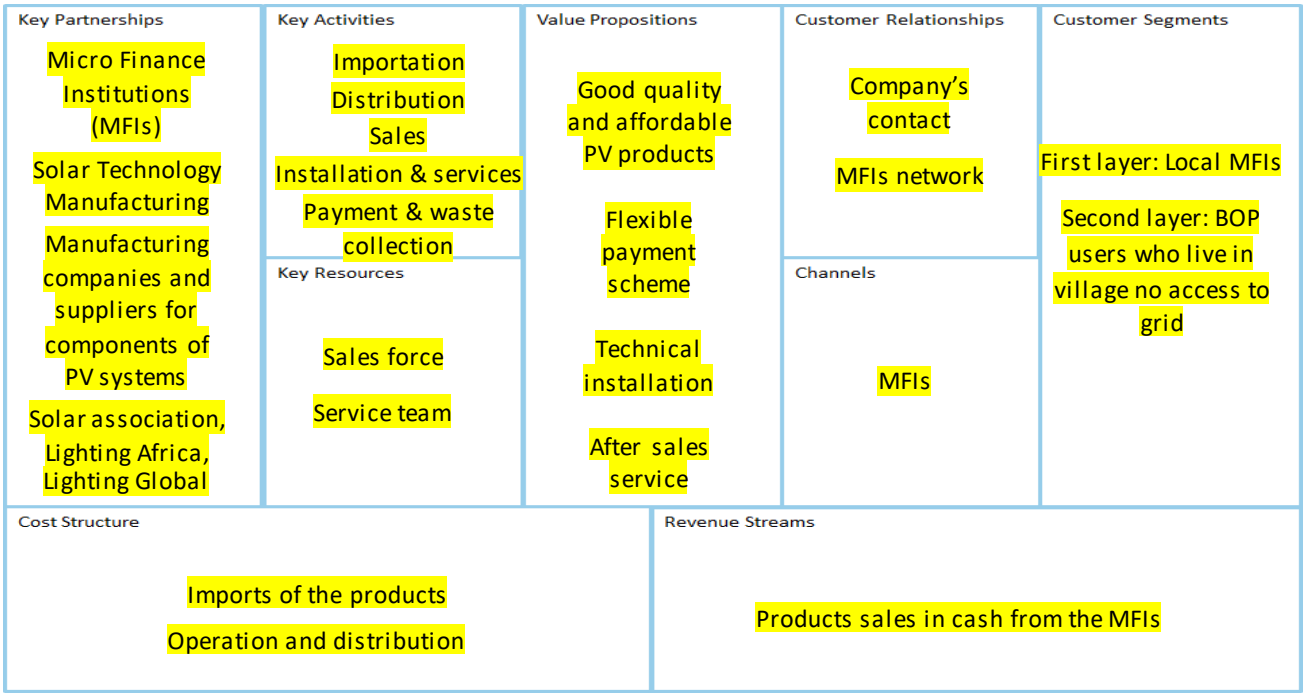

Figure 3.3. SunTransfer's business model

3.2.3 Summary

SunTransfer's case is summarized in a flowchart which is shown in Figure 3.4. This flow chart explains the flow where the company chooses its customers and defines what to offer to its customers in order to win in the competition. From the interview, it could be concluded that the company focuses on selling and distributing the technology to the end users through partnerships with the third party.

The barriers which are faced by SunTransfer are explained in Table 3.2 with different colors which represent how significant the barriers towards SunTransfer's business. In the same table, several elements of business models that are influenced by the levels of barriers faced by SunTransfer also summarized. From Table 3.2, we could see that each of the barriers influence different elements of business models. This phenomenon will be further explained in Chapter 4. Finally, the choice of SunTransfer's business model will give impact to the cost structure of the company, as shown in Figure 3.4.

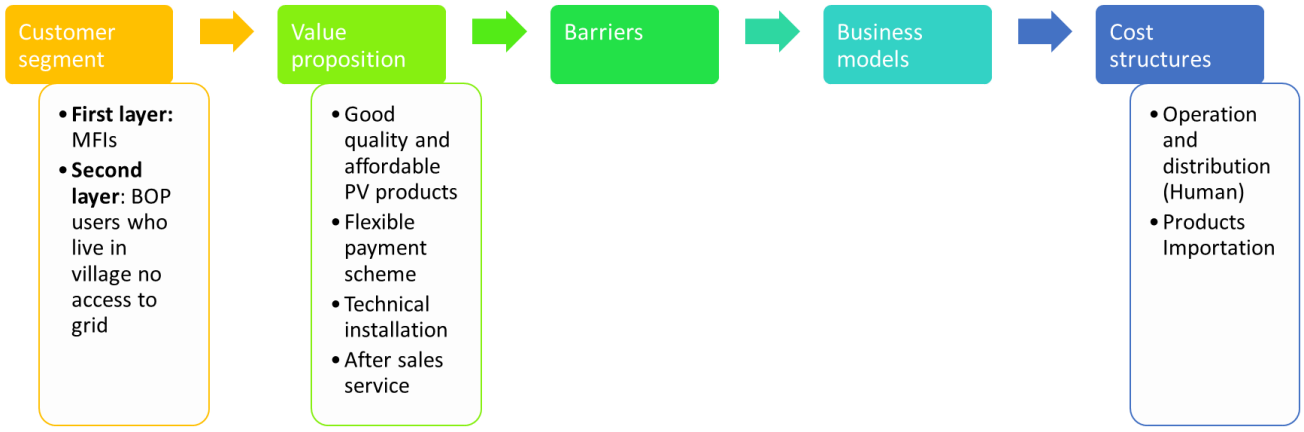

Figure 3.4. SunTransfer's flow chart

From the result of the interview, it could be concluded that SunTransfer's business relies heavily on its partners to overcome the barriers towards its business. The company relies on the third party to promote, sell, and distribute its products, which is mainly through the local Micro Finance Institutions (MFIs) networks.

The MFI networks is an important point of the company since the MFIs connect the end-users with the company. This partnership has helped SunTransfer overcome barriers in infrastructure, market demand, as well as in the social, behavioral, and cultural aspects. The local MFIs also help the company to solve the financial issues because the local MFIs help SunTransfer to assess the end-users financial condition to determine the payment scheme that is eligible for those users. Furthermore, SunTransfer depends on its partners to solve the technical issues. SunTransfer overcomes the investment issues by establishing partnerships with international investors and donors to secure some grants or loans.

Table 3.2. SunTranfer's barriers representation and elements of business model

No	Barriers	Element of business model to overcome barriers					
		Customer relationship	Channels	Key partners	Key activities	Key resources	Revenue streams
1.	Infrastructure		Local MFIs	Local MFIs	Distribution	Salesforce	
2.	Investment			• International partners and donors • Stiftung Solarenergie			
3.	Financial			Local MFIs	Payment collection		Products sales in cash from MFIs
4.	Human resources						
5.	Technical			• Solar Association • Foreign PV Manufacturing	Importation		
6.	Market demand		• Local MFIs networks	• Lighting Africa • Lighting global	Sales	Salesforce	
7.	Social, Behavioral, Cultural	• Company's contact • MFIs network	• Local MFIs		• Installation • After sales services	Service team	
8.	Governmental /Institutional			Solar Association	Lobbying activities		
9.	Network/ Partnerships			• Strategic partnerships • Solar Association			
10.	Environmental				Waste collection		

insignificant sightly significant moderately significant very significant extremely significant

The choice of this business model leads to only two key resources which are the sales and the service team which is fully employed by the company to operate SunTransfer's business. This type of business has allowed the company to cover an area with a radius of 350 km from SunTransfer's headquarter with minimum cost. Finally, this type of business model leads to two biggest spending of the company which is the operation and distribution, products importation.

3.3 Case study 3: SunSawang

In this section, we present the case study from SunSawang. Data from this section was primarily gathered from different sources. Firstly, the interview was conducted with Ms. Salinee Hurley, who is the CEO and the founder of SunSawang. Secondly, the information was collected through the official company's

website and company's official reports. The details of the results of SunSawang's case study could be seen in the Appendices.

3.3.1 SunSawang's company profile

SunSawang started as a non-profit organization named Border Green Energy Team (BGET), the entity which has seven years of experience in training villagers and refugees in installation and maintenance of RETs. BGET experienced a lack of financial support and community supports which require the NGO to raise additional funds consistently. Thus, in 2012, SunSawang was established as a social enterprise.

SunSawang aims to make clean electricity based on solar technology is sustainable and economically accessible for low-income people in rural Thailand. It offers various user-friendly products to meet each individual's needs and accommodate each financial situation. SunSawang offers from a small system, a new panel, a restored SHS with existing solar panels from the government, and a complete SHS with the new panel. Sun Sawang also offers five years payment plan which includes a warranty. Currently, the company focuses on Tak and Mae Hong Son provinces. SunSawang focuses on the customer relationship, customer's safety, financial security and the development both today and in the future.

3.3.2 SunSawang's business model

In this section, we look into the business model and its elements applied in SunSawang's business. The elements of SunSawang's business model is divided into four main areas which are customer interface, value proposition, infrastructure management, and financial aspects. Figure 3.5 shows the overview of SunSawang's business model. The detail of SunSawang's business model and its elements are discussed in the Appendices.

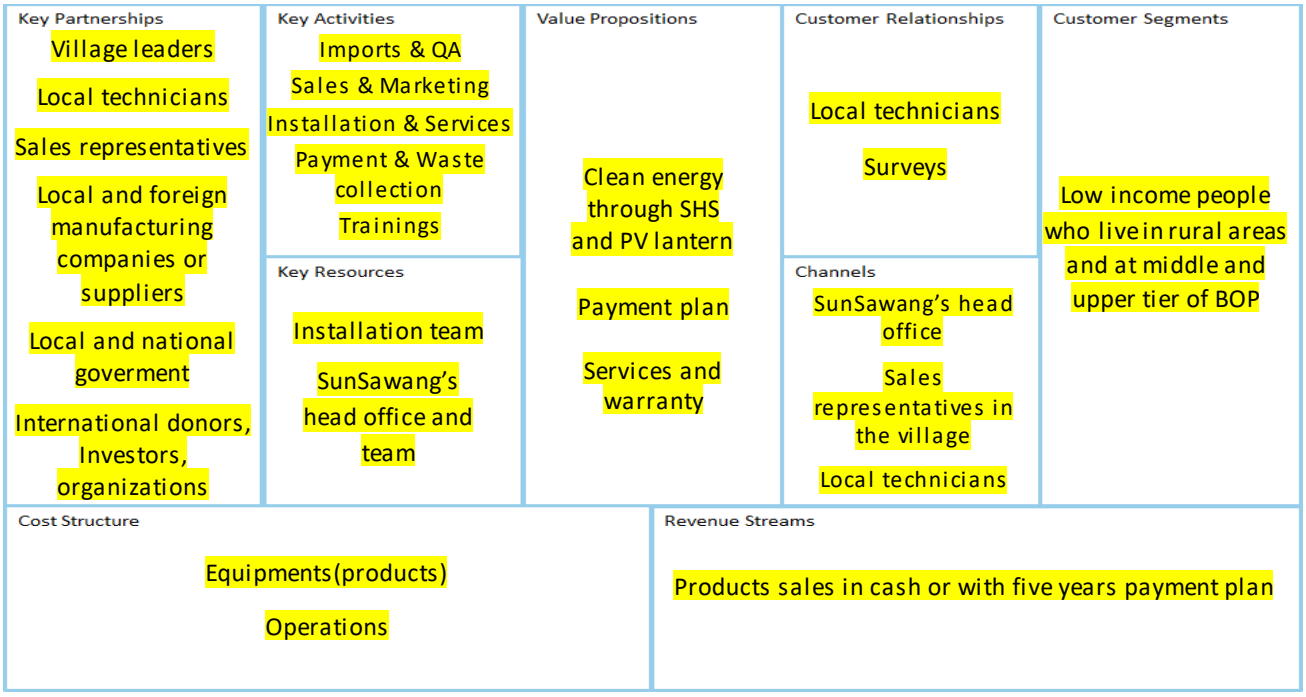

Figure 3.5. Sun Sawang's business model

3.3.3 Summary

The result of the interview on the case of SunSawang's business is summarized in Figure 3.6. SunSawang operates its business based on the choice of its customer segment. The company focuses on selling and distributing technology to the end users directly from its head office or indirectly through its local partners.

From the interview, it could be concluded that SunSawang relies heavily on its local partners such as local technicians and sales representatives to operate the company's business.

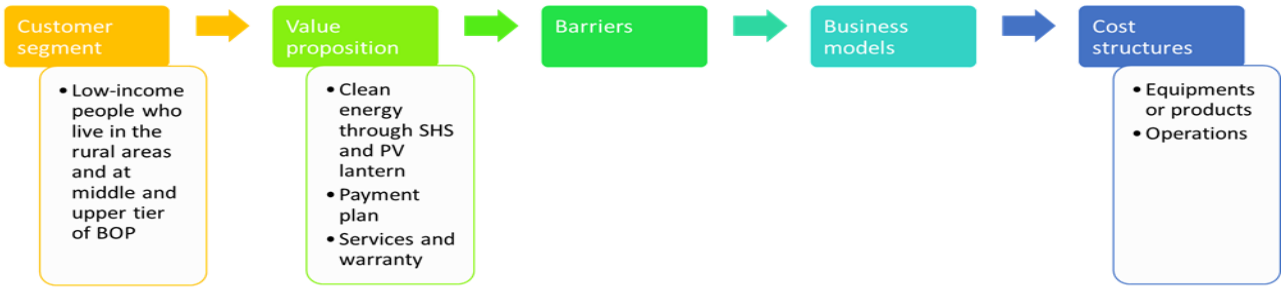

Figure 3.6. SunSawang's flow chart

Table 3.3. SunSawang's barriers representation and elements of business model

No	Barriers	Element of business model to overcome barriers					
		Customer relationship	**Channels**	**Key partners**	**Key activities**	**Key resources**	**Revenue streams**
1.	Infrastructure		Sales	• Local networks of village leaders • Local technicians • Sales representatives	• Distribution • Sales		SunSawang head office & team
2.	Investment			Local/international investors and donors			
3.	Financial			• Local technicians • Sales representatives	Payment collection		Cash or Five years payment plan
4.	Human resources				In-house trainings		
5.	Technical			Local and foreign manufacturing companies and suppliers	Importation and QA	Installation team	
6.	Market demand		• Local technicians • Sales representatives • SunSawang's head office	• Local technicians • Sales representatives	• Marketing • Sales		
7.	Social, Behavioral, Cultural	• Local technicians • Sales representatives		• Government • Local village leaders • Local sales representatives • Local technicians		Installation team	
8.	Governmental /Institutional						
9.	Network/ Partnerships						
10.	Environmental				Waste collection		

insignificant | sightly significant | moderately significant | very significant | extremely significant

The barriers which are faced by SunSawang are summarized in Table 3.3 with different colors which represent how significant the barriers towards SunSawang's business. In the same table, several elements of business models that are influenced by the levels of barriers faced by SunSawang also summarized. From Table 3.3 we could see that each of the barriers influence different elements of business models. This phenomenon will be further explained in Chapter 4. Finally, the choice of SunSawang's business model will give impact to the cost structure of the company, as shown in Figure 3.6.

The choice of SunSawang's business model has made the operation of the company's business at minimum cost. It is because the only key resource which the company needs is the installation team which consists of a group of technicians based in SunSawang's headquarter. This team is responsible for the quality assurance of SunSawang's products as well as the installation of SHS in the villages. Finally, this type of business model leads to two biggest spending of the company which is the stock up of the products or the equipment and the operational cost.

3.4 Case study 4: Devergy

In this section, we present the case study from Devergy. Data from this section was primarily gathered from different sources. Firstly, the interview was conducted with Mr. Gianluca Cescon, who is one of the founders of Devergy. Secondly, the information was collected through the official company's website. The details of the results of Devergy's case study could be seen in the Appendices.

3.4.1 Devergy's company profile

Devergy is an energy services company which was founded by Fabio De Pascale, Gianluca Cescon, and Daniel Ponz in 2010. The company began its operations in 2012 by providing low-income people who live in rural villages and do not have access to the grid with affordable and reliable energy. The company sells the targeted energy service for a limited amount of time, or as a bundle, which is different with other utility company which sells the electricity per kWh.

Devergy aims to empower people in developing countries by improving freedom of choice to use as little or as much energy as they want at any time they want. Devergy currently operates in Tanzania where only about 7% of the country's rural population has access to the grid. The company operates in 12 villages and supported by 100 passionate employees on the ground. Devergy focuses on the BOP market which 80% of customers earn less than $2.50 per day.

Devergy focuses a lot on its customers. The company's goal is happy customers. To achieve this goal, Devergy provides reliable electricity for 24 hours a day, seven days a week through expandable microgrids. The systems work for the households who want to use one light bulb or the family who has larger appliances such as a television or a fridge. The system is monitored closely. Thus, whenever there is a need to supply more energy, Devergy systems could be expanded. Devergy also provides flexible payment scheme through PAYG mobile money. In this way, Devergy is able to provide freedom of choice and flexible payment to its customers. Currently, there are about 7,000 households connected and more than 20,000 lives impacted by Devergy services.

3.4.2 Devergy's business model

In this section, we look into the business model and its elements applied in Devergy's business. The elements of Devergy's business model is divided into four main areas which are customer interface, value proposition, infrastructure management, and financial aspects. Figure 3.7 shows the overview of Devergy's business model. The detail of Devergy's business model and its elements are discussed in the Appendices.

Figure 3.7. Devergy's business model

3.4.3 Summary

The result of the interview on the case of Devergy's business is summarized in Figure 3.8. Devergy chooses to serve its customer segment with reliable and affordable electricity services. The company acts as an independent utility company which the main product is the electricity services. All the physical assets remain on the ownership of Devergy. The customers pay the service fee to the company in an exchange of electricity services through a top up mobile money scheme.

The barriers which are faced by Devergy are summarized Table 3.4 with different colors which represent how significant the barriers towards the company's business. In the same table, several elements of business models that are influenced by the levels of barriers faced by Devergy also summarized. From Table 3.4, we could see that each of the barriers influence different elements of business models. This phenomenon will be further explained in Chapter 4. Finally, the choice Devergy's business model will give impact to the cost structure of the company, as shown in Figure 3.8.

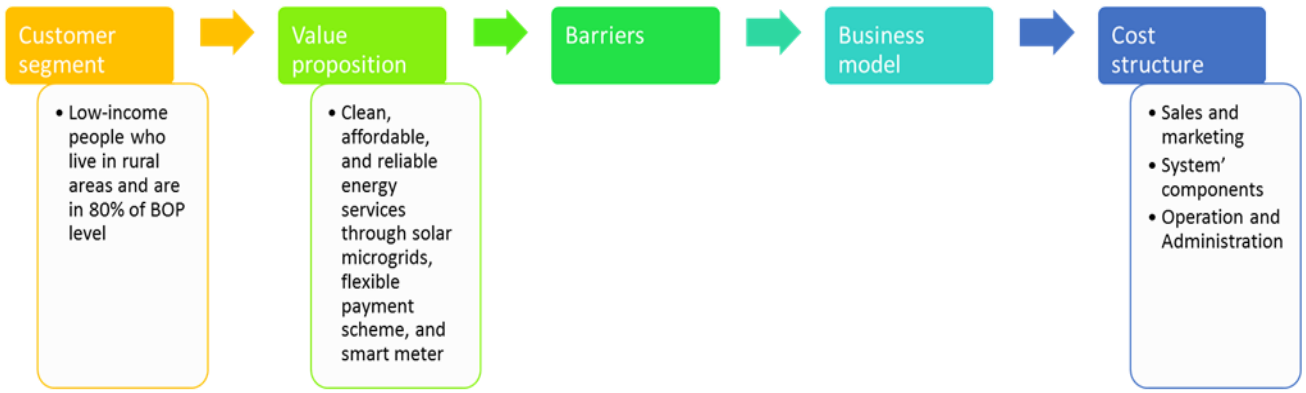

Figure 3.8. Devergy's flow chart

Table 3.4. Devergy's barriers representation and elements of business model

No	Barriers	Element of business model to overcome barriers					
		Customer relationship	**Channels**	**Key partners**	**Key activities**	**Key resources**	**Revenue streams**
1.	Infrastructure		• Sales team through roadshows • Local sales agents	• Local transportation (bus) • Local maintenance technicians • Local sales agents • Mobile network operator	• Sales • Installation • Maintenance & services	• Sales & marketing team • Logistics team • Installation and service team • Warehouses and regional hubs	
2.	Investment			• Crowdfunding social networks • Local/internatio-nal investors and donors • Finnish government			
3.	Financial			Mobile network operator		R&D team	Mobile money through PAYG scheme
4.	Human resources				In-house trainings and supports		
5.	Technical			• Local and foreign manufacturing companies and suppliers • Q&A partnering company	• Product designs • Importation	R&D team	
6.	Market demand		Sales team through roadshows	• Local technicians • Local sales agents	Sales & Marketing	Sales and marketing team	
7.	Social, behavioral, Cultural	• Dedicated customer care team (call center) • Devergy smart meter		• Local technicians • Local sales agents			
8.	Governmental /Institutional			International organizations such as World Bank			
9.	Network/ Partnerships					Good manager for each of departments	
10.	Environmental			Foreign recycling company	Waste collection		

insignificant sightly significant moderately significant very significant extremely significant

From the interview, it could be concluded that Devergy is not solely relying on its partners to sell the service. The company employs full-time sales and marketing team to do the marketing activities such as roadshows as well as technician team to do great maintenance or services as well as the installation of the system. The company also has an R&D team as one of the key resources and established partnerships with

third-party companies to manufacture the products that the company needs and to do the quality control on behalf of Devergy to eliminate most of the technical barriers. Logistics team was employed to maintain the warehouses and regional hubs to make sure that Devergy has enough spare-parts close to the villages.

In collaboration with its partners, Devergy tries to overcome the barriers which might influence the company's business. Local technicians and local sales agents are employed based on commissions to help Devergy solving the issues on market demand as well as challenges on infrastructural, social, behavioral, and cultural aspects. Devergy also provides good customer care to enhance the company's relationship with its customers. Devergy relies on crowdfunding platforms and donors to solve the investment issues. Also, to solve the financial issues on the end users, Devergy's R&D team works with the mobile network operator to enable the flexible top-up PAYG scheme. Devergy eliminates the environmental barriers by having partnering company to do the recycling process. The company develops its in-house training and the company structure to be able to overcome issues of the human resources as well as network and partnerships.

The choice of this business model has led to several key resources which the company needs to prepare. Not only people but also the physical resources such as warehouses and the regional hubs. Moreover, the company also needs to be responsible for the technology and the systems for the whole time since the ownership of the systems remain to Devergy. Thus, proper maintenance is required in order to deliver electricity to the users and make them happy customers. Finally, this type of business model leads to three biggest costs for the company which are the systems' components, operation, administration, sales and marketing.

3.5 Case study 5: Meragao Power (MGP)

In this section, we present the case study from MGP. Data from this section was primarily gathered from different sources. Firstly, the interview was conducted with Mr. Nikhil Jaisinghani, who is one of the founders of MGP. Secondly, the information was collected through the official company's website. The details of the results of MGP's case study could be seen in the Appendices.

3.5.1 MGP's company profile

MGP is a utility company which was founded Sandeep Pandey, Brian Shaad, and, Nikhil Jaisinghani in 2010. MGP focuses to serve rural off-grid households and communities who live in the hamlets. A hamlet is a settlement with few people, usually about 50 households in the community. MGP offers high quality, clean and affordable services by building, owning, and operating solar microgrids in Uttar Pradesh, India.

By the end of 2015, MGP has served about 22,000 households. A microgrid to serve a typical hamlet costs less than $1,000 and could be constructed in one single day. The MGP system is fully automated design. It generates, stores, and distributes power on its own, turning itself on and off each night automatically at the pre-set time. It consists of 24 V solar panel which could electrify up to 20 households which are connected to each of the households with cables. The systems also come with two LED light bulbs and a mobile phone charger for each household. Despite many challenges from the local bodies, MGP envisions to eliminate the use of kerosene in rural India by replacing it with clean energy.

3.5.2 MGP's business model

In this section, we look into the business model and its elements applied in MGP's business. The elements of MGP's business model is divided into four main areas which are customer interface, value proposition, infrastructure management, and financial aspects. Figure 3.9 shows the overview of MGP's business model. The detail of MGP's business model and its elements are discussed in the Appendices.

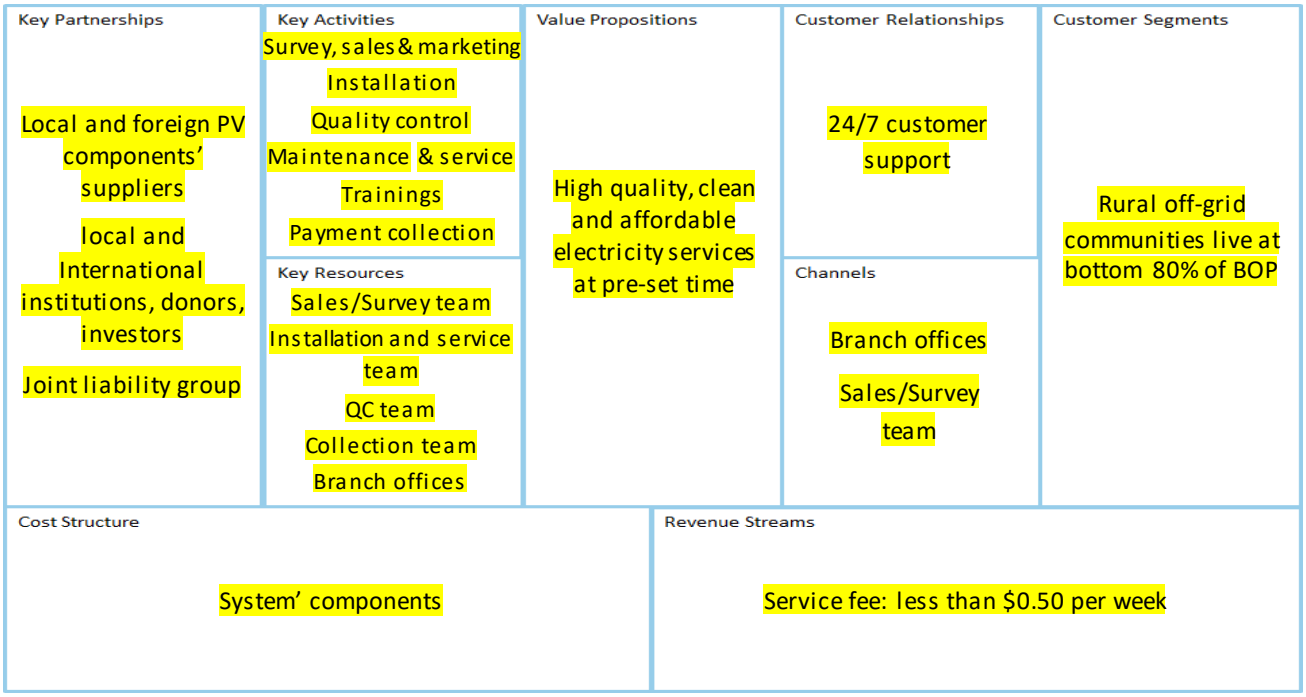

Figure 3.9. MGP's business model

3.5.3 Summary

Based on the interview with MGP, the case of MGP's business is summarized in Figure 3.10. MGP chooses to deliver electricity to the bottom 80% of the BOP community. There are several challenges which need to be overcome in order MGP to be able to sustain its business in this part of the community. All the barriers faced by MGP are summarized in Table 3.5 with different colors which represent how significant the barriers towards the company's business. A set of business model's elements is used to overcome the barriers which might influence MGP business. MGP comes with a business model which offers affordable electricity service which is paid weekly at a fixed price for a pre-set time of electricity service. In this way, MGP acts as an independent utility company which delivers electricity directly to the users. All the physical assets of the systems remain to the company. Thus, the company is responsible for installing, maintaining, and providing services to the systems in exchange for a small fee which is collected weekly. This choice of business model leads to cost structure or the spending of the company which at the end will influence the profitability of the company.

From MGP's case, it could be concluded that the company mainly relies on its resources to overcome barriers they face to operate on the BOP and rural market. The only partnerships MGP has are the international donors or investors to help the company with the investment issues as well as local and foreign systems' components manufacturers to help the company to solve technical, network/partnerships and environmental issues. Other than those partnerships, MGP relies on its own resources to solve several issues which might influence its business.

MGP relies on its teams, such as installation and maintenance team, sales and survey team, quality control team, and collection team to overcome issues on market demand as well as barriers on infrastructural, financial, technical, social, behavioral, and cultural aspects. MGP also develops mobile apps to help the QC and collection team monitor the quality of the systems and the payment of the users. Moreover, MGP has branch offices close to the villages to provide 24/7 customer care and to be able to deliver services quickly to the customers. In this way, lack of proper infrastructure is no longer an issue.

The choice of this business model has led to several key resources which the company needs to prepare. Not only people but also the physical resources branch offices and mobile apps. However, since MGP sells electricity, which everybody knows and needs, and operates close to the end user, the company does not spend much on marketing and operational costs. MGP explains that the operational costs are covered by the

companies' revenue within 12 months. The biggest cost which the company needs to spend is the systems' components because MGP needs to pay the upfront cost of all the systems as well as maintain and service the systems to deliver its promises to the customers.

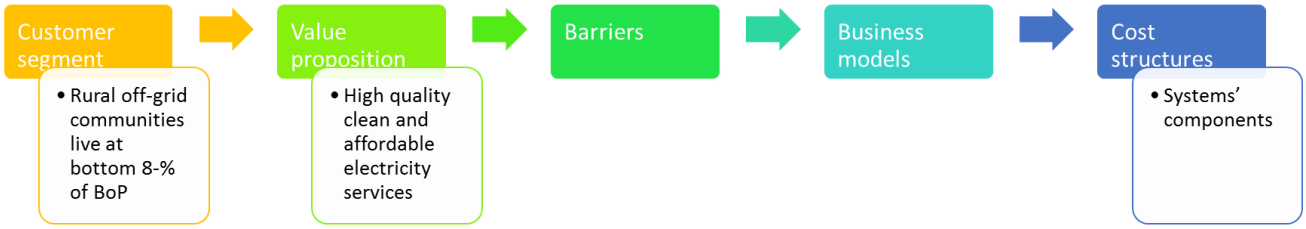

Figure 3.10. MGP's flow chart

Table 3.5. MGP's barriers representation and elements of business model

No	Barriers	Element of business model to overcome barriers					
		Customer relationship	**Channels**	**Key partners**	**Key activities**	**Key resources**	**Revenue streams**
1.	Infrastructure		Sales and marketing team		• Sales • Installation • Maintenance & services	• Branch offices • Installation and services technician	
2.	Investment			• Crowdfunding lending institutions • Local/international investors			
3.	Financial			• Joint Liability group	Payment collection	Collection team	Weekly service fee
4.	Human resources				Regular training		
5.	Technical			• 80% Local & 20% Foreign manufacturing companies and suppliers	Quality control	• Mobile apps • QC team	
6.	Market demand	24/7 customer supports	• Sales/survey team • Branch office		• Sales & marketing • Survey	• Sales team • Technicians team	
7.	Social, Behavioral, Cultural	24/7 customer supports			Survey	Sales and marketing team	
8.	Governmental /Institutional			Strong relationships with customers			
9.	Network/ Partnerships			80% local partnering companies/institutions			
10.	Environmental			Local manufacturing partner companies	Waste collection	QC team	

insignificant | sightly significant | moderately significant | very significant | extremely significant

3.6 Case study 6: Mobisol

In this section, we present the case study from Mobisol. Data from this section was primarily gathered from different sources. Firstly, the interview was conducted with Ms. Paula Berning, who is the Mobisol's communications manager. Secondly, the information was collected through the official company's website. The details of the results of Mobisol's case study could be seen in the Appendices.

3.6.1 Mobisol's company profile

Mobisol is a social enterprise established in 2010. This Berlin-based company offers a clean energy which is an alternative to unhealthy, harmful and expensive fossil fuel for low-income customers in developing nations by providing an innovative solution. Mobisol combines high-quality solar home systems with an affordable payment plan, comprehensive customer service, and innovative remote monitoring technology. Mobisol's systems come in different sizes from 80 to 100 Wp to match the customers' needs.

Mobisol focuses on operating its business in East Africa which is currently based in Tanzania, Kenya, and Rwanda. It is one of the world's leading companies for Solar Home Systems with about 700 passionate employees delivering clean energy to low-income households with limited access to reliable energy. At the moment, Mobisol has installed over 72,000 solar home systems on households and businesses which enabling over 350,000 beneficiaries to access affordable, clean, and reliable energy from the sun.

3.6.2 Mobisol's business model

In this section, we look into the business model and its elements applied in Mobisol's business. The elements of Mobisol's business model is divided into four main areas which are customer interface, value proposition, infrastructure management, and financial aspects. Figure 3.11 shows the overview of Mobisol's business model. The detail of Mobisol's business model and its elements are discussed in the Appendices.

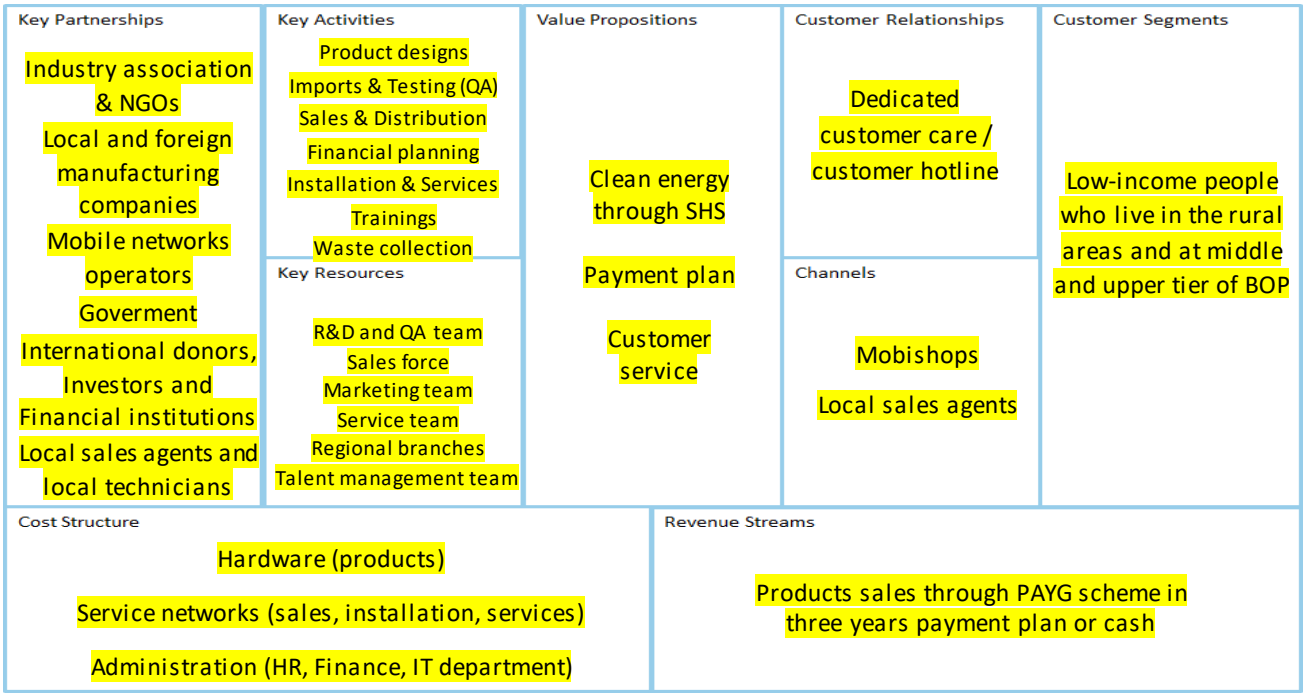

Figure 3.11. Mobisol's business model

3.6.3 Summary

Mobisol business' case study is summarized in Figure 3.12. From the case study, it could be concluded that Mobisol provides end-to-end services from the product designs to after sales services to the end users. The company also provides payment plan to overcome financial issues for its end-users. The company relies heavily on its own resources and facilities to run its business and face the barriers which might influence Mobisol's business. The barriers which might influence Mobisol's business are presented in Table 3.6 with different colors which represent how significant the barriers towards the company's business. The choice of business model will influence the cost structure of the company.

Mobisol relies heavily on its own resources to solve its challenges. Thus, its business model results in several activities and key resources which need to be done by the company in order to sustain its business in the market. Mobisol owns regional branches and private shops called mobishops which located close to the

villages and employed a full-time salespersons to maintain the shops and sell the products. In this way, Mobisol tries to eliminate infrastructural issues. Mobisol also has full-time sales and marketing team to promote its products in the villages and communities. More over, local sales agents and technicians are employed based on commissions to help the company promote and sell its products. Mobisol also provides dedicated customer care for the users. In this way, the company tries to solve challenges in market demand as well as social, behavioral, cultural issues at its maximum efforts. Mobisol also designs its own products. Thus, R&D team is part of the key resources which the company needs to have. To solve issues on Human resources, Mobisol relies on its own resource which is the talent management team and Mobisol Akademie to provide a pool of good talents as well as in-house training for Mobisols employees.

Table 3.6. Mobisol's barriers representation and elements of business model

No	Barriers	Element of business model to overcome barriers					
		Customer relationship	**Channels**	**Key partners**	**Key activities**	**Key resources**	**Revenue streams**
1.	Infrastructure		Mobishops		• Distribution • Sales • Installation & services	• Regional branches • Mobisol sales forces • Local sales agents and technicians	
2.	Investment			• European Union • Financial institutions • International donors and investors			
3.	Financial			Mobile networks operators	Financial planning	R&D team	• PAYG on three years installments
4.	Human resources				Trainings	• Mobisol Akademie • Talent management team	
5.	Technical			• Foreign Manufacturing companies • Lighting Global certification	• Product designs • Imports • Quality control and assurance	• Q&A team • R&D team	
6.	Market demand		Mobishops	Local sales agents and telesales	Marketing	• Mobisol sales forces • Marketing team	
7.	Social, Behavioral, Cultural	Dedicated customer care and customer hotline	• Mobishops • Mobisol sales force	Local sales agents and technicians		• Local technicians • Service team	
8.	Governmental /Institutional			GOGLA Other NGOs and institutions	Lobbying activities		
9.	Network/ Partnerships			• Government • Industrial sectors			
10.	Environmental				Waste collection	Q&A team	

insignificant | sightly significant | moderately significant | very significant | extremely significant

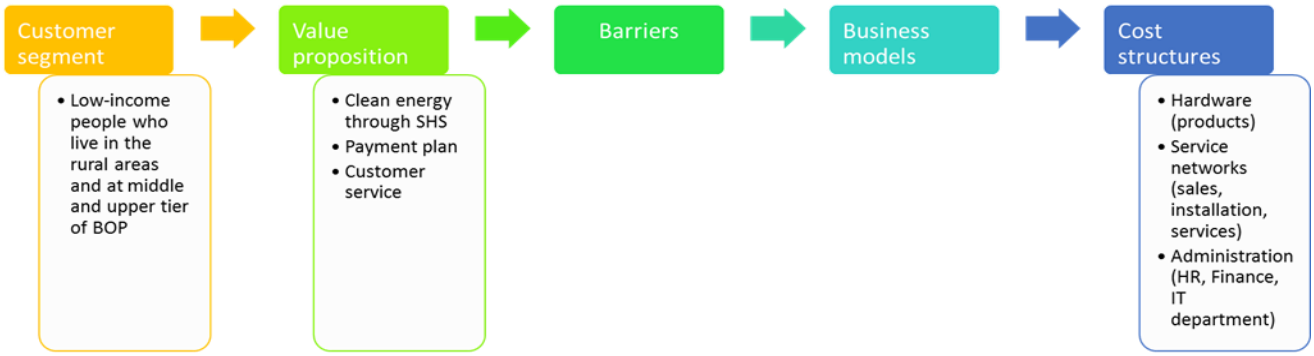

Figure 3.12. Mobisol's flow chart

3.7 Case study 7: SELCO

In this section, we present the case study from SELCO. Data from this section was primarily gathered from different sources. Firstly, the interview was conducted with Ms. Sarah Alexander, who is the communication leader at SELCO Foundation. Secondly, the information was collected through the official company's website. The details of the results of SELCO's case study could be seen in the Appendices.

3.7.1 SELCO's company profile

SELCO Solar Pvt. Ltd. is a social enterprise established in 1995. The company aims to uplift the socioeconomic status of underserved communities in rural and urban areas by providing sustainable energy solutions which are tailored based on the needs of the poor. SELCO promises three things to its customers who are affordability, reliability, and services. Thus, SELCO offers a complete package of product, service, and consumer financing through Grameen banks, cooperative societies, commercial banks, and MFIs.

Currently, SELCO employs more than 450 people, in which about 300 people are local talents. SELCO operates in Karnataka, Gujarat, Maharashtra, Bihar and Tamil Nadu spread across 49 Energy Service Centers (ESC). SELCO has sold, installed, serviced, and financed more than 200,000 solar systems to its customers.

3.7.2 SELCO's business model

In this section, we look into the business model and its elements applied in SELCO's business. The elements of SELCO's business model is divided into four main areas which are customer interface, value proposition, infrastructure management, and financial aspects. Figure 3.13 shows the overview of SELCO's business model. The detail of SELCO's business model and its elements are discussed in the Appendices.

3.7.3 Summary

SELCO business' case study is summarized in Figure 3.14. From the case study, it could be concluded that SELCO provides a customized and end-to-end service for its targeted customers. This service includes product development through its R&D team and its incubation lab, financial solution, and services for its end-users. SELCO relies on its partners to overcome several challenges which might influence its business. However, the company also has its own resources to handle its own problems. The barriers which might influence SELCO's business are presented in Table 3.7 with different colors which represent how significant the barriers towards the company's business. The choice of business model will influence the cost structure of the company.

SELCO relies on its partners to help them to solve several issues such as investments, financial, technical, market demand, network and partnerships, as well as environmental aspects. SELCO relies on its partners to secure investments, especially during the early phases of the company. The company also relies

on the local financial institutions to help them to provide customized payment and financial plan for its end-users. In this way, SELCO transfers the risk of payment default from the company to the local financial institutions. To solve technical issues, SELCO works together with its partners to develop and manufacture its products. Moreover, commission agents are also included to help the company to sell and promote SELCO's products and services. With the help from the commission agents who come from the local people, the company reduces issues on market demands. On the environmental aspects, SELCO works together with a local recycling company to take care of its waste from faulty and old products.

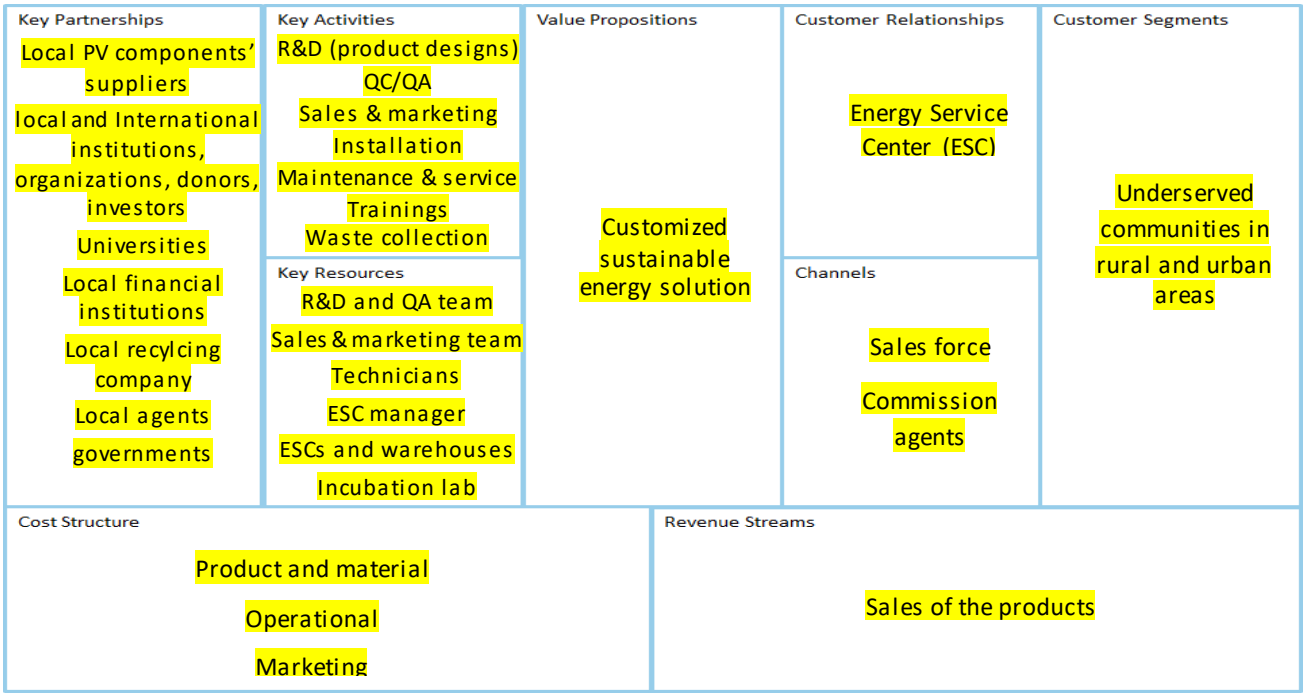

Figure 3.13. SELCO's business model

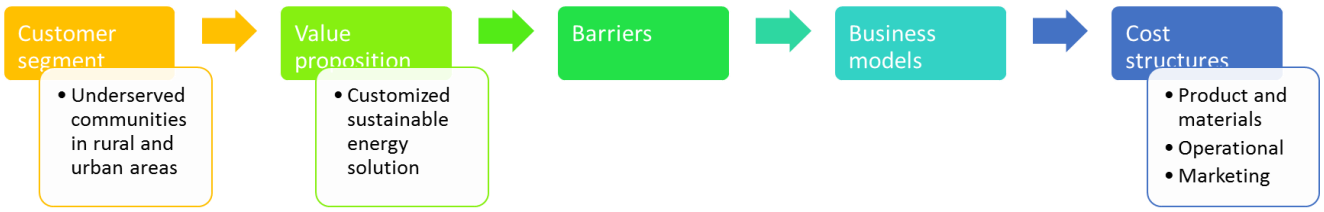

Figure 3.14. SELCO's flowchart

Despite all the partnerships that the company has established, SELCO also uses its own resources to tackle some serious issues on infrastructure, technical aspects, market demand, social, behavioral, cultural aspects, and governmental issues. SELCO owns 49 branch offices called ESC which located close to the villages. Moreover, the company owns two warehouses to cover the area the company operates its business. These physical instruments help the company to solve infrastructural issues. On the technical aspects, while the company relies on its partners to produce its products, SELCO has its own R&D and QA team to develop new products. Moreover, the company has its own lab to overcome any technical issues and trigger some innovations in the market. SELCO also has its own team to stimulate the demand for its products in the market. On the social, behavioral, and cultural aspects, SELCO relies on its own employees to earn trust from the people. It is because SELCO hires local talents or local people to work in the company. To make sure that the company has a good relationship with the government and to solve issues on governmental aspects, SELCO has its own dedicated team who works closely with the government.

Table 3.7. SELCO's barriers representation and elements of business model

No.	Barriers	Element of business model to overcome barriers					
		Customer relationship	**Channels**	**Key partners**	**Key activities**	**Key resources**	**Revenue streams**
1.	Infrastructure		• Sales force • Commission agents		• Sales & Distribution • Services	• 49 ESCs • 2 warehouses	
2.	Investment			• Local/international investors			
3.	Financial			• 30 financial institutions			• 3-5 years payment plan through banks
4.	Human resources				Trainings		
5.	Technical			• International R&D institutes • Universities • Local companies		• R&D Team • QA team • Incubation labs	
6.	Market demand	ESCs	• Sales force • Commission agents	Commission agents	• Sales & marketing • Installation • Maintenance and services	• Sales & marketing team • Technicians team • ESC manager	
7.	Social, Behavioral, Cultural	ESCs				Local talents	
8.	Governmental /Institutional					Dedicated team works with government	
9.	Network/ Partnerships			Local companies/vendors			
10.	Environmental			Local recycling companies	Waste collection		

insignificant sightly significant moderately significant very significant extremely significant

The choice of SELCO's business model results in key resources and key activities which the company needs to prepare. Thus, it leads to big spending on the products and materials, operations, and marketing activities.

4 CHAPTER 4: Cross cases analysis and initial framework construction

In the previous chapter, we have seen several cases study from different types of PV companies which operate in the rural energy market in developing countries. The case study yielded us insights into several barriers the companies face which might influence their business and most importantly different types of business model employed by those companies.

In this chapter, the results obtained from seven cases in the previous chapter will be compared. We will look into the cases to find differences and similarities to help us generalize our findings on how a business model could be derived from the barriers faced by the companies from our case study.

4.1 Cross cases analysis

From the previous chapter, the result of the interview with seven PV companies, which have different business models, have been presented. In this section, we will discuss different business models employed by PV companies and try to compare the barriers experienced by different companies. We will discuss each of the barriers and its significances towards the companies' business and different elements of business model used to overcome those barriers.

4.1.1 Business model elements: Value proposition, key activities, cost structure, and revenue model

Based on the result of the interview, the seven PV companies could be distinguished based on its business model. The classification of business model is done by looking at the companies' key activities and its value proposition. The end-to-end (E2E) model and the distributor model can be distinguished based on the key activities done by the companies, as shown in Figure 4.1. The companies which employ the E2E model design and manufacture its own products while the companies with distributor model have other companies to supply the products or technologies needed to build PV systems. These different key activities lead to different key resources and cost structures which at the end will lead to different investment needed to start such companies. The E2E model has its benefit of designing its own products tailored based on the needs of companies' targeted customers. Nevertheless, it needs people and resources to design and manufacture such products which lead to more investment needed compared to the distributor model. On the other hand, the distributor model needs fewer investments since these types of companies rely on other PV manufacturers or suppliers to supply technologies needed for them. The companies which employed the E2E business model are Mobisol, and Devergy, SELCO. MGP, SunnyMoney, SunTransfer, and SunSawang are classified as the distributor business model.

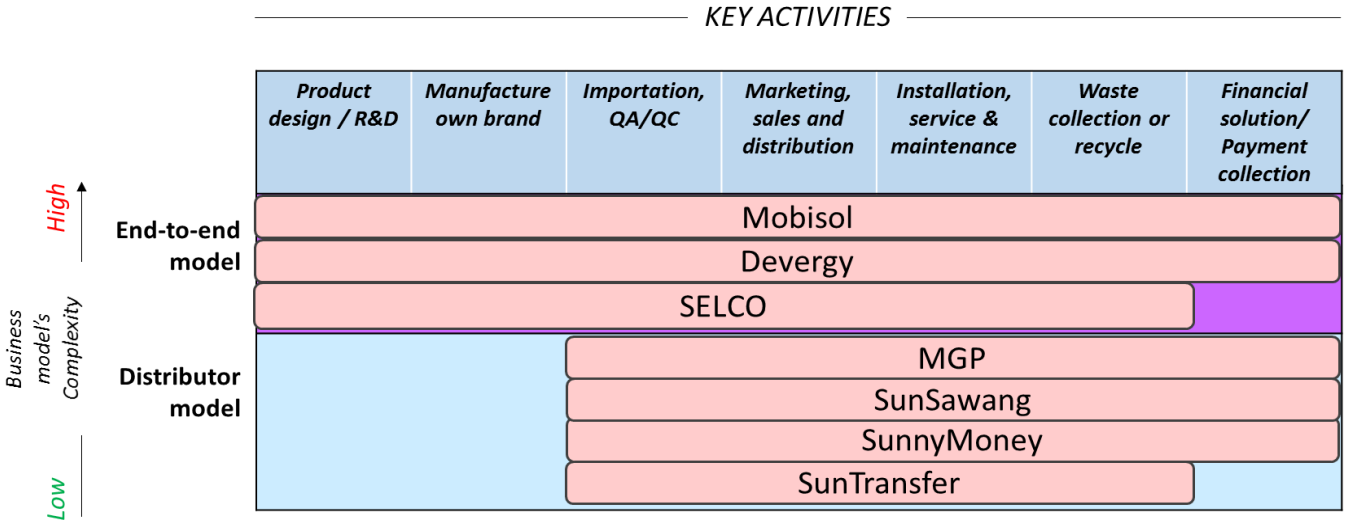

Figure 4.1. Types of business model based on the key activities of different PV companies

Moreover, the types of business model employed by the PVCs also could be distinguished based on the value proposition offered to the customers, as it is shown in Figure 4.2. The choice of the value proposition offered by the PVCs also plays a major role in determining PVCs' revenue model. The types of business model based on its value proposition are classified as products-focused and service provider model.

Other business models which are employed by PVCs are products focused and service provider model. These models are classified based on the value proposition offered by the PVCs. The service provider model enables the users to pay a small fee to the company in exchange for reliable electricity services. With the regards to PVCs' revenue model, the companies with the service provider model tend to apply a fee-for-service revenue model or subscription fee. This fee could be made flexible through PAYG or pre-paid model as well as a fixed fee which can be paid periodically determined by the companies

On the other hand, the companies which employed products-focused model, offer PV technologies to its customers. With the regards to PVCs' revenue model, the companies which employed the products-focused business model tend to apply cash or a pay-to-own revenue model. The customers could pay for the technologies through different payment schemes such as cash, PAYG, installments, or loans through the third parties, which could be partnering banks, financial institutions or other organizations, with an interest rate at an agreed period

The companies which employ service provider model could also employ the E2E or distributor model based on the key activities done by the PVCs. For instance, the main difference of Devergy and MGP is that Devergy employs E2E model while MGP employs distributor model in order to electricity services to its customers. The companies which employ service provider model have the benefit of serving a wider customers segments compared to those companies which sell products to its customers. It is because the service provider model enables the PVCs to adjust the subscription fee for its customers whether it is a fixed fee, just like MGP, or a PAYG just like Devergy. However, since the ownership of the systems remain to the PVCs for the whole time, all services and maintenance of the systems also remain as the PVCs' responsibility. Thus, dedicated technicians and control systems are needed to enable reliable services for its customers.

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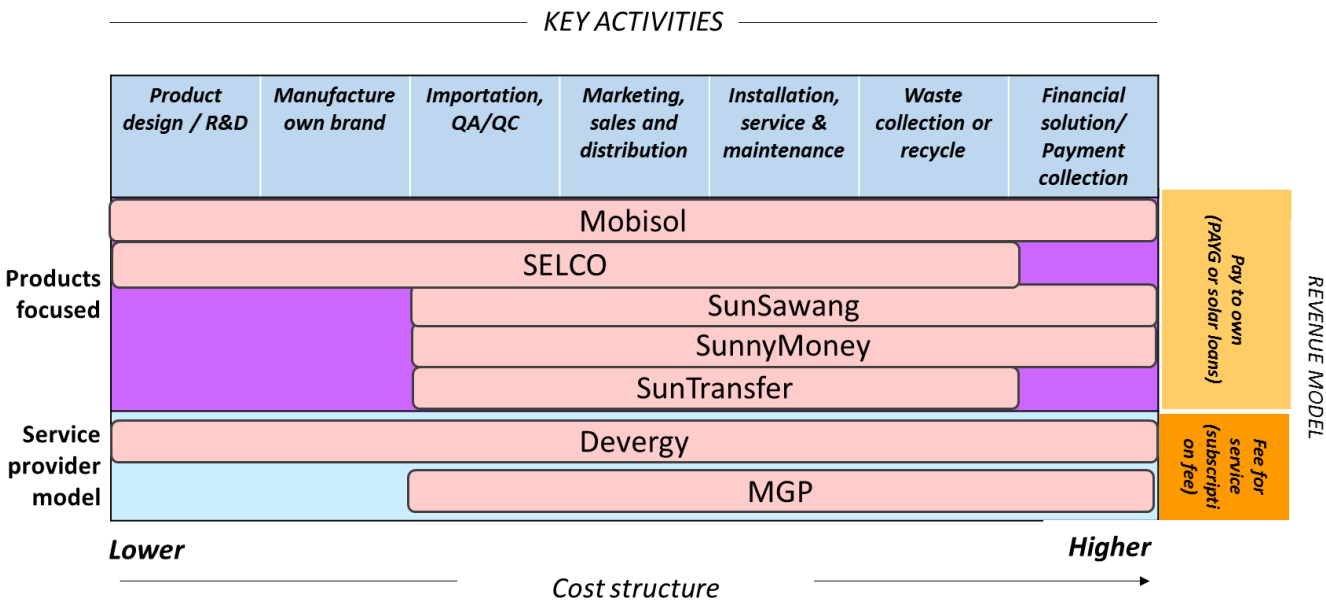

Figure 4.2 Types of business model based on value proposition of different PVCs

Table 4.1 summarizes the comparison of the different model employed by PVCs based on its value proposition and its key activities. In addition, Figure 4.3 summarizes types of business model employed by PVCs from seven case studies in this research.

Table 4.1. Comparison of PVCs business model

End-to-end (E2E) model		Distributor model		Service provider model		Products-focused model	
+	-	+	-	+	-	+	-
• Design own products • Own its own brands • High standard of QA/QC and product quality	• Complicated model • More resources needed • More investments needed	• Less hassle compared to E2E model • Less investment compared to E2E model • Fewer resources needed	• Do not own its own brand • Cannot have its own specific products' requirements	• Could serve a wide customer segmentation • Adjustable subscription fee (fixed or PAYG fee)	• Regular maintenance and services needed • Dedicated technicians needed • Control systems needed	• No regular services and maintenance needed • Ownership transfer to the customers	• Need to sell different products to serve wide customer segmentation

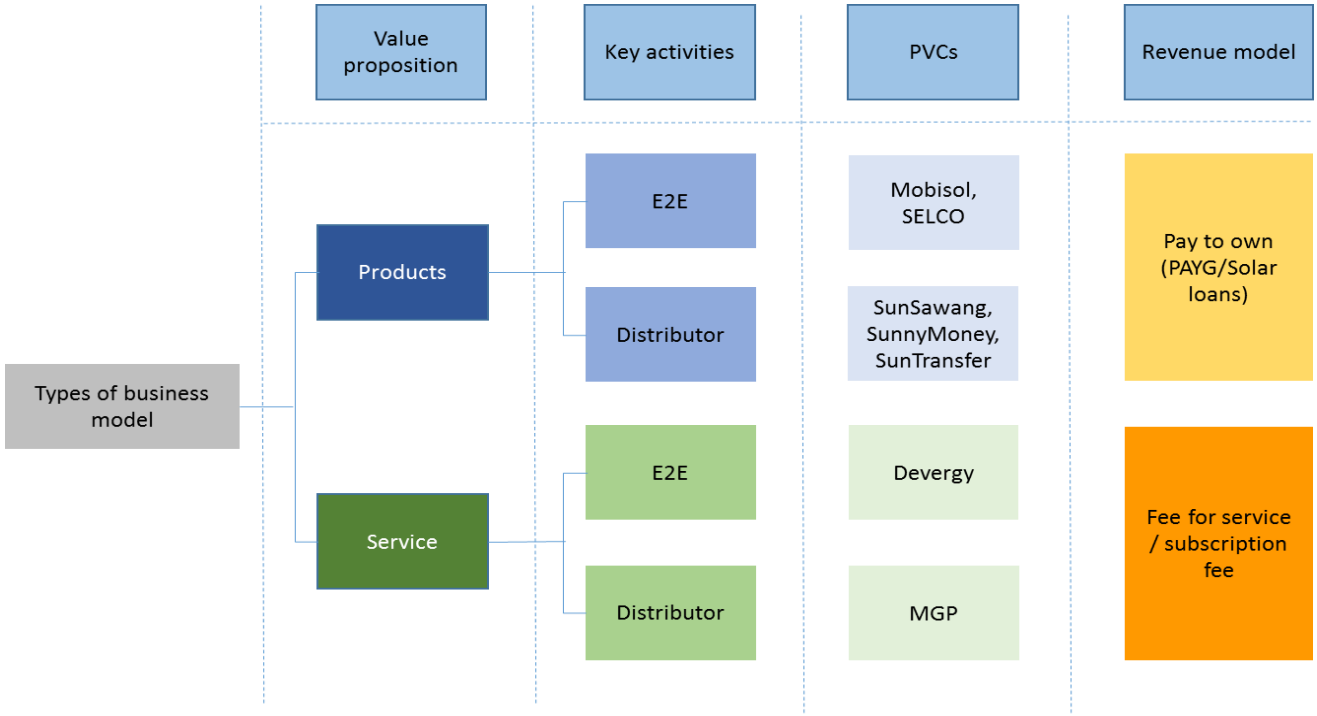

Figure 4.3. Summary of different types of business model employed by PVCs

Finally, the different types of business models employed by the companies will lead to different cost structures. The more activities are done by the companies' themselves, the higher costs needed to operate their business

4.1.2 Business model elements: Customer segmentation

One element of business model is the customer segment. This element describes a group of people whom the companies aim to serve with its value proposition. It is explained in the previous section that our research focuses on the BoP market. However, from the interview, it could be concluded that there is no company that can serve 100% of BoP market. There is always room left by the company because of several reasons, such as costs and risks. Thus, before we discuss the barriers experienced by PV companies, it is important to understand which group of people the companies sell its value proposition.

Figure 4.4 shows different targeted customers group from different PV companies. The lower tier of BoP could be classified as a group of people with the lowest income in the BoP segment, while the upper tier means a group of people with a higher income inside the BoP segment. From the figure, it could be concluded that the companies with the E2E business model tend to aim the middle and upper tier of BoP market. SunSawang, one of the companies with distributor business model, also try to reach a group of people who sit in the middle and upper tier of BoP. These group of people tends to have lower financial risks since they have a higher income than the other groups in the BoP market. The other companies, which employ the distributor

business model, as well as Devergy, one of the companies which employed service provider and E2E model, aims to serve the mid-tier of BOP market. MGP is the only company which aims to serve the lower tier of BoP market compared to the other companies.

From the interview result, we could conclude that the choice of the customer segmentation has its own unique implication. A different choice of customer segment could lead to different technologies or services which could be offered to the customers. It is because a different customer segment will have a different "willingness to pay" of value proposition offered by the companies. Thus, right products or services will determine the success of the companies doing its business.

Mobisol and SELCO, the companies which employ the E2E business model, aim to serve the upper tier of BoP market. From our interview, this type of customers usually has a stable income and enough money for living although they still do not have access to financial institutions. Furthermore, it could be concluded that these types of customers tend to use more electricity than the lower tier group. Thus, Mobisol and SELCO offer solar home systems to fulfill their customers' needs. SunSawang, one of the companies which employ the distributor business model, also aim to reach customers on the mid-upper tier of BoP market. Thus, the company also offers big systems such as SHSs to fulfill its customers' needs of electricity.

SunTransfer and SunnyMoney aim to reach the mid-upper tier of BoP market. Thus, the types of customers could have more variation compared to the customers served by SELCO, Mobisol, and SunSawang. Thus, SunTransfer and SunnyMoney try to serve wider scope of customer segments with a wider variation in its products. SunTransfer and SunnyMoney offer big systems such as a complete SHS to fulfill their customers' needs on the upper tier of BoP. However, the companies also offer small systems such as solar lamps or solar lanterns for those customers who have lower income. In this way, SunnyMoney and SunTransfer try to fulfill the variation of their customers' needs based on their income by offering a wide variation of products.

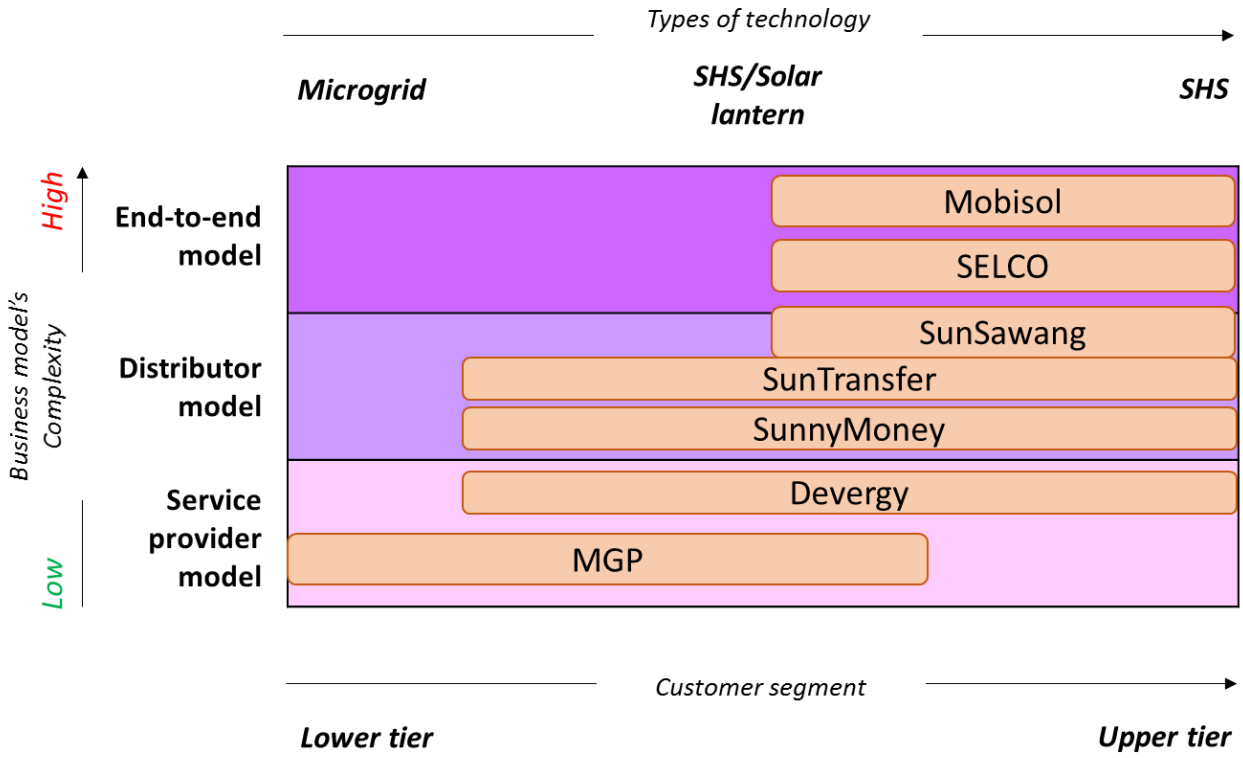

Figure 4.4. Customer segmentation of different PVCs

MGP and Devergy, like utility companies, offer different value proposition compared to other companies. Instead of offering PV products, MGP and Devergy offer reliable electricity services for its customers. In doing so, these companies use PV micro grid to deliver electricity to their customers. MGP and Devergy have a slightly different customer segment, where MGP aims to serve the customers from the bottom

tier of BoP market and Devergy aims to serve the customers which are on the a slightly upper tier of BoP market compared to MGP. The choice of these targeted customers influences the choice of technology used in the PV microgrid systems. MGP offers electricity at the pre-set time which could be used to electrify pre-determined electrical appliances, such as two lamps and one mobile charger. This offer could be achieved only by using a simple PV microgrid system with an automatic pre-set time. By using simple PV microgrid, MGP could reduce the cost of its technology and sell its services at the lowest price possible to its customers. Nevertheless, MGP sacrifices the freedom of choices of the customers since they only have electricity for limited appliances at a limited amount of time. This condition is different with Devergy model since the company aims to serve the mid-upper tier of BoP. Devergy offers a freedom of choice for its customers to decide what appliances they want to use as well how much electricity they need. This offer leads to Devergy to put more investments in its technology compared to MGP. Devergy uses a smart meter to control the electricity use. This smart meter is used to control the electricity quota on each of the customers' house. When the customers run out of quota, they could top-up the quota by paying a certain amount of credits through the mobile money. Otherwise, the systems will be shut down by the company. Although Devergy offers much flexible electricity uses, it could be concluded that the weekly fee of its service is higher than MGP's service fee. It is because the company needs to invest more in the technology, especially the automatic smart meter which needs to be installed in every customers' house. Thus, it leaves 20% of the lower tier of BOP market which could not be served by Devergy.

4.1.3 Barriers and other elements of business model

In this part, the several barriers which influence PV companies' business are discussed. Firstly, the significances of each of the barriers are presented, then elements of business model, which are used by the PV companies to overcome those barriers are compared. Finally, the relation of the significances of each of the barriers and the elements of business model could be concluded.

4.1.3.1 Infrastructure

It is interesting on how PV companies experience the infrastructure barriers differently. Although all the PV companies which have been interviewed operate mainly in rural areas, not all of them experience difficulties in reaching its targeted customers. Figure 4.5 shows the infrastructure barriers experience by different PV companies. From the figure, we could see that Mobisol is the only company which experiences no difficulties in reaching its customers. The company explains that all the areas have good road and communication infrastructures except during the rainy season. The different experiences on infrastructural issues lead to the different choice of business models' elements, especially on how the company reaches its customers. Thus, the companies' channel, key partners, and key resources are discussed to understand on how each of the companies overcome infrastructural issues differently, as shown in Table 4.2.

From Table 4.2, it could be concluded that the more significant the infrastructural issues, the more PV companies rely on the third party to reach its customers. It is because the more difficult access to reach the customers, the more cost required to serve the customers. All PV companies which focus on distribution, such as SunSawang, SunTransfer, and SunnyMoney, do not sell its products directly to their end-users. These companies rely on the existing sales infrastructure such as local MFIs and local entrepreneurs who could help the companies sell and deliver the products to its end users. These MFIs and local entrepreneurs act as the companies' partners who operate based on commissions, or in the case of MFIs; they earn profits from the sales of the products. Most of these local entrepreneurs or sales agents or sales representatives as well as the local MFIs are located in the trading center or the village. They cover an area with a radius of 30 km or approximately two hours travel. In this way, SunSawang, SunTransfer, and SunnyMoney are able to reach its targeted end-users in rural areas without sacrificing high operational costs.

On the other hand, the less significant the infrastructural issues, the fewer PV companies rely on the third parties to reach its customers. It means that the PV companies with low infrastructural issues tend to have its own resources to deliver its value proposition and its promises to the end-users. SELCO describes that

the company experiences infrastructural issues as moderately significant. Despite relying only on the commission agents, the company also invests on Energy Service Centers which cover areas with a radius of 80 km as well as warehouses. The company sells its products through the commission agents and its own sales forces. Devergy and MGP describe the infrastructural issues as slightly significant towards its business. Devergy explains that its end-users could be reached by using local transportation or local bus. Also, MGP relies on its own branch offices which cover areas with a radius of 20 km to reach its customers. Since the operational areas of MGP and Devergy are considered reachable by the companies, MGP and Devergy rely on its own resources, such as the companies' sales and marketing team, as well as the third parties who operate based on the commissions.

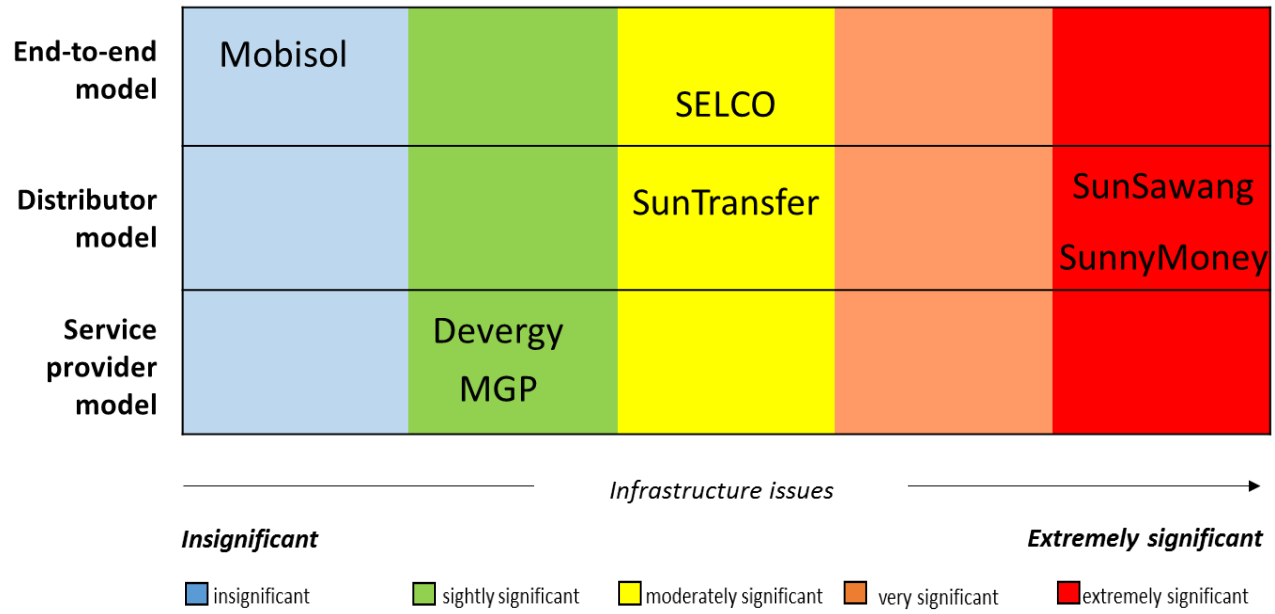

Figure 4.5. Infrastructural issues faced by PVCs

Table 4.2. Infrastructural barriers vs. elements of business model applied by PV companies

	Name of company	Element of business model		
		Channel	Key partners	Key resources
End-to-end model	Mobisol	• Mobishops • Local sales agents (commission based)	Local sales agents (commission based)	• Mobishops • Regional branches • Mobisol's sales force
	SELCO	• SELCO's Sales force • Commission agents	Commission agents	• 49 ESCs • 2 warehouses
Distributor model	Sunsawang	Sales representatives (commission based)	• Sales representatives and local technicians (commission based) • Local networks of village leaders	Sunsawang's head office and team
	SunTransfer	**Retail:** Local MFIs	Local MFIs	Suntransfer's sales force
	SunnyMoney	Local sales agents (commission based)	Local sales agents (commission based)	SunnyMoney's sales team
Service provider model	Devergy	• Devergy's sales force • Local sales agents	• Local transportation (bus) • Local sales agents and technicians (commission based)	• Devergy's sales & marketing team • Logistics team • Warehouses & Regional hubs
	MGP	MGP's Sales & marketing team		Branch offices and branch offices team

insignificant sightly significant moderately significant very significant extremely significant

Mobisol, which is the only company without infrastructural issues, has more flexibility on how the company reaches its customers compared to other PV companies. Since the company does not have any

difficulties in reaching its customers, Mobisol could focus on winning the competition by having good visibility in the community to earn the customers' trusts. Mobisol could easily own dedicated shops, called Mobishops, which are located close to the company's targeted end-users. The company also owns regional branches as well as establishes partnerships with local sales agents who operate based on commissions.

In summary, the more significant infrastructural barriers faced by PV companies, the more PVCs rely on the third parties to reach its end-users to reduce operational costs. It also means the lower infrastructural issues lead to the more flexibility that the PVCs have to reach its end-users. The flexibility of choices is determined by how much investments that the PVCs willing to make in order to reach its end-users and win ahead of the competitions in BOP market.

4.1.3.2 Investment

Figure 4.6 shows a plot of significances of investment barriers towards the companies' business. In general, all PV companies, which we have interviewed, describe that it is hard to secure investments and grants for their business, especially in the early phase of the company. Furthermore, commercial loans are not available for these types of companies. It is because the rural electrification industry and the BoP market are not mature enough and have huge risks for new business. All the companies that we have interviewed rely on donors, philanthropic funding's, and grants from the third parties. These third parties could be an institutions, organization, or even a crowdfunding community who are interested in doing business on PV for rural electrification at the BOP market. All the companies that we have interviewed agree that they do not receive funding from the third parties which have different vision and mission with them. While access to the commercial loans is insufficient, Mobisol, SELCO, and SunTransfer have managed to secure some commercial loans. It is because, these companies could prove that they are financially healthy, for instance, in general, these companies have a good cash flow as well as have been able to generate enough profit for themselves.8

From this result, it could be concluded that the choice of business model cannot be derived from the significances of investment barriers. All the companies are racing to secure as much funding and investment as possible from any resources they could possibly find.

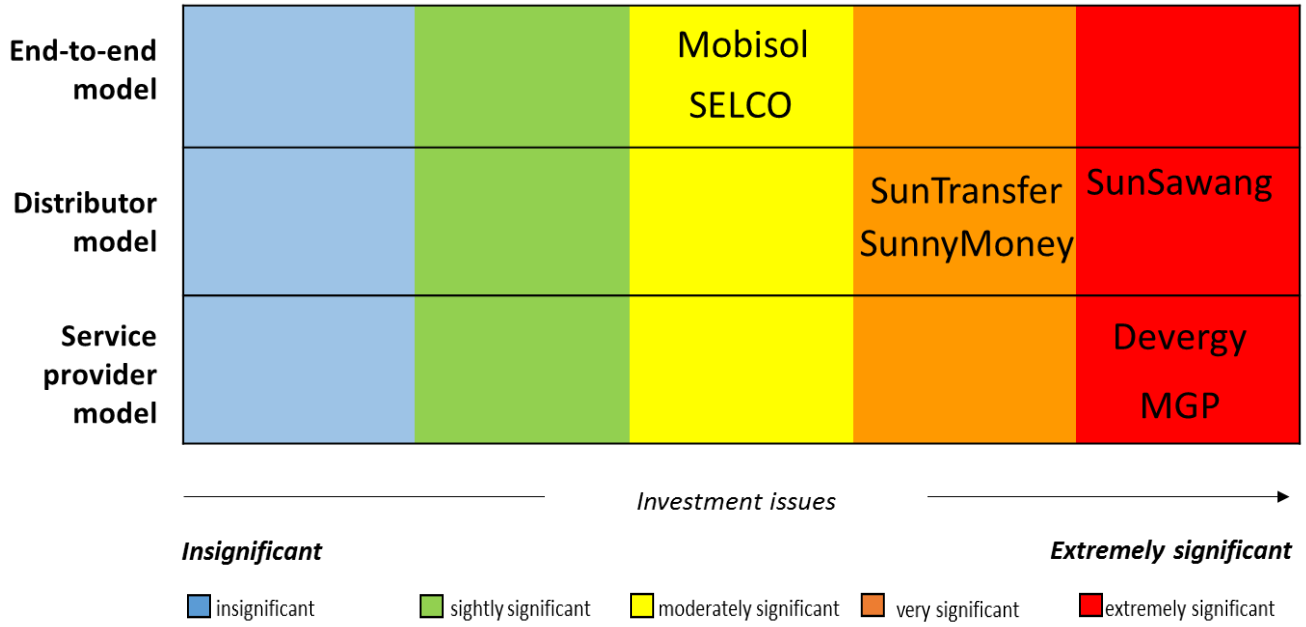

Figure 4.6. Investment issues faced by PVCs

4.1.3.3 Financial

Figure 4.7 shows the significances of financial barriers face by different PV companies. From the figure, we could see that majority of PV companies experience relatively high financial issues from its customers' sides. It is because the main target of these companies is a group of people who live at the BoP and have

limited financial access or financial supports. However, MGP describes the financial issues as slightly significant towards its business. It is because MGP could offer value proposition which is well-matched its customer's profile. From the interview, MGP explains that the company offers electricity service at the same price or lower than the consumption of kerosene at the same amount of time. This offer becomes very attractive for those who live even at the lower tier of BoP. Hence, this condition increases the "willingness to pay "and reduces financial issues on the customers' sides faced by MGP.

The different experiences on financial issues from the customers' side could lead to different elements of business model applied by the PV companies, especially the ways of companies collect its revenue streams. Thus, the companies' key partners, key activities, key resources and revenue streams are discussed to understand on how each of the companies overcome financial issues on the customers' side differently, as shown in Table 4.3.

From Table 4.3, we could conclude that the ways of PVCs collect its revenues are highly dependent on the risks emerge from the financial issues on the customers' side as well as its value proposition. For those companies which offer products to the end-users, the more significant the financial issues, the more PV companies tend to transfer the risks of payment default to the third parties, such as banks or other financial institutions. For those companies which provide electricity services to the end users, the risks of payment default could not be transferred to the third parties. It means that those types of companies should be able to take up the risks by themselves.

PV companies which transfer the risks of payment default are SELCO, SunTransfer, and SunnyMoney. These companies receive its revenues in cash from its third parties, such as banks and MFIs. In this way, these companies transfer the risks of payment default to the third parties as well as enable the end-users to pay for the PV systems in installments with an agreed interest rate at a certain amount of time. However, this type of payment scheme could work if only the customers are aware of the banking or installment systems and they live nearby the banks, MFIs, or other financial institutions where they could easily pay for the systems. SELCO could have experienced high payment defaults because the company relies 100% on its customers to make the payment for the systems to the banks. Although SELCO has transferred the risk of payment default to the banks, a high payment default will affect the trust from the banks towards SELCO's business model. Thus, it important that SELCO makes sure that the end-users are able to pay back the systems to the banks. SunTransfer and SunnyMoney's payment schemes could have lower risks of payment default than SELCO. It is because these companies have PAYG systems which are handled by the local MFIs (SunTansfer) and the local sales agents (SunnyMoney) where the end-user could make the installments for their PV systems or top up their electricity credits. If the end-users fail to pay the installments, they will not have enough electricity credits for their systems. Hence, the systems will go off.

However, there is an exception for SunSawang. Although the company possesses huge risks from the financial issues on the customers' side, SunSawang decided to provide solar loans for its customers which are managed by the company itself. The revenue is collected once a year directly by SunSawang's team or through the sales representatives in the villages. This scheme might be possible because the size of the company is small enough compared to the other companies, such as SELCO, SunTransfer, and SunnyMoney. Thus, SunSawang is willing to take risks on its financial issues.

From Figure 4.7, we could see that Mosbisol's experience on the financial issues is slightly lower than most of PV companies interviewed for this research. From the interview, Mobisol describes its financial barriers as moderately significant. Thus, the company collects its revenue directly from the customers. Mobisol offers flexible three years installment which could be paid through PAYG scheme using mobile money. This payment scheme is only possible because Mobisol uses smart meter technology installed on each of the SHSs. The installments could be made whenever the customers have the money, or they run out of electricity credits. The meter is used to control the electricity usage of each of Mobisol's customers. Thus, the company needs to invest in the research and development team to develop such technology. Also, Mobisol has established partnerships with mobile networks to enable payment through mobile money.

Another exception could be seen from Devergy. Although the company describes financial issues as extremely significant towards its business, the company could not transfer the risks to the third party. It is because of Devergy, as a utility company, offers electricity services as its value proposition. Devergy uses a smart meter to control the electricity use and pre-paid mobile money for the payment systems. The smart meter is used to control the electricity quota on each of the customers' house. When the customers run out of quota, they could top-up the quota by paying a certain amount of credits through the mobile money. Otherwise, the systems will be shut down. In this way, Devergy reduces the risks of payment default from the customers automatically. To enable this payment collection scheme, Devergy needs to invest in the smart meter technology as well as the R&D team to work on the meter. The company also needs to collaborate with mobile networks to enable subscription fee through mobile money. This condition is different with MGP's payment scheme. As the company has lower risks of payment default than Devergy, MGP collects its revenue directly through the weekly collection. The end-users pay a fixed service fee for the electricity services delivered by MGP. However, this direct collection model could work if only the company has quite low infrastructural barriers. It is because the barriers on the infrastructural aspects will influence the difficulties to reach the collection point as well as the cost required to collect the payment.

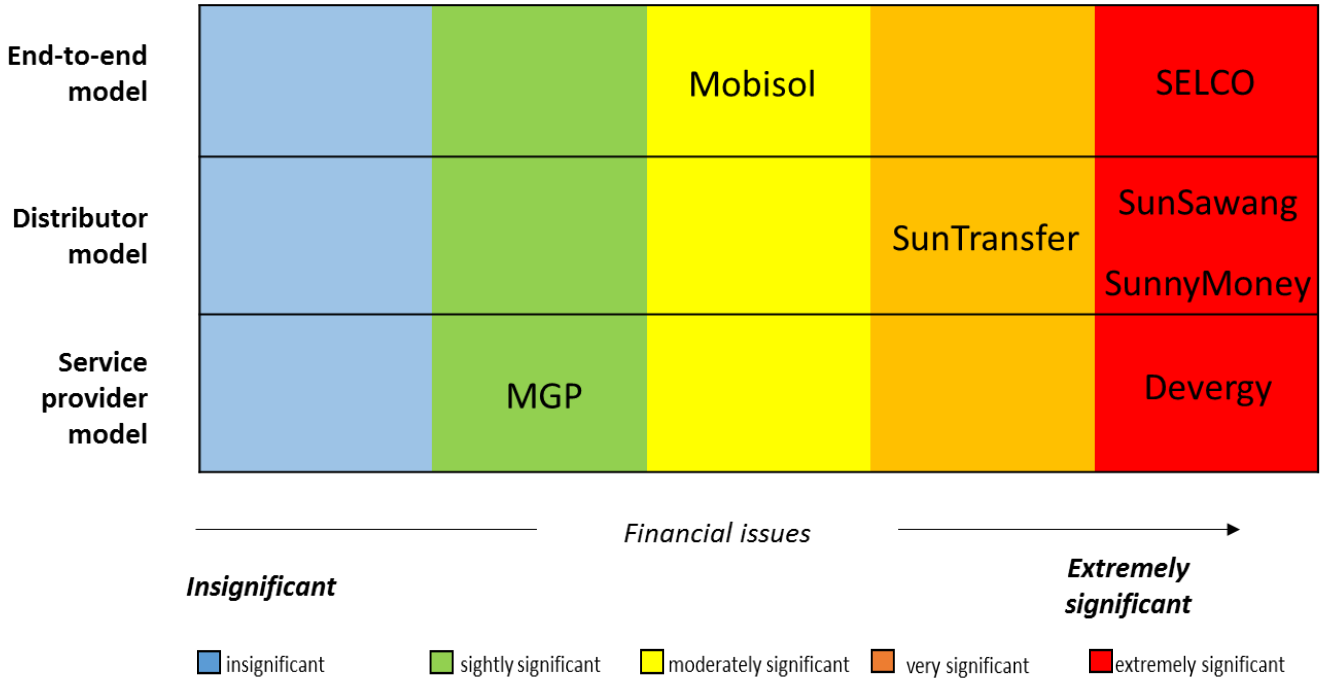

Figure 4.7. Financial barriers faced by PVCs

In summary, the ways of PVCs collect its revenues are highly dependent on the risks emerge from the financial issues on the customers' side as well as its value proposition. For those companies which offer products to the end-users, the higher risks of a payment default or, the more significant the financial issues, the more PV companies tend to transfer the risks of payment default to the third parties, such as banks or other financial institutions. On the other hand, those companies which provide electricity services to the end-users, the risks of payment default could not be transferred to the third parties. It means that those types of companies should be able to take up the risks by themselves. Besides, there are other factors which influence the choice and the success of the payment scheme employed by PVCs. Based on this study, it could be concluded that factors such as the size of the company, infrastructural barriers, technological investments, the location of the banks, and the behavior of the customers it selves. Table 4.4 shows how different companies determine the ways of its payment or revenue collection from the risks which might influence their business as well as the factors which influence the success of payment or revenue collection applied by PV companies.

Table 4.3. Financial barriers vs. elements of business model applied by PV companies

	Name of company	Element of business model			
		Key partners	Key activities	Key resources	Revenue streams/model
End-to-end model	Mobisol	Mobile network operators	Financial planning	R&D team	PAYG or pay-to-own on 3 years installment directly to Mobisol
	SELCO	30 financial institutions			3-5 payment plan through partnering banks (solar loans)
Distributor model	Sunsawang	Sales representatives and local technicians	Payment collection		5 years payment plan collected yearly (solar loans)
	SunTransfer	Local MFIs	Payment collection		Product sales in cash from MFIs
	SunnyMoney	• Local sales agents • FINCOOP	Payment collection		Product sales in cash from FINCOOP
Service provider model	Devergy	Mobile network operator		R&D team	Subscription fee through Mobile money
	MGP	Joint liability group	Payment collection	Collection team	Weekly service fee

insignificant | sightly significant | moderately significant | very significant | extremely significant

Table 4.4. Payment or revenue collection derived from barriers significances and factors which influence its success

	Barriers significancies	Payment or revenue collection method	Name of company	Factors influencing success of payment or revenue collection
End-to-end model or Distributor model	Very to extremely significant	The end users pay the installment through banks partners at agreed interest rate at certain amount of time	SELCO	• The distance of the banks with the end-users (the location of the banks) • Customers' awareness of banking and installment systems • Customers behaviour to pay the installment on time
		The end-users pay installments to the companies' partners (local MFI or sales agents) through PAYG systems	SunTransfer SunnyMoney	• The companies' third parties are equipped with PAYG devices • A meter is available on the SHS to control the electricity credits
		Solar loans which is collected directly by the company	SunSawang	The size of the company (small company)
	Moderately significant	The end-users pay directly to the company through PAYG scheme	Mobisol	A PAYG and smart meter are available on the SHSs to control the electricity usages or credits
Service provider model	Extremely significant	Flexible and pre-paid subcription/service fee through PAYG scheme using mobile money	Devergy	Smart meter technology
	Slightly significant	Fixed service fee collected through weekly direct collection	MGP	Low infrastructural barriers

insignificant | sightly significant | moderately significant | very significant | extremely significant

4.1.3.4 Human resources

Based on the result of our interview, it could be concluded that all PV companies experience the barriers on finding good human resources for the companies differently. Figure 4.8 shows a plot of significances of issues on human resources towards the companies' business. From the figure, we could see that SunTransfer is the only PV Company which has an adequate amount of skilled and trained people to hire

by the company. While other PV companies' experiences on finding a good source of qualified human resources vary a lot, these PV companies which experience issues on human resources aspects agree that it is rather hard to find trained and qualified people in the country where the companies operate the business. It is because there is limited access to education as well as a lack of well-educated role model in the country. This condition leads to limited well-trained and well-educated candidates to match with these PV companies qualification, especially at the managerial level. However, it is easier to find people to work for local technicians' position.

Although these PV companies experience the issues related to human resources differently, these companies agree that it is important to have continuous training for their employees when these companies see there is a lack of qualified candidates to work in these companies. Mobisol even has its own training institutes called Mobisol Akademie to make sure that all of its employees and its partners, such as local technicians and local sales agents who operate based on commission, are equipped with adequate knowledge and training from the company. Devergy and Mobisol explain that another way to overcome the issues related to lack of skilled human resources is to increase the pool of talents or candidates for each of the positions available in the company. Nevertheless, SunnyMoney describes that despite training from the company, there are things that are impossible to be done in the country, where the company operates its business, because of the issues related to human resources, such as manufacturing process. Thus, much company produces its products abroad because manufacturing the products locally is merely impossible.

In summary, there is no pattern which can be drawn to derive a business model from the barriers on human resources aspects. From this study, it could be concluded that there are several ways to overcome issues related to human resources. Firstly, adequate and continuous training need to be prepared by PV companies. Secondly, the company needs to increase the number of candidates for each of the positions in the company. Lastly, for things that are impossible to be done locally, it is better to have them done by the third party even if they are located abroad.

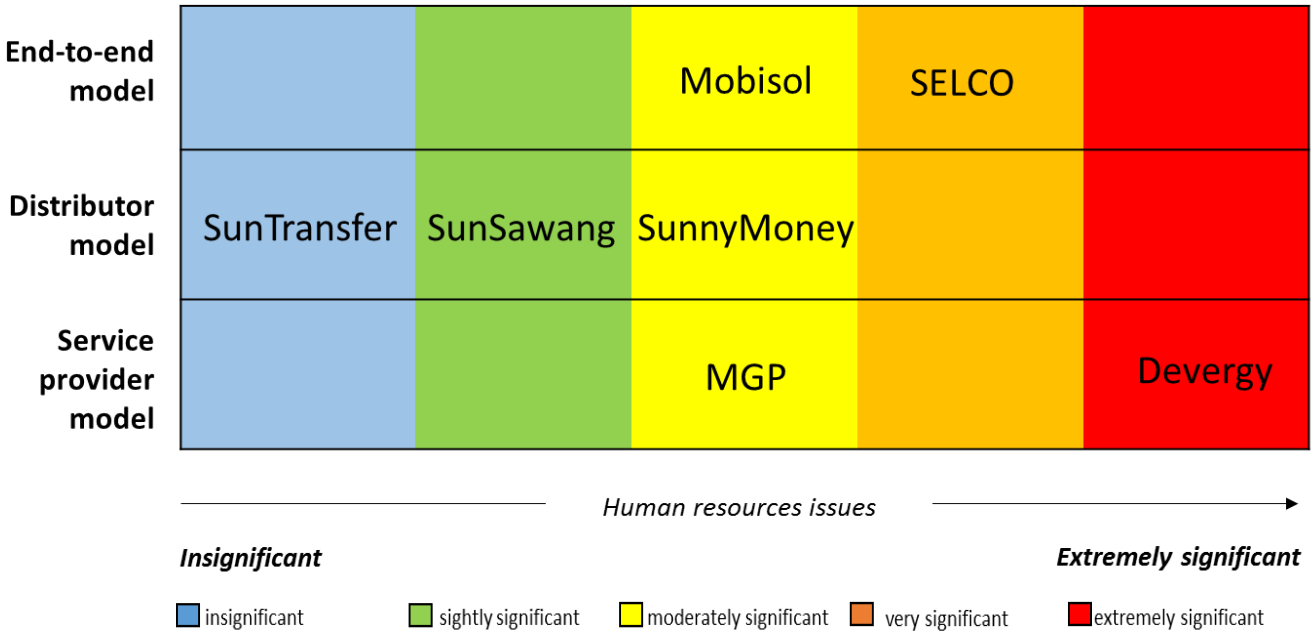

Figure 4.8. Human resources issues faced by PVCs

4.1.3.5 Technical

Figure 4.9 shows the differences of the significances of technical issues faced by PV companies which focus on the rural energy market. From the figure, we could see that the technical issues faced by the PV companies vary a lot. Devergy and SunSawang are the companies which describe that the technical issues are insignificant towards its business, while other companies show slightly higher remarks.

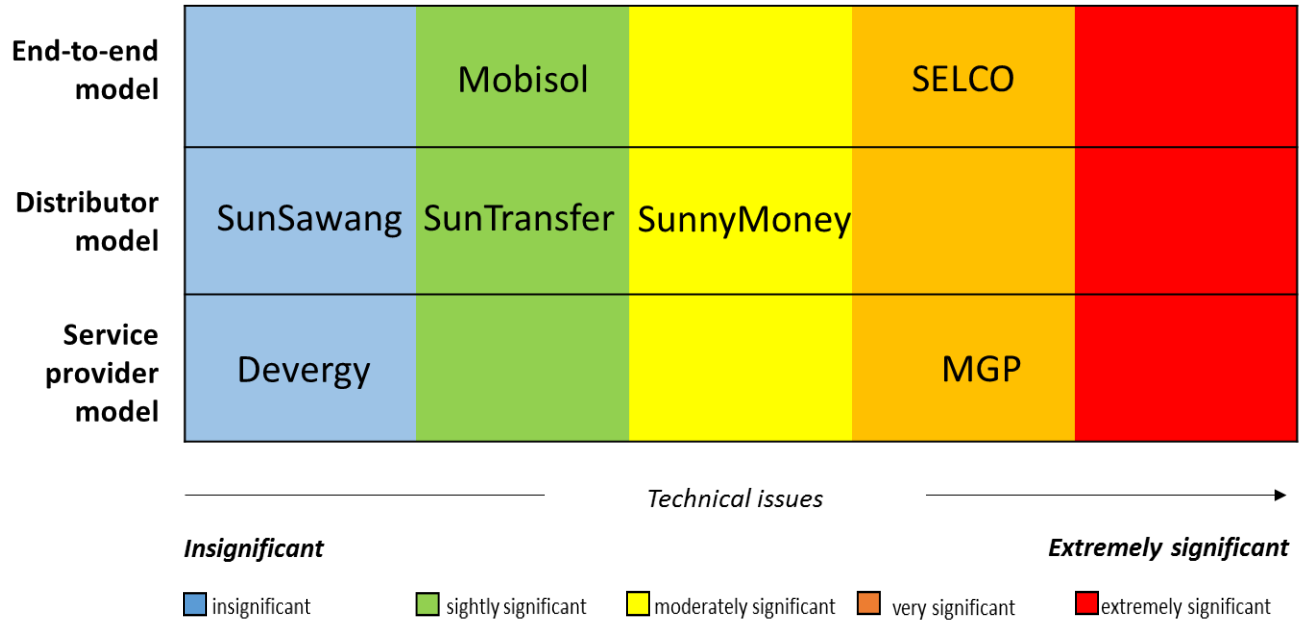

Figure 4.9. Technical issues faced by PVCs

Table 4.5. Technical barriers vs elements of business model applied by PV companies

	Name of company	Element of business model		
		Key partners	Key activities	Key resources
End-to-end model	**Mobisol**	• Foreign manufacturing companies • Lighting global certification	• Products design • Importation • QC/QA	• QA team • R&D team
	SELCO	• International R&D instituties • Universities • Local companies	R&D	• R&D team • QA team • Incubation labs
Distributor model	**Sunsawang**	Local and foreign PV manufacturing companies and suppliers	Importation and QA	
	SunTransfer	• Solar association • Foreign PV manufacturing companies/suppliers	Importation	
	SunnyMoney	• Lighting africa • Foreign manufacturing companies/suppliers	Importation	
Service provider model	**Devergy**	• Local and foreign PV manufacturing companies or suppliers • QA partnering company	• Products design • Importation	R&D team
	MGP	80% local and 20% foreign PV manufacturing companies or suppliers	• Importation • QC	• Mobile apps • QC team

insignificant | sightly significant | moderately significant | very significant | extremely significant

According to the interview results, all the companies which operate in Africa, such as Mobisol, SunTransfer, SunnyMoney, and Devergy, face similar technical issues which are the lack of standardization of PV products from the national government. Thus, a lot of cheap and low-quality PV products which are sold in the markets without control from the government. This condition could be a problem for the companies which sell PV products to its customers, such as Mobisol, SunnyMoney, and SunTransfer. From Table 4.5 we could see that these three companies rely on the third party such as Lighting Africa, Lighting global, and local solar association to overcome these difficulties. Mobisol, which designs and produces its own PV brand, the company obtains industrial certification from the Lighting Global in order to show that the company only sells good quality products. SunTransfer and SunnyMoney which apply distributor business model rely on other organization to choose the products that the companies sell in the market. SunnyMoney only sells products

which are certified by Lighting Africa, while SunTransfer only sells PV products which certified by the Solar Association in the country where the company operates its business. On the other hand, the issues related to the certification and the standardization of PV products do not affect Devergy's business. It is because Devergy sells electricity, not the products. Thus, the company focuses on providing reliable electricity services to its customers. This reliable electricity services could be done by using good quality PV products. Since Devergy designs and partly produces its own systems, the company could make sure the quality of its systems. Hence, the technical issues related to the lack of standardization from the government is no longer an issue for the company.

SELCO and MGP show higher remarks on the technical issues compared to other companies. However, according to our interview, this high remark on the technical issues are caused by external forces and one-time issues. SELCO explains that the company could not expand its business quickly because there is a lack of innovation from current PV and other electrical appliances' manufacturers. SELCO describes that most of the current electrical appliances do not fit with PV requirements. The company describes that current electrical appliances are not efficient enough to be powered by PV systems. Hence, it wastes of money. Thus, SELCO faces difficulties on developing its customer segments because there are only limited options on supporting electrical appliances which are available in the market. Thus, the company works together with the universities, local companies, and other R&D institutes to stimulate and accelerate the innovation for appliances which are suitable for PV products.

MGP, just like Devergy, the technical issues, which are faced by the utility companies, are ideally quite insignificant. However, in the case MGP, where the company uses a direct payment collection, the technical issues related to the payment default could be higher compared to Devergy, where the company relies on the automatic systems. MGP describes that the company used to face a one-time technical accident which could not be repeated. The company faced a payment default because there was a lack of control and project management. Thus, MGP develops a mobile application and arrange a quality control team to go to the villages and make sure there is no technical issues happen on the field.

Technical issues which are faced by PV companies which we have been interviewed happened due to various reasons. Thus, each of the companies overcome those barriers with different solutions which are tailored to specific technical barriers. From Table 4.5, it could be seen that there is no general correlation which can be drawn from the technical barriers faced by PV companies with the business model used by these companies to overcome technical issues which influence its business.

4.1.3.6 Market demand

Market demand is one of the important issues faces by PV companies which operate at the rural and BOP market. It is because not all people who live at the BoP could afford the high up-front cost of PV technology. Despite a good business or revenue model, a proper education and socialization are required in order to stimulate demand for PV technology at the BoP market. Based on our interview with PV companies, there are several reasons which influence the market demand at the BoP market. Firstly, although the technology could be paid through flexible installment, the amount of money which the villagers need to pay for a PV technology is still slightly higher than the amount of money they pay for kerosene for the same amount of time. Thus, a proper education is important to switch the villagers' mindset. Secondly, in some countries, there are PV technologies which are sold at a very low price. However, the quality of these types of PV technology is very low. Furthermore, there are several government programs which give the PV systems for free. However, these programs are often followed without adequate after sales services and maintenance. The low-quality PV products and the failure of government programs to introduce PV technology to the villagers could lead to disappointment of the users and mistrusts of the potential PV users. Thus, the use of good quality products followed by a proper socialization, marketing activities, and adequate after-sales services are essential to earn back trusts from the community as well as to stimulate the demand for PV technology.

Figure 4.10 shows the significances of market demand barriers face by different PV companies. From the figure, it could be concluded that each of the companies experiences difficulties on stimulating market

demand at the BOP market differently. The reasons behind this variation could depend on three factors. Firstly, the awareness of the people in the country where the PV companies operate its business about PV technology. Secondly, the previous or existing PV programs from the government which play an important role in increasing awareness of PV technology in the community. Thirdly, the value proposition offered by PV companies.

SunSawang is the only company which describes barriers on market demand as insignificant towards its business. It is because the government of Thailand had invested a lot for donor-driven PV project before SunSawang began its operations in 2012. The company describes that their targeted customers have been exposed to large solar home systems from the Thailand's government's program since 2004. Thus, the lack of awareness of the technology from the users' side is no longer an issue for SunSawang.

From Table 4.6, it could be concluded that the more significant the market demand barriers, the more key partners and resources involve helping the company to stimulate demand in the companies' targeted customers. SunSawang which describes market demand barriers as insignificant relies only on the local people in the villages such as sales representatives or local technicians as well as the village leader to stimulate the demand for PV technology and promote its products. Mobisol and SELCO deem their experiences on the barriers related to market demand are slightly higher than SunSawang. Thus, these PV companies not only rely on its sales agents who operate based on commissions but also rely on its own resources. Mobisol aims to earn trusts from the villagers by having dedicated local shops called Mobishops. In the Mobishops there is always a full-time salesperson who is responsible for promoting and stimulating demand for Mobisol products. SELCO relies on the ESC managers and its team who are responsible for all the company's operational activities. SunnyMoney and SunTransfer describe the barriers on market demand are extremely significant. Thus, these companies rely on both its partnerships with other organization, institutions or trusted people in the villages as well as its own resources. SunTransfer relies on the network of local MFIs which these MFIs have many experiences in promoting products in the rural energy market. Together with Suntransfer's team, the local MFIs help the company to promote the products and earn trusts from the people through community gatherings, local events, and during the market days. The company relies on other organizations such as Lighting Africa and Lighting Global help to promote solar energy in general. SunnyMoney stimulates the demand for its products through several channels such as community meetings, school programs, and its own marketing activities. Thus, the company relies on its partnerships with the local schools, the local respected people such as village leader, the ministry of education, marketing firms, and other NGOs to help the company increase the demand for PV products in general as well as SunnyMoney products.

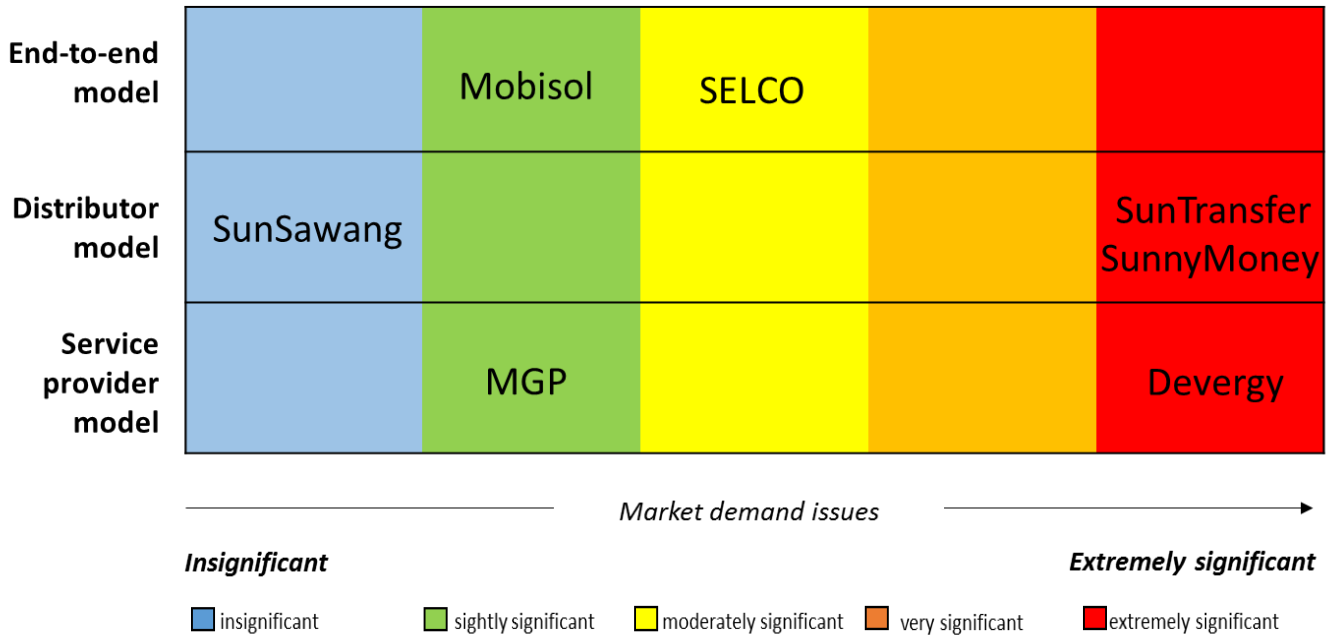

Figure 4.10. Market demand issues faced by PVCs

Despite selling PV technologies, Devergy and MPG focus on selling the electricity in an exchange of service fee. People in the villages are already aware of electricity. However, there is limited access to electricity, especially in rural areas. Often, they could not afford to have electricity although they live nearby the national grid due to high up-front installation costs. Hence, the demand for electricity is already on the market yet it depends on how much the electricity costs. In the case of independent utility companies, such as Devergy and MGP, it depends on the value propositions. MGP experiences lower difficulties on the market demand issues than Devergy. It is because MGP could sell its electricity services at the same price as the subsidized kerosene while Devergy sells its services at a slightly higher price than the price of kerosene. Thus, there are still some group of people who hesitate to use Devergy's services. Devergy relies on both its own resources and its partners to promote Devergy's services around the country. The company conducts road shows throughout the regions to attract new customers. Devergy also relies on the local sales agents or technicians to promote its services based on commissions. This condition is very different compared to MGP which rely only on its own resources to attract new customers. The company only relies on the presence of its branch offices nearby the villages and its sales and marketing team to create the demand for its services.

In conclusion, different elements of business model could be derived from the barriers on market demand faced by PV companies. Based on this study, it could be concluded that the more significant the market demand barriers, the more key partners and resources involve helping the company to stimulate demand in the companies' targeted customers.

Table 4.6. Market demand barriers vs. elements of business model applied by PV companies

	Name of company	Element of business model		
		Channel	Key partners	Key resources
End-to-end model	Mobisol	• Mobishops • Telesales	Local sales agents (commission based)	• Mobishops • Mobisol's sales and marketing team
	SELCO	• SELCO's Sales force • Commission agents	Commission agents	• ESC managers • Sales and marketing team
Distributor model	Sunsawang	• Sales representatives and local technicians (commission based) • Sunsawang's head office	• Sales representatives and local technicians (commission based) • Local networks of village leaders	Sunsawang's head office and team
	SunTransfer	Local MFI networks	• Lighting Africa • Lighting Global • Local MFIs	Suntransfer's sales force
	SunnyMoney	• SunnyMoney's sales team • School programs • Community meetings program	• Ministry of education • Local schools • Local marketing firm • NGOs	SunnyMoney's sales team
Service provider model	Devergy	• Devergy's sales force through roadshows • Local sales agents	• Local sales agents and technicians (commission based)	• Devergy's sales & marketing team
	MGP	• MGP's sales & marketing team • MGP's branch office		Branch offices and branch offices team

insignificant | sightly significant | moderately significant | very significant | extremely significant

4.1.3.7 Social, behavioral, cultural

Figure 4.11 shows the significances of social, behavioral, and cultural barriers face by different PV companies. From the figure, it could be concluded that the barriers related to social, behavioral, and cultural aspects are moderately low, except for SELCO. SELCO deems the barriers one these aspects as extremely significant. Based on our interview with SELCO, the company explains that SELCO aims to serve the customers who are in different level of poverty. It means that the company tries to serve bigger customer segment than other PV companies in India in order to develop its business as well as to win the competition in the market.

This group of customers has huge variations in occupations, income, as well as norms and culture. Thus, SELCO needs to fulfill the different needs of these customers. To achieve that goal, SELCO relies on heavily on local talents and its own resources in the form of ESCs as well as its employees to do most of the operational activities from marketing, demonstration, sales, installation, maintenance and services. In this way, SELCO aims to grab attention and trusts from new customers from a different level of poverty and expand its business.

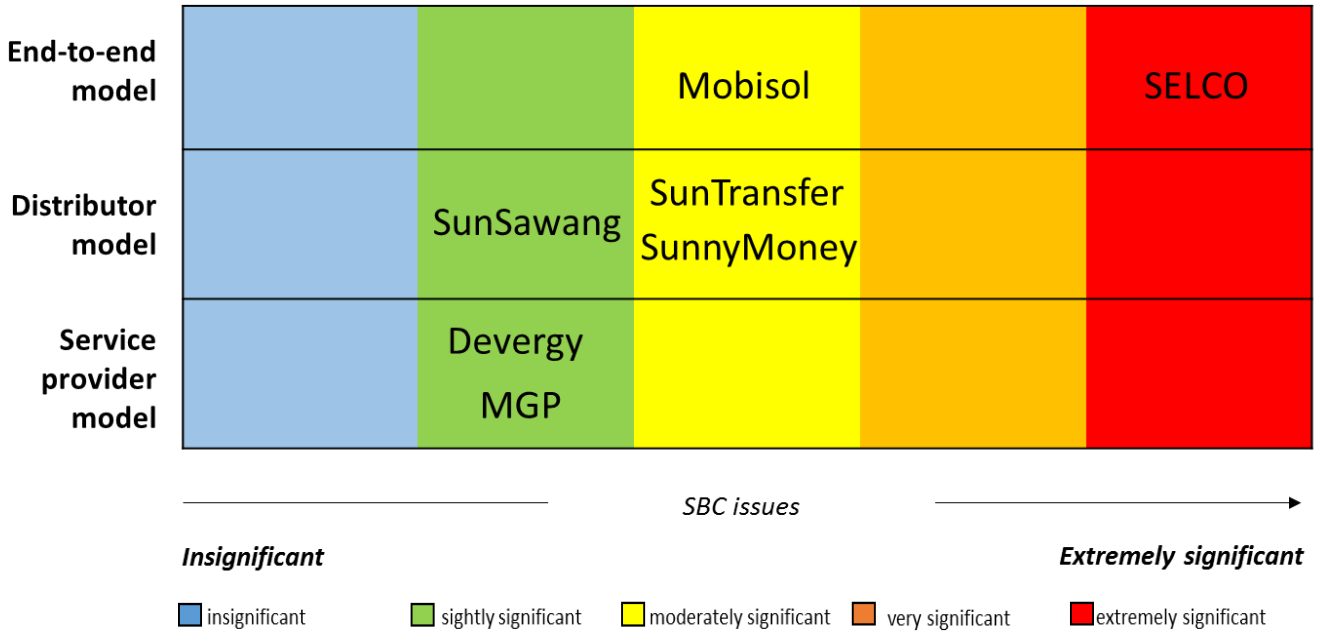

Figure 4.11. Social, behavioral, and cultural issues faced by PVCs

Table 4.7. Social, behavioral, and cultural barriers vs elements of business model applied by PV companies

	Name of company	Element of business model			
		Customer relationships	Key partners	Key activities	Key resources
End-to-end model	Mobisol	• Dedicated customer care • Customer hotline	Local sales agents and local technicians (commission based)	Installation & services	• Mobisol's services team
	SELCO	ESCs		Marketing, demonstration, sales, installation, maintenance, and services	• Local talents for SELCO's team
Distributor model	Sunsawang	Sales representatives and local technicians (commission based)	• Local government • Sales representatives and local technicians (commission based) • Local networks of village leaders		Installation team
	SunTransfer	• Company's contact • MFI networks	Local MFIs	Installation and services	Suntransfer's services team
	SunnyMoney	• Call center • Dedicated sales team for local agents	• Teachers from local schools • Village leaders • NGOs	Installation and services	• SunnyMoney's sales team • Centralized service team in HQ
Service provider model	Devergy	• Devergy's call center • Devergy smart meter	Local sales agents and technicians (commission based)	Maintenances and services	Devergy customer care team
	MGP	• 24/7 customers supports		Survey Maintenance and services	• MGP branch offices • Sales and marketing team • Installation & services team

insignificant | sightly significant | moderately significant | very significant | extremely significant

Table 4.7 shows that for those PV companies who sell PV technologies as its value proposition, the more significant social, behavioral, and cultural issues, the more these PV companies tend to do all the operational activities by themselves, such as SELCO. Mobisol, SunTransfer, and SunnyMoney describe the barriers related to social, behavioral, and cultural aspects as moderately significant. These companies tend to rely on its partners such as local sales agents, local technicians, and local MFIs to promote the products as well as to earn the customers' trusts while the companies still provide its customer care or call center which could be reached easily by the end-users. These companies agree that small repair, which could be done locally, will be done by the local technicians in the village, sometimes with guidance from the company's customer care or call center. A huge repair could be done in two ways. SunnyMoney has a centralized repair center in its head office. Hence, broken systems or parts could be sent back to its head office to be repaired. On the other hand, SunTransfer and Mobisol send their technicians whenever there is a huge repair needed in the villages.

SunSawang is the only PV Company which sells PV technologies as its value proposition and describes the barriers related to social, behavioral, and cultural aspects as slightly significant. Thus, the company mostly relies on its third party for the operational activities except for the installation. SunSawang relies on the sales representatives, the village leader and local government to promote the products and earn the customers' trusts. The company also relies on the local technicians to do the maintenance and services. This scheme only can be done because SunSawang has a robust and good relationship with people in the villages since the company used to be an NGO which works closely with rural electrification projects. Thus, the company has earned the trusts from the people in the village at the very beginning of its operations.

PV companies which employed a service provider business model have a slightly different pattern since these types of companies own the systems. These PV companies are responsible for the services and maintenance of the systems for a lifetime. Thus, although Devergy and MGP describe the issues related to social, behavioral and cultural aspects as slightly significant, these companies need to handle the service and the maintenance by themselves. Although Devergy seems to rely on the third party for its maintenance and services, the company also has its own smart meter to control the systems from its head office. Thus, whenever there is something happen to the system, Devergy's technicians will be instantly informed.

In summary, a specific business model could be derived from the barriers related to Social, behavioral, and cultural aspects faced by PV companies. For those PV companies who sell PV technologies as its value proposition, the more significant social, behavioral, and cultural issues, the more these PV companies tend to do all the operational activities by themselves. On the other hand, companies which offer services as its value proposition tend to handle at least the services and the maintenance by themselves since the ownership of the systems remains to the company for a lifetime. Thus, these types of company are responsible for making the systems work properly in order to provide reliable electricity services to its customers.

4.1.3.8 Governmental/institutional

Figure 4.12 shows a plot of significances of barriers related to the government or institutional aspects towards the companies' business. In general, the majority of PV companies, that we have interviewed, describe that the significances of the issues on governmental or institutional aspects are quite high, except for SunSawang. SunSawang explains that the company does not receive any benefits from the government because currently there is a lack of supporting policies for social enterprises and for the renewable energy companies which operate in the rural energy market or at the BOP market. Despite the lack of supporting policies, SunSawang considers this type of barriers does not have any influences in the company's business. It is because the size of the company which is still not big enough even to enjoy small benefits from the supporting policies. The company also does not involve in any lobbying activities since SunSawang explains that those kinds of activities are not their field of expertise.

For other companies, the barriers on the government or the institutional aspects are considered quite significant. All of these companies experience the lack of supporting policies towards renewable energy companies which operate in the rural energy market with a BOP as its targeted customers. These companies also explain that they experience the change of regulations which happened quite often. The change in the

regulations could influence the companies' business since they need to adapt to the new policies or regulations.

There are several ways which the PV companies have done in order to overcome barriers on the governmental or institutional aspects. Several companies involved in direct lobbying activities, such as SunnyMoney and SELCO. SELCO even develops a dedicated team to work closely with the government. Other companies tend to rely on the organizations which actively promote PV for rural electrification such as Lighting Africa, Lighting global, Global Off-Grid Lighting Association, the World Bank and other solar association which exists in the country where the PV companies operate its business.

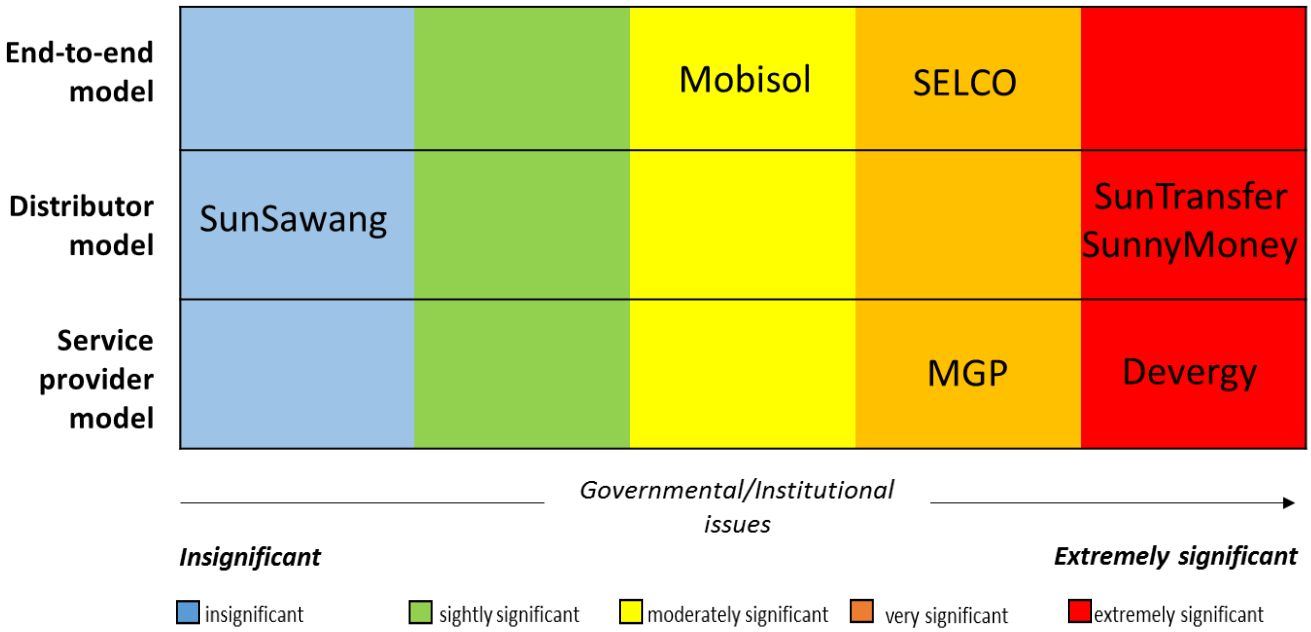

Figure 4.12. Governmental or Institutional issues faced by PVCs

From this result, it could be concluded that the choice of business model cannot be derived from the significances of governmental or institutional barriers. As a business unit, the PV companies try to get or to push the government to establish regulations or policies in favor of their companies, in this case is PV for rural electrification.

4.1.3.9 Network/partnerships

It is interesting on how PV companies experience the barriers related to networks or partnerships differently. Although all the PV companies which have been interviewed operate in the same field, not all of them experience problems with establishing partnerships with other companies, institutions or organizations. Figure 4.13 shows a plot of significances of barriers on establishing networks or partnerships which might influence the companies' business. From the figure, we could see that SunSawang is the only PV Company which does not face any difficulties in establishing networks or partnerships with other key stakeholders. Based on our interview with SunSawang, the company describes that all the key stakeholders or partners which are required to operate its business are very supportive. SunSawang's experiences as an NGO which focus on rural electrification for seven years before the company was established could be the main reason behind strong networks and partnerships amongst the key stakeholders.

Despite the differences on the difficulties that the PV companies face to establish strong networks and partnerships with other institutions or organizations. All of PV companies agree that it is essential to have good partnerships with other stakeholders who could help the business to grow. Hence, it is important to have partners who have the same goals and understand the behavior of rural electrification business, especially at the BOP market. There are no specific elements of business models which could be derived from the barriers on the networking and partnerships aspects. Nevertheless, the choice of companies' value proposition could influence the key partnerships required to help the business to grow.

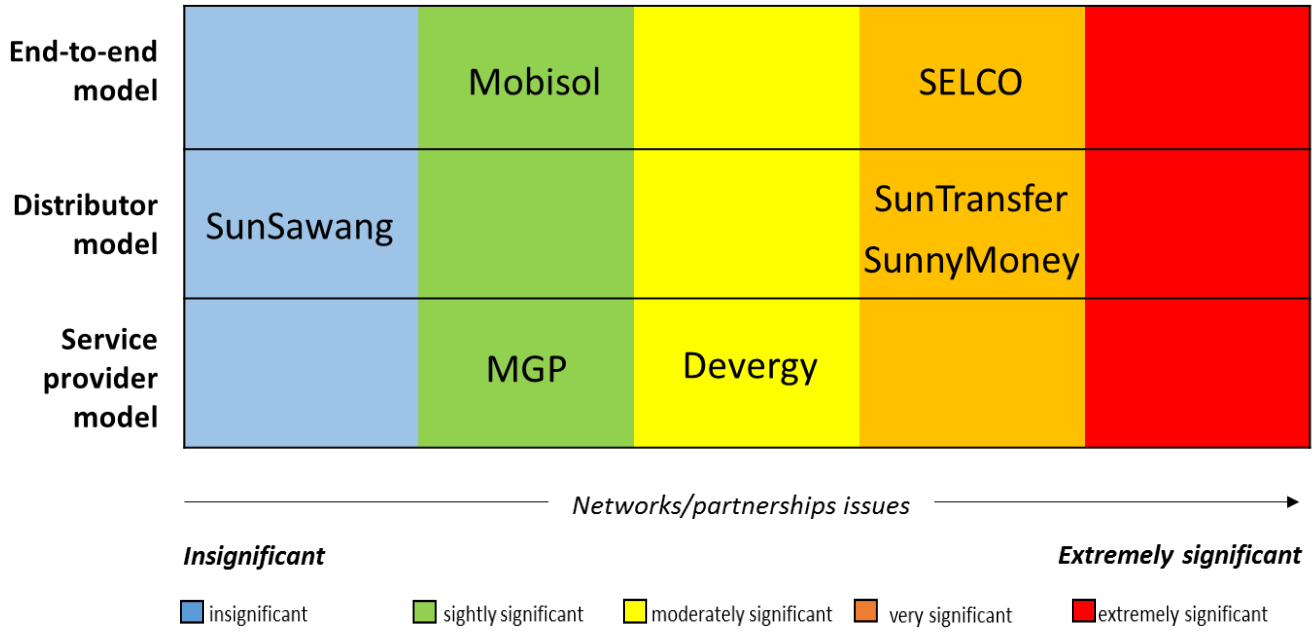

Figure 4.13 Networks/partnerships issues faced by PVCs

4.1.3.10 Environmental

Based on our interviews with PV companies in the previous section, the barriers on the environmental aspects vary on each of the companies. However, in general, the environmental issues faced by the PV companies are moderately insignificant, except for SunnyMoney which describe the environmental issues as extremely significant, as shown in Figure 4.14. Thus, the company develops and owns its own recycling company in the country where the company operates its business. In this way, it is easier to control the issues related to environmental aspects since the company is responsible for the whole recycling process.

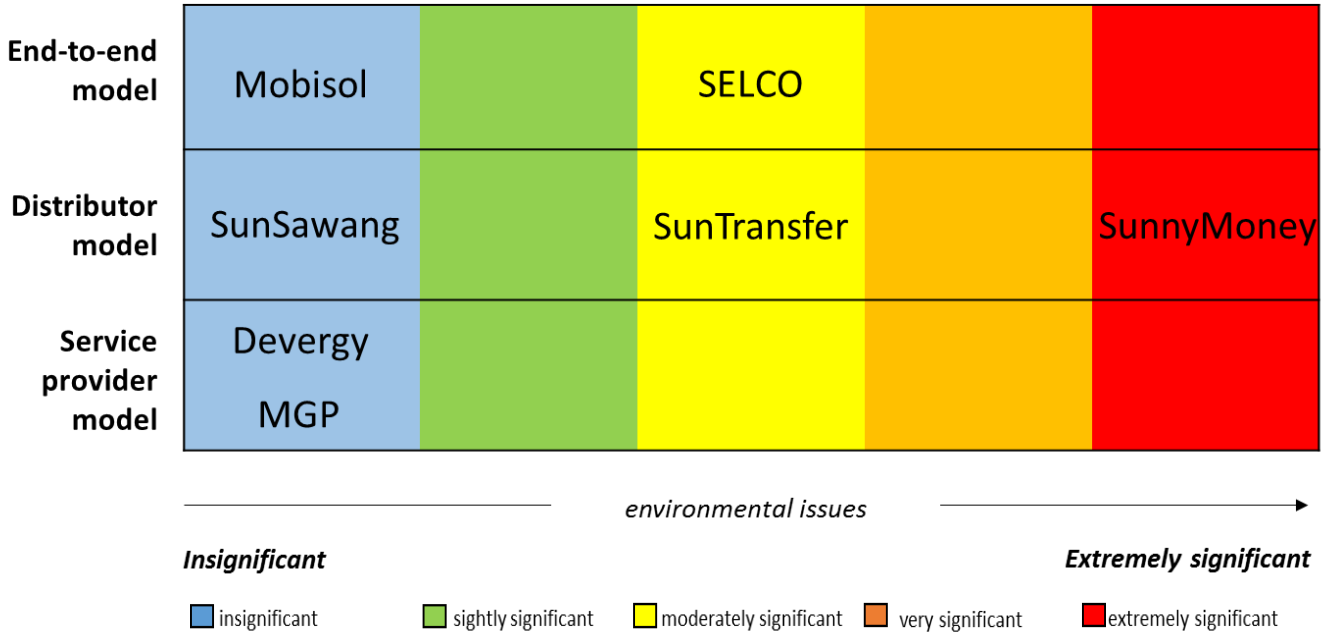

Figure 4.14. Environmental issues faced by PVCs

Other companies which describe the environmental issues as moderately significant are Mobisol and SunTransfer. These companies explain that they only sell low voltage and well-sealed products. Currently, these companies are responsible for the collection of broken and faulty products from the customers. Mobisol

and SunTransfer explain that the number of broken or faulty products are still insignificant. Thus, these companies still collect these faulty parts in the warehouses. In the future, these companies are looking for a long-term partnership with a recycling company which will be responsible for recycling these broken parts.

The rest of PV companies which we have interviewed described the environmental issues as insignificant. It is because these companies have agreed with the manufacturers to take out and recycle any broken and faulty products from the very beginning. Thus, these companies do not face any environmental issues since these issues are beyond their scope of operations.

In conclusion, different elements of business model could be derived from the barriers related to the environmental issues. The more significant the environmental issues faced by the company, the more responsible the company towards these issues, For instance, SunnyMoney which owns its own recycling company.

4.2 Initial framework: linkage between barriers to the adoption of PV electrification in the rural energy market and business model employed by the PVCs

In this part, we summarize the results obtained from the cross cases analysis in the previous chapter. The main goal of this chapter is to understand how the characteristics of business model employed by PVCs can be derived from the barriers faced by PVCs which focus on the BoP and rural energy market. Based on our analysis in the previous chapter, apparently, not all elements of business models employed by PVCs could be directly derived from the level of barriers faced by the PVCs on doing the business.

From Figure 4.1, 4.2, 4.3 and Figure 4.4 in the previous section, we could see that the choice of value propositions and customer segmentation are derived independently from the level of barriers faced by the PVCs in the rural energy market. In fact, several barriers emerge due to the choice of specific customer segments and value proposition. On Figure 4.4, we could conclude that the choice of customer segmentation will influence the choice of technology or services the company offered to the customers. Hence, it influences the value proposition. From Figure 4.1, 4.2, and 4.3, we could see that the choice of value proposition influences other elements of business model such as key activities, revenue model, and the cost structure. Thus, it could be concluded that the several elements of business model are strongly influenced by choice of PVCs' customer's segmentation and its value propositions. It is because the choice of customer's segmentation and value propositions will lead to several barriers faced by the PVCs.

Figure 4.15 shows the initial framework developed from this study which explains the linkage between the level barriers to the adoption of PV electrification in the rural energy market and characteristics of business model derived from the level of barriers faced by the PVCs. From this figure, it could be seen there are ten barriers which were derived from the literature earlier in Chapter 2. From those ten barriers, only five of them influence the choice of business model's elements employed by PVCs. These barriers are (1) infrastructure, (2) financial, (3) market demand, (4) social, behavioral, and cultural, as well as (5) environmental. The level of these barriers will influence the elements of business models employed by the PVCs, such as the key partnerships, key activities, key resources, customer relationships, channels, and revenue streams. Several factors also play important roles in influencing the choice of elements of business models which derived from the levels of financial barriers. These factors are (1) the size of the company, (2) infrastructural barriers, (3) technological investments, (4) the location of the third parties, and (5) the behavior of the customers it selves.

From the same figure, we could also see that several elements of business model could not be derived from the level of barriers faced by the PVCs in the rural energy market. The difficulties on several barriers faced by the PVCs, such as barriers to (1) investments, (2) human resources, (3) governmental/institutional aspects, and (4) networks or partnerships, do not lead to specific elements of business model employed by the PVCs. All of the PVCs have a general solution for each of those barriers regardless of its level of significances towards its business. For instance, despite the variation on the difficulties of finding the investment, all the PVCs do not have specific ways other than having the third parties for its partners on investments, donors, loans, and grants. On the human resources issues, all the PVCs describe that it is important to equip the

employees with enough knowledge and skills through extensive and continuous training. Also, it is important that the company need to increase the pool of candidates for a certain position and hire good third party whenever there are things which are impossible to be done by the companies themselves. Furthermore, in the government or institutional aspects, all the PVCs strongly believe that the only solution is to do direct or indirect lobbying activities to push the government to develop policies or regulations in favor of the PVCs' business. Finally, on the issues related to the networks and partnerships, all the PVCs explain that it is important to have right partners in doing its business. Thus, having several criteria for choosing the right partners is the only solution to overcome issues in the networks and partnerships aspects.

On the technical barriers, there is no general correlation which could be drawn in order to develop elements of business models. Based on our analysis in the previous chapter, each of PVCs face different technical barriers which could be influenced by different reasons, such as lack of innovation, lack of standardization of PV products in the country, and lack of project management. Each of these issues leads to specific elements of a business model which are tailored based on the PVCs' needs. Thus, it could be concluded that each of the technical barriers will lead to specific elements of business model.

Finally, the choice of elements of business models employed by the PVCs will eventually influence the cost required to operate the PVC's business. The detail of the framework's usage is explained further in the Appendices.

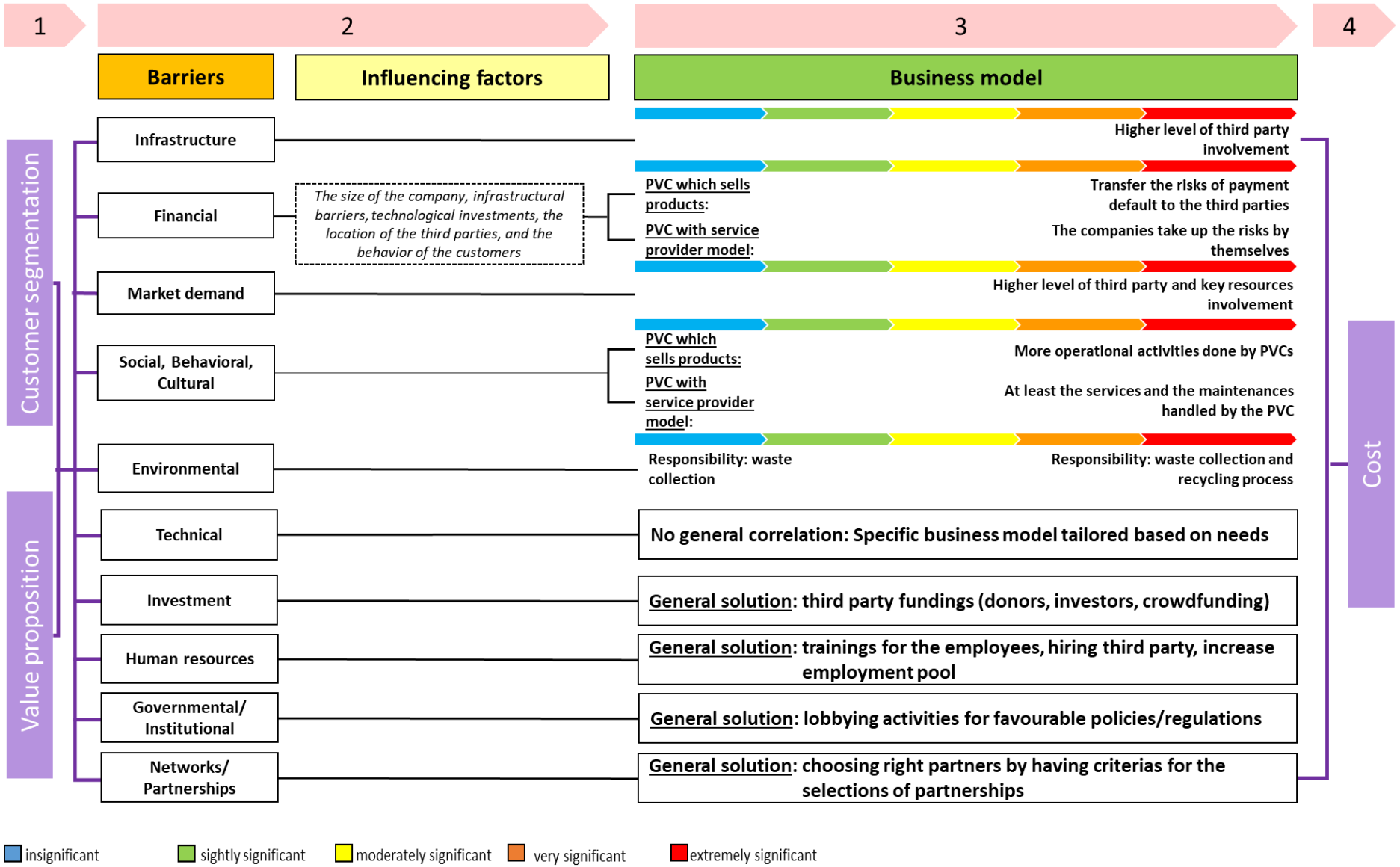

***Figure 4.15. Initial framework**: The linkage between the level barriers to the adoption of PV electrification in the rural energy market and characteristics of business model employed by PVCs derived from the barriers faced by PVCs which focus on the BOP and rural energy market*

5 CHAPTER 5: Off-grid PV Market in Sumba Island, Indonesia

5.1 Overview of Sumba Island

Sumba is an island which is located in the eastern part of The Indonesian Archipelago. The total area of the island is 11,052 km^2 which are about one-fourth of the size of The Netherlands (International, 2010). Sumba Island is a part of East Nusa Tenggara Province (Nusa Tenggara Timur or NTT). As it can be seen in Figure 5.1, Sumba Island is divided into four regencies (Kabupaten) which are West Sumba, Southwest Sumba, Central Sumba, and East Sumba. The largest town on the island is Waingapu, which is the capital city of East Sumba region.

In general, Sumba Island has a dry climate. The dry season could last up to eight months while the rainy season only lasts for four to five months (International, Energi, & Angels, 2017). The western part of the island is more fertile and more heavily populated than the eastern region. Southwest Sumba is the most densely populated district which is home to about 312,510 people living in an area of 1,447 km^2. On the contrary, East Sumba is the largest district with its most sparse population. It consists of about 245,260 people in an area of 7,000 km^2 (33 people per square kilometer). The island has a total population about 750,000 inhabitants who live in a highly stratified society based on castes. Sumba Island has 44 subdistricts (International et al., 2017) and 433 villages (PLN, 2017) with a typical village which consist of 1,000-2,000 residents (International et al., 2017).

In general, the roads which connect the eastern and the western part of Sumba Island is good. However, village access roads are often found with loose stones and potholes. Not all roads are paved, and sometimes the roads only paved with stones and sand. A four-wheel drive car is required to access some of the villages. In the rainy season, these types of roads could not be easily accessible. According to Kantor Pekerjaan Umum (PU) or the local public works office, 40% of roads in Sumba Island is badly damaged, and roads between sub-villages are generally not paved (International et al., 2017)

Figure 5.1. Map of Sumba Island (International, 2010)

5.1.1 Socioeconomic aspect of Sumba Island

Sumba is one of the poorest regions in Indonesia. In 2014, the Human Development Index (HDI), which is the indicator of life expectancy, education, and income per capita, for NTT was ranked on 31st out of 34

provinces in Indonesia. All Sumba districts score below the provincial average with the best performing district was East Sumba, and the worst performing districts were Central and Southwest Sumba (International et al., 2017). Poverty is also widespread in Sumba Island. Badan Pusat Statistik (BPS) or The Central Agency on Statistics recorded that in 2010, about 34% of Sumba's population is poor and approximately 28% of its inhabitants live below the poverty line who earn less than a dollar a day (BPS, 2014).

People who live in the rural village tend to live together as one big family under one roof. One house could consist of six to twelve members of the family. It usually consists of a father, a mother, and four children or a father, two mothers, a grandmother and a grandfather, and several children. The majority of the rural communities work in the agricultural sector. They rely on monoculture agriculture which leads to high risks because it creates additional poverty once the harvest fails (Ritter, 2011). The income of a traditional village household is highly dependent on the harvest season which happens to be up to four times a year. About 80% of the harvest is sold, and 20% are self-consumed. They earn about EUR 25 to EUR 42 per harvest (Ritter, 2011). In Kataka village, the majority of the villagers are highly dependent on corn harvest. However, instead of selling the harvest to earn some profit, the villagers use the harvest to sustain the living during the dry season. It is because the price of the corn is very low, which is about 0.20 EUR / kg of corn.

Livestock is also an essential part of life on Sumba Island. The livestock has more than economic value, which represents the owners' wealth and social status. Furthermore, the animals could be used for cultural rituals such as weddings and funerals which demand the slaughter and exchange of the animals (International et al., 2017). Some of wealthier villagers who live in rural areas could own more livestock such as goats, pigs, and chickens. Pigs are highly valued compared to other animals, even to the cattle. A small piglet could be sold as much as 36 EUR, and the big one could be sold as much as 360 EUR. In contrast, a goat could be sold as much as 100 EUR during the peak season, such as during the Muslim festive.

The villagers have cash in a limited amount of time due to fluctuating and unstable income which depends on the harvest time and the sales of handicrafts, such as traditional woven sarong and grass mats, and live stocks. Thus, the microcredit scheme faces severe challenges because of low repayment rate in the rural communities (Ritter, 2011). In fact, there is no microcredit scheme available in Kadahang and Kataka for the villagers. Despite the economic conditions, a big share of the economic power is spent on traditional ceremonies and several things to show social statuses, such as a mobile phone and a satellite dish (Ritter, 2011). It means that some poor people can own a mobile phone although they could not afford their living. According to the previous research, about 50% of Sumba's households have telecom expenditure , and about 20% of people who live in rural locations seem to have a mobile phone (International et al., 2017).

Many of the villagers in Sumba do their transaction based on the mixed cash-barter economy, especially those who live in isolated areas (International et al., 2017). For instance, the service to mill 10 liters of corn could be paid with one or two liters of it, the payment of agricultural labor or other services could be made using rice or maize. Other examples of exchange rates in Sumba are the following (International et al., 2017):

- 1 pig (4 months) = 200 kg sweet potatoes / 200kg rice / 10 medium size chickens
- 100kg maize = 1 breeding hen + 10 chicks
- 1 bar of soap = 1 coconut

5.1.2 Electricity access in Sumba Island

Sumba Island has only two main grid systems which are located in Waikabubak, West Sumba district, and Waingapu, East Sumba district. The peak load of Waikabubak and Waingapu systems is about 7.65 MW and 7.60 MW which 25% of Waikaubak system and 11% of Waingapu system come from on-grid centralized renewable energy power plants (PLN, 2017). Currently, these east and west main grid systems are not interconnected yet. Due to this limited number of capacity generation and infrastructure, the electrical

connection in Sumba Island is quite unreliable, and blackouts often occur, even in a big city such as Waingapu or Tambolaka.

The electrification ratio in Sumba Island has been increased in the past five years from about 24.5% in 2010 to about 43% 2015 in which 55% of the share supplied by renewable energy resources (Hivos, 2015). The increased on electrification ratio is achieved through Sumba Iconic Island program, which involves several stakeholders to make the electricity access available in Sumba Island, especially in remote and rural areas through centralized off-grid, individual off-grid systems, or on-grid power plants.

Despite the progress on electrification ratio, there are still about 238 out of 433 villages which do not have electricity access (PLN, 2017). It is because some of these villages are located in the remote areas and several challenges related to the land acquisitions as well as the lack of potential customers which affect PLN's decision to extend the grid to those areas. Furthermore, there are also some people who live close to the grid which is not connected to the grid because of the issues related to high initial connection fee, which cost about EUR 30 for the smallest connection (450 VA). Thus, affordable and reliable off-grid systems are considered more suitable for these types of customers, especially those who live in rural areas and far away from the grid.

In rural areas, most of the villagers do not see the electricity access as the primary needs. They see the access to clean and reliable electricity as secondary needs or even a luxury. It is because people who live in rural villages in Sumba Island are considered poor, and they have been living without electricity for a long time, even some of them have been living without electricity in their entire life. Currently, rural households use subsidized kerosene for lighting which cost about IDR 7,000 to IDR 10,000 (EUR 0.5 to EUR 0.7) per liter. They spend from IDR 12,000 (EUR 0.85) to more than IDR 40,000 (EUR 2,85) per month (Ritter, 2011). Some of the villagers might also use diesel power generator to provide their electricity needs which vary from 0.60 EUR (450 VA), 2.15 EUR (900 VA), 6.5 EUR (1,300 VA), and up to 9.3 EUR (2,200 VA).

5.2 Overview Sumba Iconic Island Program

In 2010, a Dutch non-profit organization introduced Sumba Iconic Island (SII) initiatives supported by the Directorate General of New and Renewable Energy and Energy Conservation (DGNREEC), Ministry of Energy and Mineral Resources (MEMR) of the Republic of Indonesia. This program aims to *"ensure the provision and utilization of renewable energy sources that can encourage an inclusive economy and gender in order to improve the welfare of people in Sumba Island"* (Hivos, 2014). This goal is achieved by (1) ensuring the domestic energy availability through renewable energy, (2) increasing the value of renewable energy sources, (3) managing sustainable energy which include environmental conservation, (4) providing energy at affordable price especially for the poor, (5) developing local capacity in technology, finance, human resources, (6) utilizing energy efficiently, (7) developing gender-equitable economy through the use of RET (Hivos, 2014).

By 2011, all Sumba districts, the Provincial Government of East Nusa Tenggara, and PLN have committed themselves to achieving SII program. Other international institutions such as Asian Bank Development (ADB) and The Norwegian Embassy for the Republic of Indonesia have joined to support this program later on in 2012 and 2013. In 2014, SII program gained support from the Millennium Challenge Account – Indonesia (MCA-I).

SII program is a project which consists of multiple key stakeholders. The committees of SII program works based on SK EBTKE 64K/73/DJE/2014 on the Establishment of the Steering Committee, the Organizing Committee and the Working Groups on SII program. The Working Group is divided into three different groups. Each group has different responsibilities such as policy & institution; provision & energy utilization; promotion, cooperation & funding. The committees and the Working Groups of SII are listed in the decree of Directorate General New, Renewable Energy and Energy Conservation (DG NREEC) No. 64K/73/DJE/2014. The list consists of various institutions which range from national and local government, NGOs, private sectors, donors, PLN and HIVOS. In performing the duties, the local government at the district level could form a team which

facilitates the implementation of SII program in the area. The institutional governance of SII Program can be seen in Figure 5.2.

In 2014, the blueprint of SII program was endorsed by the Steering Committee. All the institutions which work on SII program need to have good cooperation and collaboration to achieve the SII's blueprint. Thus, coordination meetings are held to facilitate all the stakeholders to discuss several issues they face during the implementation of SII program and try to solve the issues in the meeting. The meetings consist of Stakeholders Coordination Meetings which are held twice a year, a Plenary Meeting, a Steering Committee Meeting and a Working Groups Meeting which are held at least once a year.

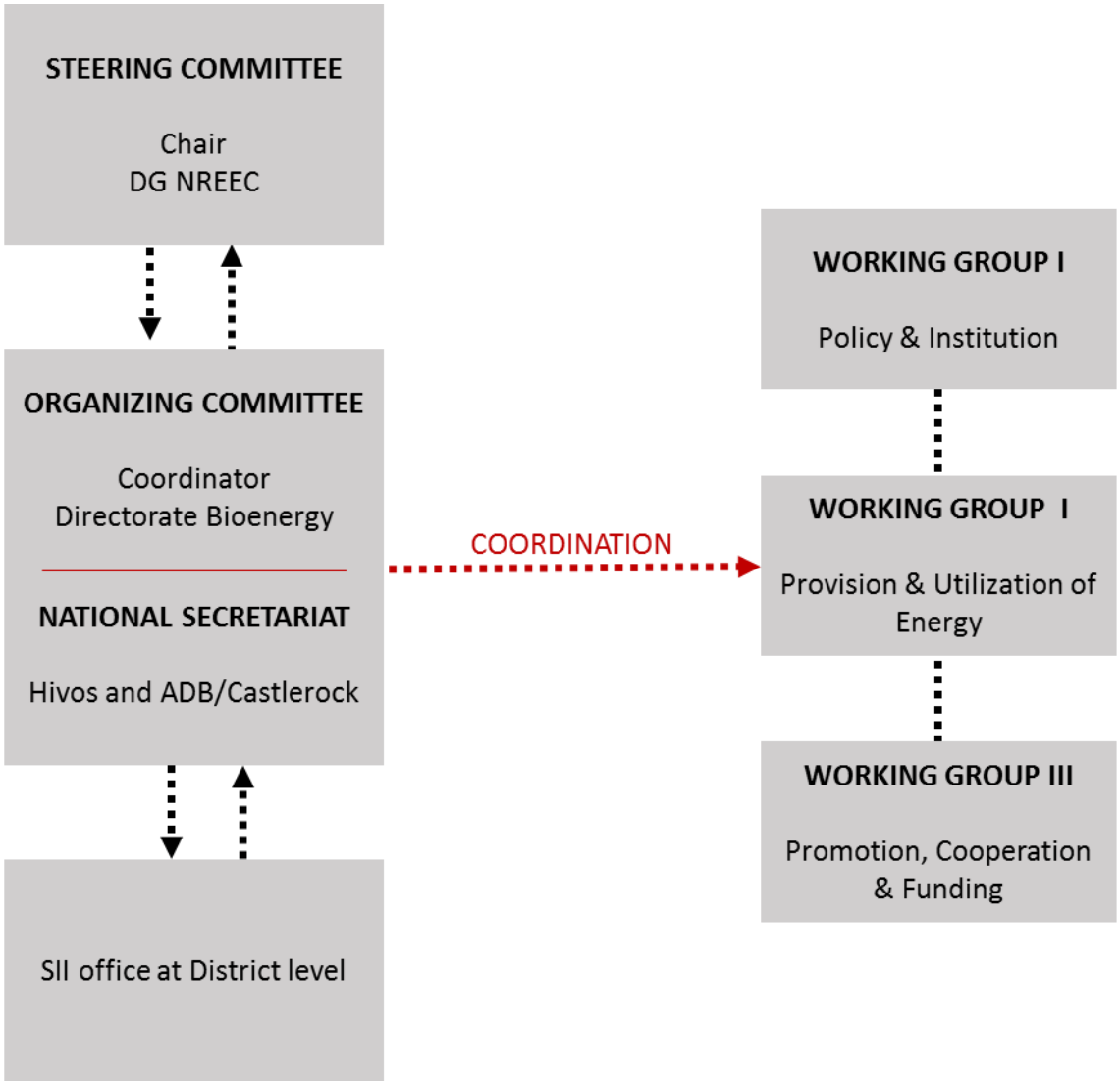

Figure 5.2. SII stakeholders (Hivos, 2014a)

5.3 Solar potential in Sumba Island

As a tropical country, most of the locations in Indonesia have huge potential of solar energy. It is because these locations have a good solar radiation or insolation. Sumba island has an average insolation of 5kWh/m^2/day, which means that the island gets a solar radiation of 1,000 Watt/m^2 for five hours a day (Alphen, Hekkert, & Sark, 2008).

Thus, the energy per square meter generated by the sun can be calculated using the formula below:

Solar energy = solar radiation x daily sun hour x available area
= solar insolation x available area

Therefore, total solar energy potential in Sumba Island with an area of 11,052 km^2 is about 55,260 Gigawatt.

Practically, all locations in Sumba Island are suitable for both off-grid and on-grid PV installation. However, considering the availability of infrastructure and access to the locations such as grid availability and road access as well as the cost, the technical potential of solar energy in Sumba Island is 10 Megawatt (Hivos, 2014).

5.4 Previous or current off-grid PV projects in Sumba Iconic Island Program

5.4.1 Government programs

There are many government programs which support SII program through PV electrification in rural areas. One of the programs is carried by Dinas Pertambangan dan Energi (DISTAMBEN) or Mining and Energy Agency, which later will be the case study from the government programs for this study. Firstly, the data for this section was obtained through an interview with the former head of DISTAMBEN in East Sumba, Mr. Daniel Lalupanda. Other information was also gathered from the interview during the field study in the villages and existing reports on SII programs. The details of the interview's results on the government programs could be seen in the Appendices.

5.4.1.1 Government donor-driven PV programs

From the field study and the existing reports on SII program, it could be concluded that there have been many interventions from both local and national governments to increase Sumba's electrification ratio through the implementation of RETs. There are two different governmental budgets that can be used to support SII program through PV technologies. These budgets called Anggaran Pendapatan dan Belanja Negara (APBN) or national budget and Anggaran Pendapatan dan Belanja Daerah (APBD) or regional government budget. These budgets are requested and secured by the different ministerial department to support the SII program. The ministerial departments which play an important role in the implementation of PV technologies during SII program are Ministry of Energy and Mineral Resources (MEMR), Ministry of Village, Development of Disadvantaged Regions and Transmigration (MVDDRT), and Ministry of Home Affairs (MoHA). Other key stakeholders who play an essential role in approving and securing the budgets are a local government in the village, regional, and provincial level.

MEMR, as the steering committee of SII program, has established DISTAMBEN or Mining and Energy Agency at the regional level to promote RETs to the people who have no access to the energy as well as to the electricity. Since 2011, DISTAMBEN has been the focal point of SII program for all the projects and funding related to RETs projects. MEMR provided DISTAMBEN with a yearly budget from APBN which can be used for any projects related to the increase of electrification ratio through RETs. DISTAMBEN could also request another funding from Dana Alokasi Khusus (DAK) or special allocation fund to be added to their budget by providing MEMR a proposal and a report on the feasibility study of the projects. DISTAMBEN has built centralized PV power plants as well as give SHSs to several villages for free. However, starting in 2017, DISTAMBEN is no longer existed because of new national regulations which are The Laws of The Republic Indonesia No. 23/2014 about Local Government and the Government Regulation of The Republic of Indonesia No. 18/2016. These regulations state that the responsibility of DISTAMBEN in regional level is moved to the provincial level. The new regulation has led to several implications in SII program. One of the implications is that there is no focal point in SII program.

MVDDRT also plays an important role in promoting RETs to the rural areas during SII program. In Kataka Village, MVDDRT built a centralized PV power plant with a capacity of 13.5 kWp in 2015. This centralized

PV power plant is used to electrify 125 households who live in local transmigration location. This solar power plant was given to the community for free. Later, the government formed a village committee to take care of the O&M of the systems as well as discuss the monthly subscription fee with the villagers who use the electricity services from the plant. In the case of Kadahang village, the subscription fee is IDR 6,000 (EUR 0.42) per month. The projects from MVDDRT are funded by APBN and executed by its department at the regional level.

Figure 5.3. (Left) 13.5 KWp PV power plants for local transmigration location (Center) the systems (Right) batteries.

Starting 2004, the national government has established Program Nasional Pemberdayaan Masyarakat Mandiri (PNPM Mandiri) or National Program for Community Empowerment in all ministerial departments. MoHA developed PNPM Mandiri Perdesaan or National Program for Community Empowerment for the villages under Direktorat Jenderal Pemberdayaan Masyarakat dan Desa (PMD) or Directorate General for Society Empowerment (DGoSE). This program was funded through both APBN and APBD as well as several donor organizations in coordination with the World Bank. In Sumba Island, PMPN Mandiri has contributed in building centralized PV power plants in several villages. Similar with MVDDRT's program, the PV power plant was given for free. The government also formed a village committee to take care of the systems and manage the monthly subscription fee. There used to be five locations of centralized PV power plants in Kadahang Village and two locations in Kataka Village. However, all of the systems currently no longer exist due to several reasons such as operational and thieves issues. In Kadahang Village, the power plants were taken down, and the systems were given to each of the villagers to be used individually.

Figure 5.4. (Left) PNPM program on Mr. Ahmad's house (Right) PNPM Program on Mr. Baereunjande's house

Besides on the ministerial level, the village leader also could secure several funds in order to provide the village with the electricity through RETs. This fund called Anggaran Dana Desa (ADD) or Village Fund Budget which could be arranged by the village leader and requested to the regional government from its APBD. In Kataka Village, there are fifty SHSs which have been distributed to the villagers for free in order to provide them the access to electricity.

From the field study, it could be concluded that all current government electrification's programs are donor driven. All the centralized PV power plants and the SHSs are given for free to the communities in the villages. The systems are equipped with six to twelve months warranty, and the community development and education programs related to the systems were done in a very limited of time. In fact, from the field study, it could be concluded that the introduction and training programs related to the systems were done only in one day. Also, the villagers always state that the government should be responsible for maintaining the systems.

According to the former head of DISTAMBEN in East Sumba, Mr. Daniel Lalupanda, *"The communities in the villages are expected to be independent and responsible for the systems given by the government. In this way, it is expected that in the future, they could develop their own village and communities and will not rely on the government again."* Thus, from the government point of view, the sustainability of such projects are highly dependent on the communities. However, the message and the intention of the government to encourage the communities to be independent from the government's intervention is not yet received by the villagers. These conditions could lead to several challenges in the sustainability of the project since there were issues on the understanding the ownership of the systems and responsibility to maintain the systems between the government and the villagers.

5.4.1.2 Feedbacks on Government donor-driven programs

From the previous section, we could see that there are many donor-driven programs held by the government from different sources of funding. The donor-driven programs from the governments exist in both Kataka and Kadahang villages. Despite the generosity of the government's programs, not all PV systems work properly at the moment.

In Kakata village, there are two centralized PV power plants installed by PNPM and one centralized PV power plants for the local transmigration location installed by MVDDRT. While there are three centralized PV power plants installed by the government, two systems installed by PNPM have stopped working several months after the installation. Kataka's village leader explains that there was no technicians or PNPM people who are responsible for taking care of the systems after the systems have been installed. Moreover, currently, most of the systems have already been vandalized or stolen. The statement from the village leader shows that there was a gap between the government's intention and the expectation of the villagers. The government gives PV systems for free, and the villages are expected to be independent and responsible for those PV systems given by the government. In this way, it is expected that in the future, they could develop their own village and communities and will not rely on the government again. However, the villagers see the donor programs from the government differently, where they think that the governments, the one who installed the systems, should be responsible for the services and maintenance of the systems. This misunderstanding could happen because there is a lack of programs' socialization and transfer of knowledge from the government to the villagers in the form of educations or training.

Another PV program introduced in Kataka village is PV village program in several phases. The first phase started on 2016 when Kataka's village leader gave 50 SHSs for free to some of the villagers. The system is equipped with three lamps, and there is no subscription fee or any payment required for this program. The systems were bought for IDR 2,500,000 (EUR ~167) in one store in Waingapu where the village leaders have several acquaintances. The systems are equipped with one year warranty from the store. Hence, all the services required for the systems in the first one year are covered by the store. Based on our interview with the villagers who use these systems, they are quite disappointed with the quality of the systems. It is because the lamps can only be used for only maximum three hours during the night. The villagers added, currently from 50 SHSs were given to the villagers, only 10 of them which could still work properly. Although the villagers have filed complaints to the village leader, there is no proper services have done towards the systems. Hence, many systems are left broken although it is still covered under the store warranty. Based on our observation, this condition might happen because the low quality of PV systems used for the program. Furthermore, despite using bidding procedure to get a good quality of PV products with reliable price, the village leader relies heavily

on his acquaintances at the store in Wangiapu. This condition has led him to the limited choice of good quality of PV systems with decent prices for the program.

Kadahang village has experienced similar situations as in Kataka village. In 2013, there were centralized PV power plants installed in five different locations. The villagers were equipped with two lamps, and they need to pay a subscription fee amounted IDR 6,000 (EUR ~0.40) per month to the committee. These committees are appointed by the community and responsible for the services and maintenance of the systems. However, due to several reasons, there were problems with the inverters and the batteries of the systems which made the entire systems stopped working. According to the village leader, this condition happened because there is a lack of knowledge about PV systems in the community. He explained that there was no preparation for the community in order to accept PV systems. Furthermore, there was no continuous training or monitoring from PNPM, especially in the first one year, to enable the community to maintain and services the systems. Hence, before the systems got stolen or vandalized, the community and Kadahang's village leader decided to take down the systems and give the PV panels to each of the houses which were already connected to the centralized systems. The villagers are expected to buy the other equipment such as batteries, inverters, and lamps to complete the PV panel in order to have electricity in their houses. Some of the villagers were successfully installed the entire systems in their house, and some others have failed. Those who have successfully installed the systems, still use the PV panels from PNPM programs until now. Those who were failed to install the entire systems use kerosene lamps again.

From our observation and the interview results on the government programs at Kataka and Kadahang village, the villagers are not satisfied with current government program because of several reasons. Firstly, there is a gap between the governments' intention and the expectation of the program from the villagers. Secondly, there is no knowledge transfer in the form of socialization, education, and continuous training to the community to maintain the systems. Lastly, there is no monitoring and evaluation of the programs done by the government. Thus, a lot of donor-driven programs in Sumba Island have failed to achieve its main purpose, which is to provide electricity and to develop remote community.

5.4.2 PLN

In this part, off-grid PV program carried by PLN is presented. Data from this section was essentially gathered from different sources. Firstly, the interview was conducted with Mr. Suharto, who is the installation assistant manager for Sumba Area. Secondly, the data were gathered through the existing reports obtained from Hivos and Google. Other information was also obtained from the interview during the field study in the villages. The details of the results of PLN's interview could be seen in the Appendices.

5.4.2.1 SEHEN Program

In order to increase the electrification ratio in Sumba Island, PLN established SEHEN (Sangat Extra Hemat Energi – Very Extra Energy Efficient) program for East Nusa Tenggara in 2010. The goal of SEHEN program is to provide electricity access to those who live in remote areas using off-grid PV technology which consist of high quality and easy to install Sundaya system. PLN uses Sundaya Utilium 4 Light Kit which consists of 10 Wp PV panel and four LED lamps with integrated Li-Ion battery as shown in Figure 5.5. However, one of the LED lamps is kept by PLN as spare parts or backups. Thus, only three of the lamps are given to SEHEN customers. In 2011, PLN targeted to distribute approximately 24,000 systems in Sumba Island which are allocated to 8,300 units for West and Central Sumba, 11,600 for East Sumba, and 4,100 or South-West Sumba (Ritter, 2011). With such an ambitious target, PLN has developed a new business model to be integrated into SEHEN program as it will be shortly described in the following chapter.

Figure 5.5. Sundaya Utilium 4 Light Kit (Sundaya.com)

5.4.2.2 SEHEN business' model

In this section, we look into the business model and its elements applied in SEHEN program. Figure 5.6 shows the overview of SEHEN's business model. The detail of PLN's business model and its elements are discussed in the Appendices.

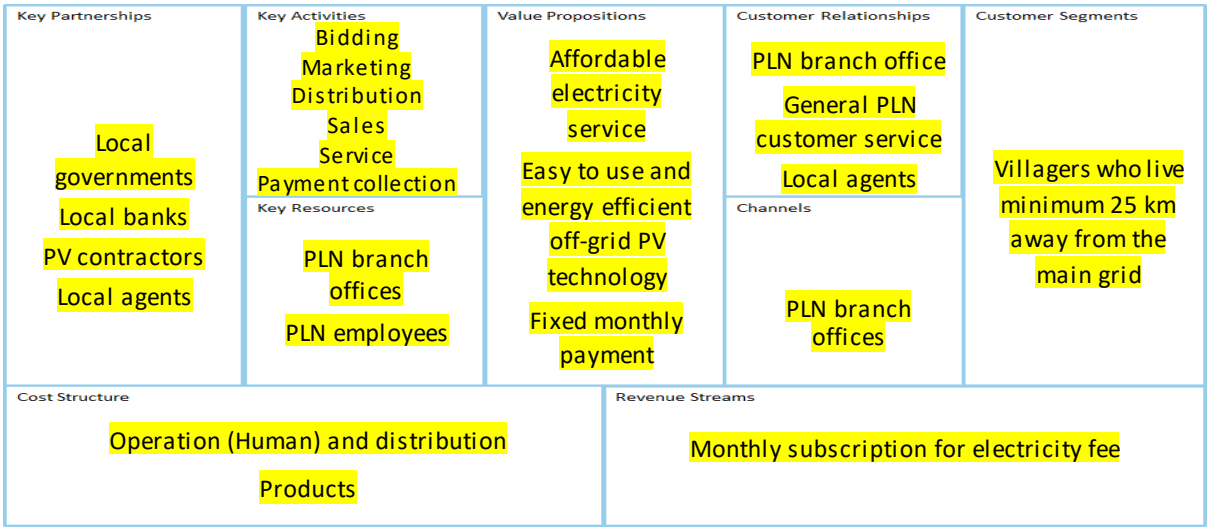

Figure 5.6. SEHEN's business model

Despite a quite rigid business model, SEHEN program is not successful as expected. Currently, from about 24,000 systems distributed in Sumba Island on 2011, there are only 1,800 systems left on the ground. The details of barriers faced by PLN in the implementation of SEHEN program could be found in the Appendices.

5.4.2.3 Feedbacks on PLN (SEHEN) program

SEHEN program used to exist in Kataka village. Based on our interview with the village leader and the villagers in Kataka village, SEHEN program was initially offered back on 2011 when there was only limited access to electricity in the village. However, not all the villagers were interested in SEHEN programs due to high upfront costs which they need to prepare as the initial deposit for the electricity service from PLN, and the location of the village which is 25 km from the nearest town with a bank access.

Currently, there is no SEHEN systems exist in Kataka village. Based on our interviews, SEHEN program was left behind by the villagers in Kataka due to several reasons. Firstly, in 2012, PNPM installed two centralized PV power plants in Kataka village. These centralized PV power plants were given for free to provide

electricity services in Kataka village. It was also worsened by the fact that the people who live at local transmigration location also received a free centralized PV power plant from MVDDRT in 2015. The local transmigration people only need to pay EUR 0.42 subscription fee per month to have the electricity access at their houses. These donor-driven project from the government gave the villagers access to limited electricity quota per day which can be used to electricity up to five lamps, radio, and a phone charger. Compared to SEHEN program, which requires the villagers to pay EUR 2.5 subscription fee per month, the government program was cheaper and more interesting since SEHEN systems were only equipped with three LED lamps. Secondly, according to the previous users of SEHEN systems, there was a lack of after sales services provided by PLN. The villagers describe, PLN employees often come to only collect the overdue subscription fees without maintaining or servicing the old and faulty systems. From our observation, the failure of SEHEN program in Kataka village was also caused by the remote location of the village and limited access to the nearest town. The villagers need to own or rent a motorbike to reach the nearest town or take a public bus which passes by the village only once in the morning and once in the evening. This condition makes the payment for SEHEN systems to the banks becomes costly. Another reason which led to the failure of SEHEN program was that PLN's value proposition as a service provider. PLN offers complete PV systems on each of the customers' house without any automatic control. Thus, it leads to misunderstanding on the ownership of the systems. One of the previous SEHEN systems' user describes that he still can have electricity from the systems even though they do not make any payments to the bank. Also, the other villagers explain, they could buy their own cheap PV systems from the local market and do not have to pay the subscription fee for the rest of the systems' lifetime.

From our interview with previous SEHEN customers, it could be concluded that they are not satisfied with SEHEN services. Not only the program has failed to meet its promises on providing reliable and affordable electricity services at the BoP market, but also it has failed to provide good maintenance and after-sales services. The villagers explain that the initial deposit which they have to make in order to be eligible for SEHEN program was quite expensive to be paid in a one-time payment. Moreover, they need to travel to the nearest town to make the deposit periodically which makes the payment of the systems becomes costly. Donor-driven programs carried by the government also influence the failure of SEHEN programs to be accepted by the villagers. It is because the electricity provided by the government programs are cheaper than SEHEN subscription fee. Hence, currently, from about 24,000 systems distributed in Sumba Island on 2011, there are only 1,800 systems used by SEHEN customers.

5.4.3 Hivos

In this part, off-grid PV programs carried by Hivos are presented. Data from this section was essentially gathered from different sources. The data for this section were gathered through interviews with Hivos team who are Mr. Rudi Nadapdap, Mr. Munawir, and Mrs. Laily Himayati (Maya). Other interviews also were done with Mrs. Sandra, Mr. Dedy Haning, Mrs. Endah, and Mr. Firman for the completion of the data. Other information was also gathered from the interview during the field study in the villages. The details of the results of Hivos' interview could be seen in the Appendices.

5.4.3.1 Hivos' program

As an initiator, Hivos has also played an essential role in introducing PV technology to people who live in rural villages. In 2012, Hivos led a PV school program which was funded by the Norwegian embassy. Hivos installed 1KWp solar power plants in five schools in Sumba Island as its first pilot projects for PV school. The systems are equipped with the charging station which can be used by the students or school's employees to charge their lamps or other electronic devices by paying a certain amount of money to the school operator. Since it is a pilot project, there was a lack of social engagement and community development in the process. The project was much focus on the technical rather than on its social aspects. There was no guideline and business model for the charging station. Furthermore, there was no agreement or a Memorandum of

Understanding (MOU) between the school and HIVOS for this project. Thus, the current use of the charging station is not as much as it was expected at the first place. This implication result to several learnings for the scale-up for Hivos's scale-up project on PV school which was funded by the MCA-I called TERANG Project starting on 2014.

TERANG project is a collaboration project between Hivos and other NGOs such as Rumah Energi, Winrock International, Gender Focal Point (GFP), and Village infrastructure. TERANG Project aims to build 25 PV schools with a capacity of 1 KWp which are equipped with charging stations and 6,000 targeted users, 50 PV corn mills with a capacity of 500 Wp and 50 targeted users, 600 biogas unit called BIRU (Biogas Rumah) with its 3,200 targeted users, and 20 PV Kiosks with a capacity of 300 Wp which are also equipped with charging stations for its 1,000 targeted users. The program also aims to enhance community's capacity related to technology, gender equality, and business management.

Hivos is the project's consortium leader which responsible for the primary contact with project partners, community engagement, monitoring and evaluation, and reporting to MCA-I. Other NGOs are also responsible for each of the projects. Rumah Energi is responsible for BIRU implementation. Winrock International is the technical service provider for PV Schools and PV Kiosks while Village infrastructure is responsible for PV corn mills' project. GFP acts as a training partner for issues related to gender equality through Gender Action Learning System (GALS).

Taking several learnings from PV school on the previous project funded by The Norwegian Embassy, TERANG Project has a more rigid and detail implementation process starting from the selection of the location, socialization and community engagement, installation and the completion of the project which is shown in Figure 5.7Figure 5.7. All the programs in TERANG project follow the same implementation procedure as PV school program. The current state of TERANG program is developing a business model which is suitable for PV school, charging stations at PV Kiosks, as well as PV corn mills. While PV kiosks and PV corn mills' business models are not ready yet, PV School's business model has been rolled out in one school as the pilot project in Kataka Village as shown in Figure 5.8.

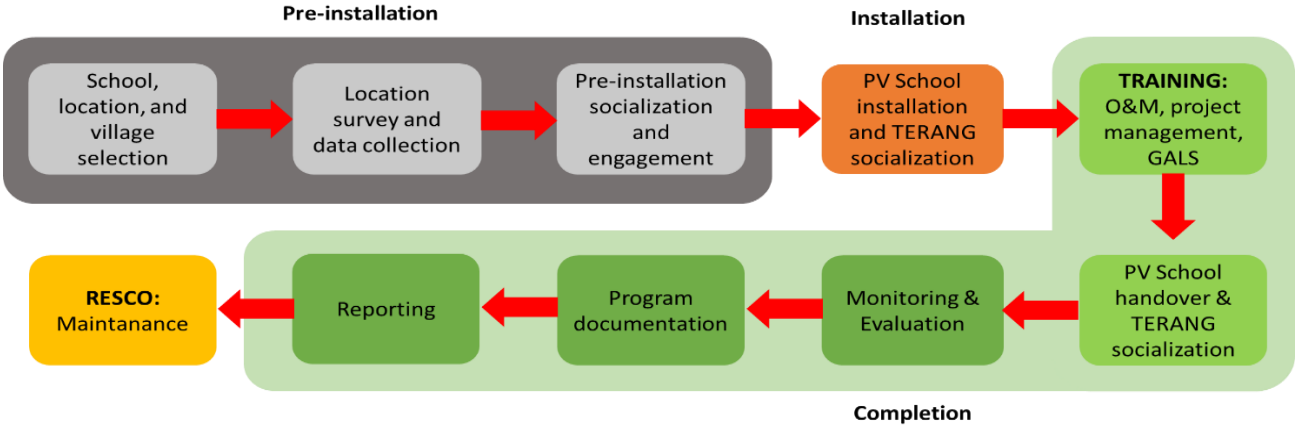

Figure 5.7. PV school implementation process in TERANG project

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Figure 5.8. (Left) PV systems in Kataka elementary school, (Right) charging station and Sundaya lamps in Kataka elementary school.

5.4.3.2 *Hivos PV school's business model*

In this section, we look into the business model and its elements applied in Hivos PV school program. Figure 5.9 shows the overview of SEHEN's business model. The detail of PLN's business model and its elements are shown in the Appendices.

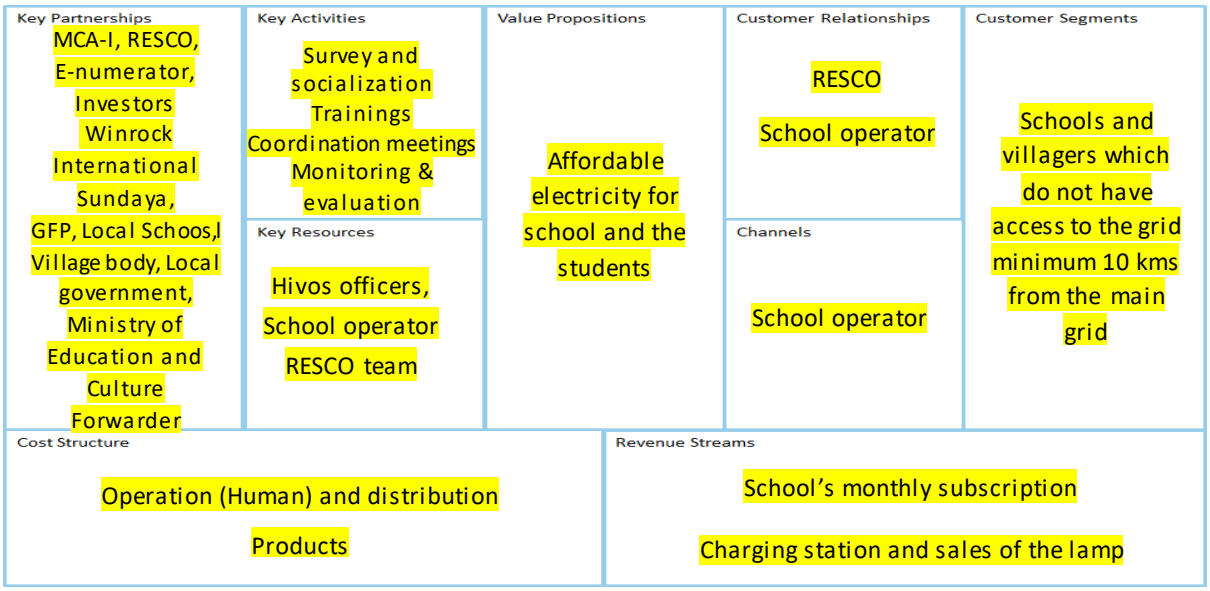

Figure 5.9. PV school's business model on TERANG program

5.4.3.3 *Feedbacks on Hivos program*

Hivos TERANG program was firstly implemented in Kataka village as a PV school pilot project. The school project enables Kataka elementary and junior high school own PV systems to electrify the schools during the day and teachers' dormitory during the night. The school project also enables the students t o own one PV lamp per student and use the charging service at the school in exchange for a charging fee.

Hivos PV lamps users described that Hivos lamp is quite expensive to be paid in cash. However, the school headmaster decided to allow the villagers to pay the lamp in up to four installments with a slightly higher price. This initiative, which was arranged by the school without any Hivos' intervention, has helped many students to own Hivos' PV lamps in their house.

All the villagers we interviewed explain that they are satisfied with Hivos lamp due to several reasons. Firstly, Hivos' lamps provide brighter lights compared to the lamps from other systems, such as the lamps from PNPM or SHSs from village program. Moreover, the charging fee for the lamp is quite affordable for the users. This could happen because Hivos uses high-quality PV lamps for the school project. Secondly, the villagers explain that they feel safe with Hivos' program because they have the school operator if there is anything happen to the lamps. In this way, the villagers trust Hivos' programs because they feel that they are always in contact with Hivos or its representatives who have enough knowledge about the technology.

From our observation in Kataka village, the success of Hivos PV school project was also influenced by good preparation and program's socialization to the community at the beginning of the projects. Also, not like the government programs, Hivos equips the community with enough knowledge about PV technology as well as train one local operator to be responsible for the maintenance of the PV systems at school as well as any complaints regarding PV lamps from the users. Moreover, Hivos has continuous monitoring and evaluation towards the project to ensure the sustainability of its projects in the village. Despite positive responses from the PV lamps' users, they explain that Hivos school program should be eligible for not only students but also other villagers who want to have PV lamps in their house. Moreover, the quantity of PV lamps should not be limited by the number of students in the school which is one lamp per student. It is because some of the

children do not go to the school where Hivos has the school projects, but they want to have their own PV lamps to support their study in the evenings.

5.5 Summary of current or previous Sumba's PV project: barriers and its business model

From the previous chapter, previous and current PV programs which have been established in Sumba Island have been explained. There are three main PV programs which come from PLN as a business unit, HIVOS as an NGO program, and local government as donor-driven programs. All of these stakeholders have its specific business models to overcome challenges which they are faced during the implementation of their programs. The interview has been conducted with the villagers and all the key stakeholders who run the programs in Sumba to understand each of the barriers they face and how the elements of business models could help them to overcome the challenges. The summary of barriers significances and elements of business model which are used to overcome those barriers are indicated in Table 5.1 in different colors. Red means that a certain barrier is extremely significant towards the program. Orange explains that the barriers are very significant towards the program. Yellow and Green represent barriers that are moderately and slightly significant towards the program. Lastly, Blue represents that the barriers are insignificant towards the program. Figure 5.10 and Figure 5.11 also explain the differences in customer segmentation, value proposition and the cost structure of programs run by PLN and HIVOS. The program runs by Governments do not necessarily have a business model because it does not generate any profits.

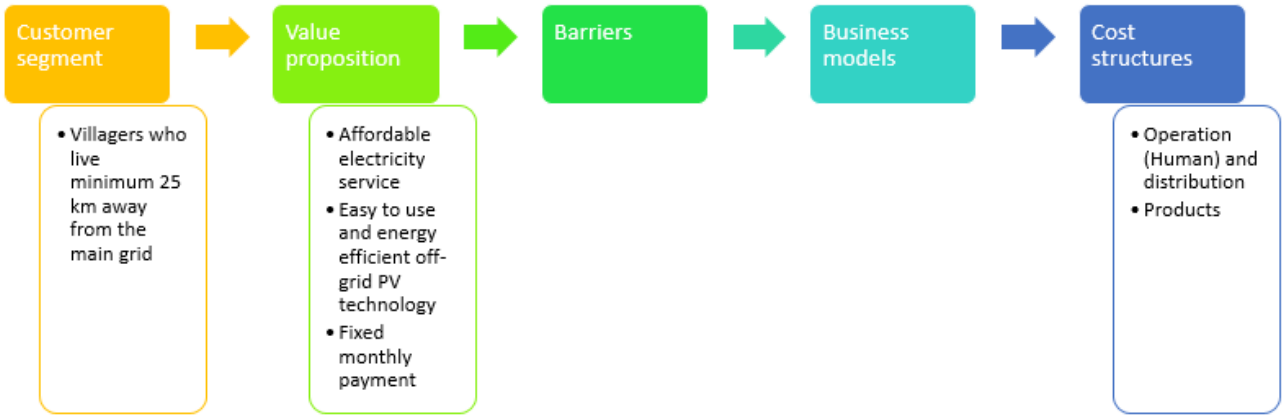

Figure 5.10. PLN's flowchart

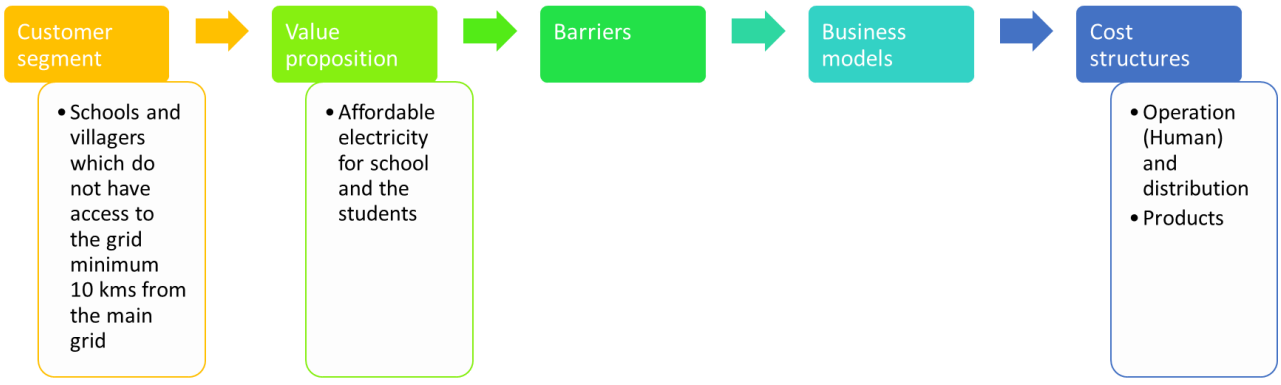

Figure 5.11. HIVOS' flowchart

From the customer segmentation, HIVOS offers its program only to the local schools which are at least ten km away from the main grid. Not only had the schools, but HIVOS program also targeted the students in the school who live nearby the areas. On the other hand, PLN does not have a clear customer segmentation. As long as the villagers do not have access to electricity, live twenty-five km away from the main grid, and they are able to pay the initial deposit, PLN will serve those types of customers.

On the value proposition, PLN and HIVOS program offers different things. PLN offers electricity service at monthly fixed service fee which is paid through a deposit in a bank while HIVOS provides PV technology for the school with a pay-to-own scheme, solar lamps for the students which could be purchased through the school in cash, and charging service.

PLN and HIVOS are two different entities. PLN is a state-owned company which apart from serving Indonesian customers, it also needs to generate profits. Thus, the main activities of PLN program focus on driving sales. While it is good at the first place, without proper education, program socialization, and customer segmentation, and after-sales services, this decision could lead to failure of the program. On the other hand, HIVOS, as an NGO, its main activities focus on community engagement and educating the customers. While the sales activities are done through the school operators and the technical activities are done through partnerships with RESCO and WINROCK, HIVOS could focus on educating the villagers and ensure the sustainability of the projects. Each of the projects has its own barriers, and each of these entities has its own way to handle these barriers which will be explained below:

Infrastructure

PLN and HIVOS programs experience challenge in infrastructural aspects as moderately significant. This is because PLN and HIVOS programs focus on the villages which are isolated from the main grid which usually located in remote areas with lack of support in infrastructure. To be able to sell its products or services, both entities rely on its partners and its own resources. PLN relies on its employees and local agents to promote its service. PLN also relies on its branch offices, which are located nearby the village, to stock up the technology and provide any services if needed.

HIVOS program has a different scheme than PLN's program. HIVOS program consists of several key stakeholders which act as partners for HIVOS and responsible on certain activates. HIVOS team focuses on the survey, socialization and community engagement. However, enumerator team is also hired to help HIVOS team to do the survey and monitoring to the villages. This enumerator team reports to HIVOS employee at Sumba headquarter. The installation is done through RESCO team. However, HIVOS also train the school operators to do basic checking and repairs. Thus, not all the technical issues solved by RESCO team. Moreover, HIVOS relies on local schools for the sales, payment collection, as well as maintenance of the systems. In this way, HIVOS reduces the barriers on infrastructure as well as saves it operational costs.

For the government projects, the barriers of infrastructure are classified as slightly significant. It is because the donor-driven project from the government often requires only the one-time installation. Thus, there is no need for the government team to go to the remote areas again.

Investments

It is obvious that the investment barriers are insignificant towards PLN business. It is due to the fact SEHEN program is fully supported by the national and local government. Thus, the investment comes in handy from the government. On the other hand, HIVOS, just like many others NGOs, faces issues on investment as very significant towards the sustainability of its program. It is because HIVOS relies on investors and grants for the investments required for the projects. Different approaches were tried to attract investors to HIVOS program, and one of them is to organize an event called *Sumba Investment Forum.* For the government projects, although it is fully supported by the local and national government as well, the funding for particular activities is very limited. Thus, the investment issues on the government projects still classified as moderately significant.

Table 5.1. Summary of barriers representation and elements of business model of Sumba's PV programs

No	Barriers	Element of business model to overcome barriers					
		Customer relationship	**Channels**	**Key partners**	**Key activities**	**Key resources**	**Revenue streams**
1.	**Infrastructures**						
	PLN		PLN branch office	Local agents	• Marketing • Sales • Distribution • Installation	• PLN branch office • PLN employees	
	HIVOS		Local school operator	• enumerator • local school operator	• Survey and socialization • Trainings • Monitoring & evaluation	HIVOS team RESCO team	
	Government						
2.	**Investment**						
	PLN			Governments			
	HIVOS			Investors	Sumba Investment forum	HIVOS team	
	Government						
3.	**Financial**						
	PLN			Local and national banks			Deposit and direct debit
	HIVOS			• enumerator • Local schools	Survey and socialization/community engagement	HIVOS team	• Charging fee • Lamp sales in cash • School monthly subscription to HIVOS in cash
	Government						
4.	**Human resources**						
	PLN			Local agents or another third party			
	HIVOS			Partnerships with RESCO, Winrock, and other stakeholders	Training and knowledge transfers		
	Government						
5.	**Technical**						
	PLN			PV contractors	Bidding		
	HIVOS			• Forwarder • Winrock International • Government • SUNDAYA	• Survey for agreement of the projects • Evaluation for the third party • Meeting coordination	HIVOS team	
	Government						
6.	**Market demand**						
	PLN		PLN branch office	Local sales agents	• Marketing • Sales • Distribution	• PLN branch office • PLN employees	

	HIVOS		Local school operator	Local school	Community engagement	HIVOS team	
	Government						
7.	**Social, Behavioral, Cultural**						
	PLN	PLN customer service			Marketing	• PLN branch office • PLN employees	
	HIVOS	• RESCO • Local school operator		• RESCO • Local school	Socialization and education	HIVOS team	
	Government						
8.	**Governmental /Institutional**						
	PLN					• PLN branch office • PLN employees	
	HIVOS			Governments	• Trainings • Coordination meetings	HIVOS team	
	Government						
9.	**Network/ Partnerships**						
	PLN						
	HIVOS				Coordination meetings	HIVOS team	
	Government						
10.	**Environmental**						
	PLN				Waste collection	• PLN branch office • PLN employees	
	HIVOS			RESCO team	Waste collection	• HIVOS team	
	Government						

insignificant sightly significant moderately significant very significant extremely significant

Financial

For the financial aspects of the end-users, PLN faces financial issues as moderately significant while HIVOS takes it as slightly significant. It is because HIVOS has a more focus and targeted customer segmentation than PLN's program which often does not consider the ability to pay of the end-users in the long term. In PLN program, as long as the customer could make the first deposit to the partnering bank, the villagers could easily get the PV package to be installed on their roof. However, on this model, PLN relies on the initiative of the customers to pay to the banks which often are located in the town or the city far from the village. Moreover, the systems will still work although the customers fail to make payment. After three consecutive months without payment, PLN will take away the systems. It is different with HIVOS model where the solar lamps stop working when it runs out of battery. When the customers need to charge the lamps, they could charge it in the school with an exchange of a small fee. In this way, HIVOS offers a small fee in a flexible payment scheme where the customers could pay the charging fee when they need the electricity. Moreover, HIVOS has done

its homework to choose the location of the project as well as the customers wisely. HIVOS takes into account the villagers' income and willingness to pay for the technology. In this way, HIVOS much more prepared to face the barriers related to financial issues because the risk of payment default has been considered at the beginning of the project. There are no issues on the financial aspect of the end-users on the government projects since the projects are donor driven.

Human resources

On the human resources, PLN explains that the barriers on human resources aspects are slightly significant. As the state owned-utility company, PLN has no issues in providing good quality of human resources. However, since the deposit payment does not work on the current model, an active payment collection was applied in SEHEN business model. This collection could not be done by PLN employees because of the lack of numbers of people available at PLN branch office. Thus, payment collection is done through the local agents or the third party. At HIVOS, just like many NGOs, the number of HIVOS team is very limited. HIVOS explains that the barriers to human resources could be classified as moderately significant. Thus, HIVOS as an NGO puts much focus on the things that they are capable of such as surveys, community engagement, securing investment, coordination with other stakeholders, training, as well as monitoring and evaluation. While on the technical aspects, HIVOS relies heavily on its partners such as Winrock International and RESCO team. The government project also experiences the barriers to human resources as moderately significant. It is because they have very limited capacity and capability to work on renewable energy field. Thus, the government often relies on its partners, such as HIVOS, to do several pieces of training related to project management and renewable energy fields.

Technical

PLN and the government programs do not experience any issues on the technical aspects. It is because all the technologies used for their programs have gone through a bidding process. Thus, all the technical aspects will be the responsibility of the PV contractors who win the projects. In this way, PLN and the government eliminate the risk of technical failures on their projects. On the other hand, HIVOS considers technical issues as moderately significant. While Winrock International helps HIVOS to decide the technology and PV suppliers which are eligible for the projects and RESCO team which help HIVOS for the on-field installation, HIVOS still heavily involves in the importation, community engagement, coordination with key stakeholders such as government and investors, and evaluation of the third party. Thus, HIVOS still possess to several technical challenges during the implementation of the projects.

Market demand

In general, all PV programs in Sumba Island do not experience significant issues related to market demand. PLN and HIVOS explain that barriers on market demand are classified as slightly significant issues, while the government projects deem these issues as insignificant towards its projects. In general, people in Sumba is very excited about new technology which could generate electricity, especially when it is given for free from the government. However, market demand is slightly emerged because of the high upfront cost which needs to be made in cash while the villagers get used to kerosene which could be bought when they need it. In PLN program, the villagers need to put a deposit for one year or six months subscription of the electricity service. In HIVOS program, the villagers need to buy the solar lantern, which costs the same as their monthly kerosene consumption, in cash. Although it is the same amount of money or even in some areas the cost of PLN service or HIVOS solar lantern could be cheaper than the cost of kerosene at the same period, the payment in cash made the villagers reluctant to buy the services or the products. Some of them even need to sell their cattle's to join PLN program. Thus, a proper education and community engagement are necessary to make the villagers understand and willing to change from kerosene to much healthier source of light.

Social, behavioral, cultural

PLN and the government program see social, behavioral, and cultural aspects and very significant issues. PLN describes that people who live in the village do not get used to with banking systems. Thus, it is quite hard to rely on their initiative to go to the bank in the nearest town and make a small deposit for the system. While the government program gives PV systems for free, it does not mean that the program does not face any barriers on the social, behavioral, and cultural aspects. A lot of SHSs are broken because a lack of knowledge, capacity, and capability of the villagers to maintain the systems. Since the program is considered as a 'grant' from the government, the government is no longer responsible for the maintenance and services of the systems.

On the other hand, HIVOS sees this type of barriers as slightly significant. HIVOS describes that majority of people in the village do not see electricity as their primary needs. PLN also faces the same problem where its customers own live stocks but could not or do not want to make a deposit for SEHEN systems. They simply get used to living with kerosene or without any electricity for a long time. Thus, HIVOS believes that a strong community engagement and proper education are needed to overcome these challenges.

Governmental/institutional

PLN sees the barriers related to the government and other institutions are slightly significant. It is because SEHEN program is fully supported by all the stakeholders, especially by the national government. However, PLN sees the government program, which gives the PV systems for free, as a minor competition for its market. Thus, PLN needs to collaborate with the local government regarding the location of the government program so that PLN could sell its service without being interrupted by free SHS program from the government.

The local government program sees that the government issues play an extremely significant role in their program. It is because the local government relies on the instruction of the national government. There is nothing that the local government could do when the national government erases the program. This type of barriers also plays an extremely significant role on HIVOS program. It is because HIVOS's program consists of several stakeholders which include local and national government. Excellent coordination and collaboration with the government are needed. Moreover, similar to the local government, there is nothing that HIVOS could do when there is a new policy established by the national government which influences Sumba project negatively.

Networks/partnerships

HIVOS and the government program agree that the network and partnerships issues are slightly significant towards their programs. HIVOS and the local government explain that although all the key stakeholders are very supportive towards their program, there is still a lack of coordination between the departments on the local government bodies, or even with the national government and PLN. Thus, a lot of similar SHS programs were executed in the same villages. A better coordination would make the use of PV program more effectively and dispersedly. For PLN, this type of barriers is insignificant since SEHEN program is fully supported by the national government. Moreover, there are no restricted operational areas because PLN, as a state-owned utility company, is the one who is responsible for providing electricity service to Indonesian people.

Environmental

HIVOS and the government program see the environmental issues as insignificant. HIVOS is responsible for the waste collection for old and faulty products through its partnerships with RESCO team. These old products could be sent back to the manufacturers to be recycled. While HIVOS takes responsibility for its products, the government program leaves this responsibility to the villagers. This barrier becomes insignificant for the government program because any issues related to the systems are no longer the responsibility of the government. It means that there could be still environmental issues when it comes to the

villagers since they do not have enough knowledge to handle and recycle old products. For PLN, this issue is considered as moderately significant. It is because PLN still does not have any recycling scheme. Currently, the company is only responsible for the waste collection. The company collects old, faulty, or even products which are still in good condition because of payment default to be placed in their warehouse in the city

6 CHAPTER 6: Business model construction

In the previous chapter, we have seen the linkage between the barriers to the adoption of PV electrification in the rural energy market and business model employed by the PVCs. Also, we have concluded all the previous and current PV programs in Sumba Island which were initiated by Hivos as an NGO and PLN as a state-owned utility company, as well as donor-driven projects carried by national and local governments.

In this chapter, we will compare and analyze the current business model used by PLN and Hivos in Sumba Island with the other business models employed by the PVCs. We do not include donor-driven programs from the government as the programs generate zero profits. Finally, the result of this comparison and analysis will be used to develop a proposed business model which might be the most suitable for PV adoption in Sumba Island.

6.1 Analysis of existing Sumba's business model vs. PVCs business model

In this section, we will compare the business models employed by PLN and Hivos with the other business models employed by seven PVCs which we have interviewed in the previous chapter. We will discuss each of the barriers and its significances towards the companies' business and the sustainability of the project, as well as different elements of business model employed to overcome those barriers. We will also try to compare the linkage between the barriers and business models employed in Sumba Island with the initial model that we have constructed in Section 4.2 to see whether the model is still relevant or not.

6.1.1 Business model elements: Value proposition, key activities, cost structure, and revenue model

In Chapter 4, we have discussed the business models employed by different PVCs in various developing countries. In this section, we will discuss and compare the elements of business models employed by PLN and Hivos with the other PVCs. Figure 6.1 and Figure 6.2 show where PLN and Hivos are located compared to the other PVCs.

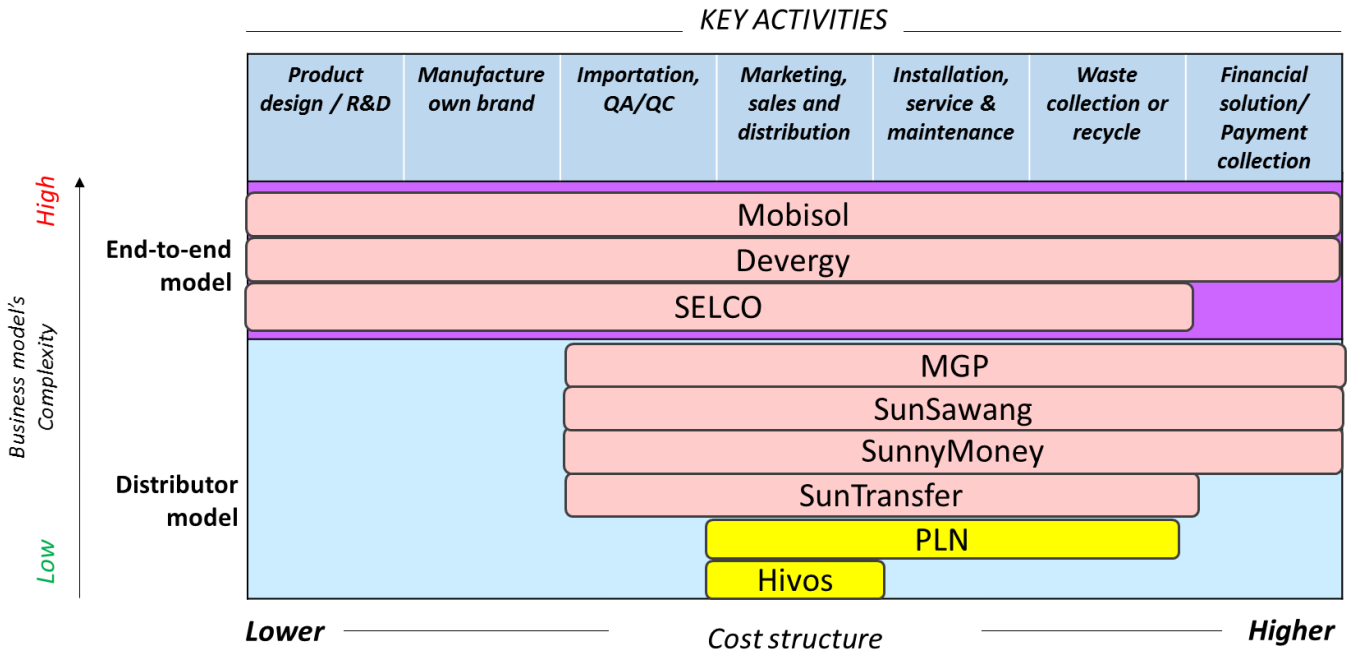

Figure 6.1. Types of business model based on the key activities of different PV companies PV companies, PLN and Hivos

Based on our interview with Hivos, it could be concluded that as an NGO, Hivos employs a combination of distributor model and a hybrid of products-focused and a service provider business model. It is because Hivos has two different layers of business models which employed for its school program. Hivos offers different value propositions for two different customers, which are the schools and the student. The first layer

is that Hivos offers PV technologies to the targeted schools. The schools could have the PV systems installed through monthly installments or a pay-to-own scheme. The second layer is that Hivos makes the schools are able to offer PV lamps to the students. The students could buy the PV lamps in cash or through installments at an agreed price and scheme with the schools. Hivos also makes the school as a service provider since the students could charge Hivos' PV lamps at the school in an exchange of small fee per one-time charge or fee-for-service revenue model. Also, from the figures, we could see that Hivos's key activities focus on the distribution, sales, and marketing of the products. It is because Hivos, as an NGO, is focus on its main activities on trainings, survey and socialization of the programs, monitoring and evaluations, while other activities such as importation, product selections, installation, services, and maintenance, as well as waste collections, are done by the third parties, such as RESCO and Winrock International. Nevertheless, as the leader of the programs, Hivos is responsible for all the activities done by its third parties.

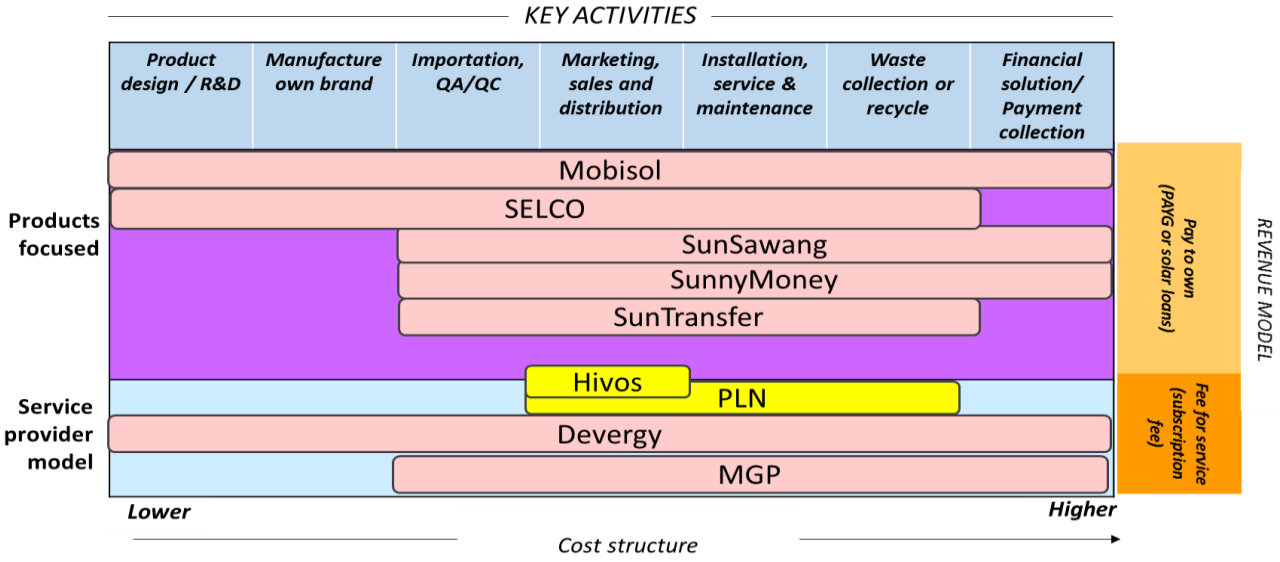

Figure 6.2. Types of business model based on value proposition of different PVCs, PLN, and Hivos

From Figure 6.1 and Figure 6.2, we could see that PLN also has a combination of distributor model and a service provider business model. However, the technology used in PLN program is different from MGP and Devergy. Instead of using microgrid to deliver the electricity services to its customers, PLN is having SHSs installed in each of the customers' houses. PLN chooses PV technologies for SEHEN program through a bidding process. Hence, the company does not have to worry about the technology used in the program since the winner of the bidding process has to meet the requirements needed for SEHEN program. In this way, PLN could focus on delivering electricity services to remote areas through SEHEN program. Nevertheless, the choice of PLN's business model could lead to misunderstanding of the ownership of the systems since the villagers have the PV systems installed on the top of their roof while they have to pay for monthly service fee as long as they use electricity in their house. It is also worsened if this type of business model is not followed by proper after sales services and maintenances from the company. This condition leads to a thought amongst the villagers of owning PV systems through installments or even in cash because they could have their own PV systems with the same money they have to pay a monthly subscription fee to PLN after four to five years. By owning their own PV systems, the villagers explain that the only costs they need to pay are the lamps, the batteries, and the liquid inside the batteries which need to be changed when it is needed. Therefore, PLN business model which combines distributor and service provider model should be followed by good maintenance and services from the company since the ownership of PV systems always remain to PLN and well-functioned systems are needed in order to deliver reliable electricity services to the customers.

6.1.2 Business model elements: Customer segmentation

Figure 6.3 summarizes the differences of customer segmentation of different PV Companies we have interviewed as well as PLN and Hivos. From the figure, we could see that PLN does not have specific segmentation for its customers. According to the company, the main targeted customers of SEHEN program are the ones who still do not have access to the grid. However, PLN does not specify its customers based on their income. The company welcomes any villagers who want to install SEHEN systems as long as they could pay for the initial deposits in the banks.

On the contrary, Hivos selects its customer's base for its program very carefully. The main targeted customers for Hivos' programs are schools in the village which have a minimum distance of ten km away from the grid. However, Hivos has some other criteria for the schools which are eligible for the programs such as the ability of the school to pay for the system and to maintain and responsible for the systems. Other targeted customers for Hivos' program are the villagers whose the children go to the selected school. Hivos focuses on the lower up to middle tier of BoP to sell its PV lamps through the school. Nevertheless, as an NGO, Hivos always make surveys before implementing any projects. Thus, Hivos also considers the ability to pay of the villagers for the PV lamps as well as its charging fees.

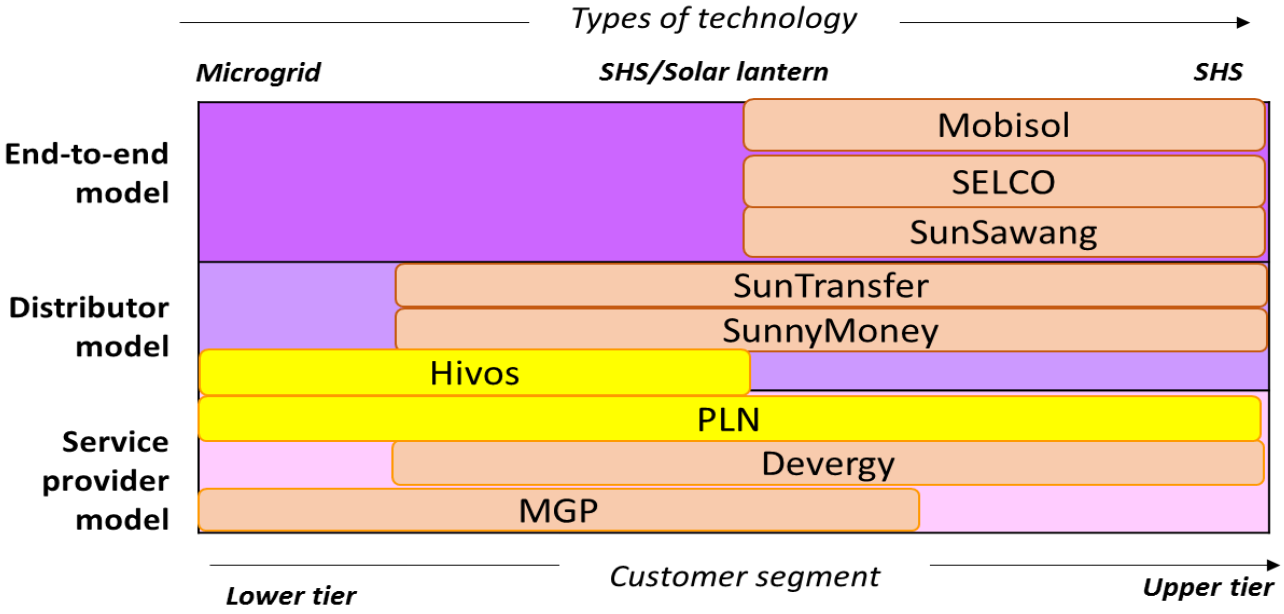

Figure 6.3. Customer segmentation of PVCs, PLN, and Hivos

6.1.3 Barriers and other elements of business model

6.1.3.1 Infrastructure

Figure 6.4 shows the significances of infrastructural barriers faced by PVCs, PLN, and Hivos. In the figure, we could see that PLN and Hivos describe its infrastructural barriers as moderately significant. Our field observation confirmed that the location of the targeted villages for Hivos or PLN programs is quite from the main city. However, most of the locations could still be reached with motorbikes and cars with a maximum of four hours travel time from the main city, which is Waingapu, where Hivos and PLN main offices are located.

From our initial framework, which is shown in Figure 4.15, it could be seen that specific business models could be derived from the significances of infrastructural barriers faced by PVCs. Based on our findings, the more significant infrastructural barriers faced by PV companies, the more PVCs rely on the third parties to reach its end-users to reduce operational costs. In the case of Hivos and PLN, this model is accurate. Hivos' school program relies heavily on the schools for the sales of the PV lamps, the collection of the sales of PV lamps as well as its charging fees, also for the small services and maintenance. Hivos also relies on its partners, RESCO, to be responsible for big services if needed. In this way, Hivos could focus on the initial phase of the program which is socialization, surveys, as well as the late phase of the program which are monitoring and

evaluations. On the other hand, PLN, just like SELCO, has its own branches across the island. PLN relies on its branch offices to promote its services. Nevertheless, PLN also employs local sales agents who operate based on commissions to sell the PLN's services as well as to collect the subscription fees if needed. PLN relies on its partnerships with the banks for the initial deposit of SEHEN systems as well as on the third party to actively collect the subscription fees if needed.

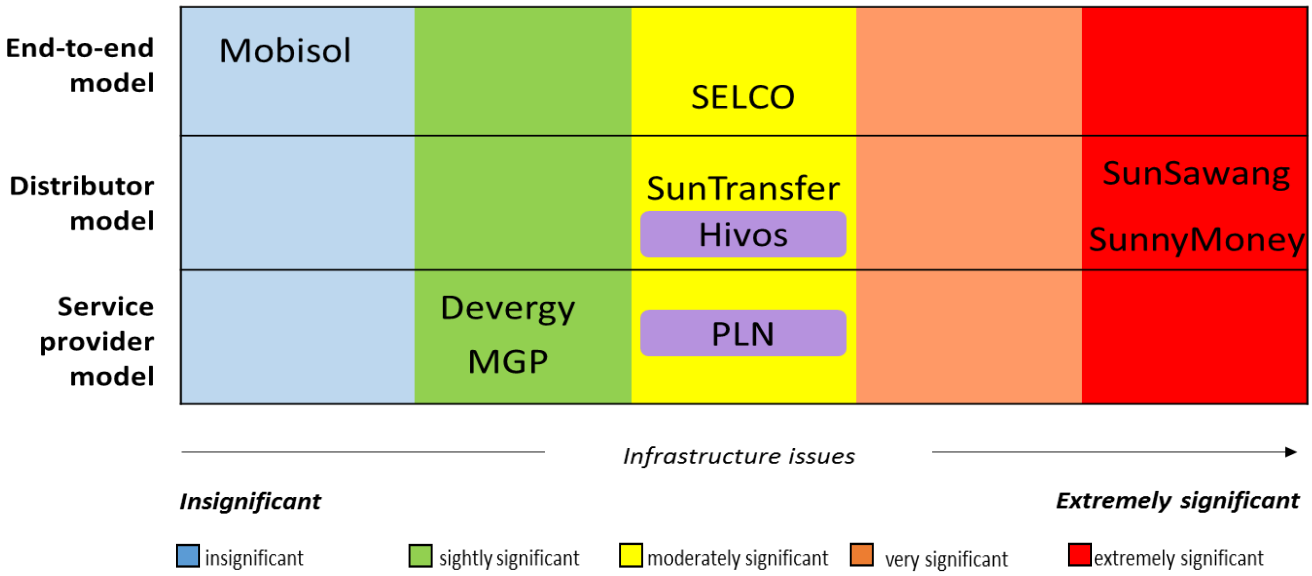

Figure 6.4 Infrastructure barriers faced by PVCs, PLN, and Hivos

6.1.3.2 Investment

From the previous chapter, it was discussed that SEHEN program is fully supported by the national and local government. Thus, PLN faces no barriers regarding the investments for the program. In contrast, Hivos, just like other NGOs and PVCs, sees barriers on the investment aspects as very significant towards the sustainability of its program. The barriers significances of PLN and Hivos could be seen in Figure 6.5.

Hivos relies heavily on the other institutions and organizations to support its programs such as Norwegian embassy, MCA-I, European Union, the Kingdom of the Netherlands and other private investors. This pattern is aligned with our initial framework shown in Figure 4.15 which conclude that the choice of business model cannot be derived from the significances of investment barriers. All the companies and NGO, like Hivos, are racing to secure as much fundings and investment as possible from any resources they could possibly find.

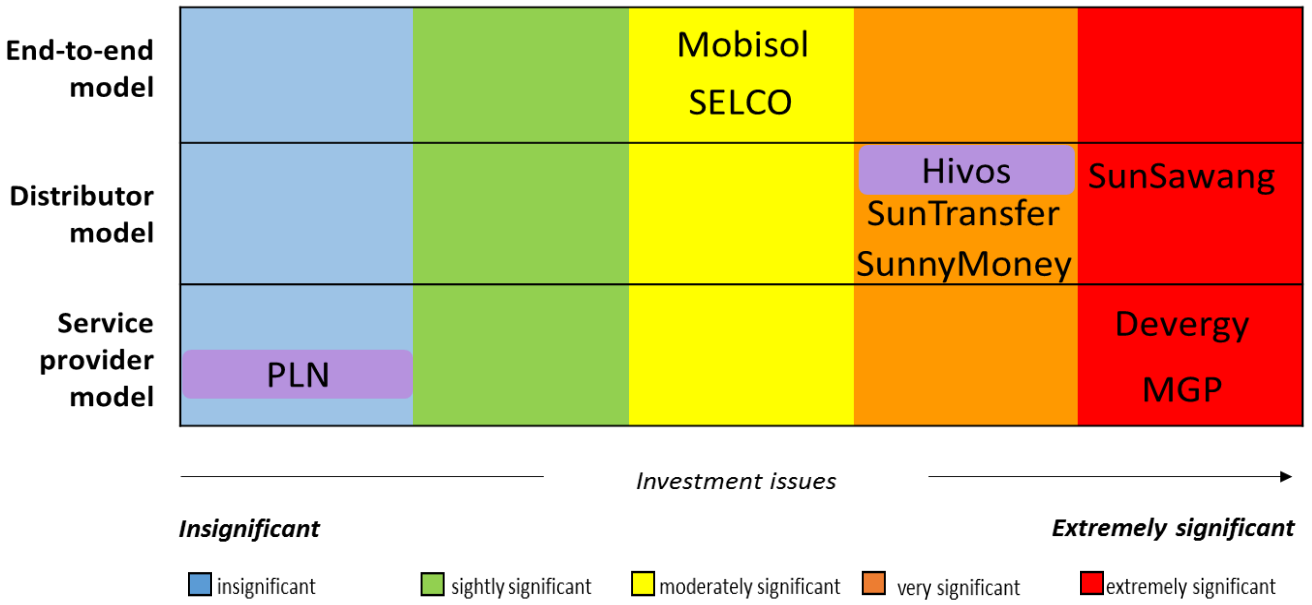

Figure 6.5 Investment barriers faced by PVCs, PLN, and Hivos

6.1.3.3 *Financial*

Based on our initial framework, specific elements of business models could be derived from the significances of the barriers faced by the PVCs. Our analysis concludes that for those companies which offer products to the end-users, the higher risks of a payment default or, the more significant the financial issues, the more PV companies tend to transfer the risks of payment default to the third parties, such as banks or other financial institutions. On the other hand, those companies, which provide electricity services to the end-users, should be able to take up the risks by themselves. Nevertheless, there are several factors which could influence the success of the payment scheme chosen by PVCs, such as the size of the company, infrastructural barriers, technological investments, the location of the banks, and the behavior of the customers it selves, as it is shown in Table 4.4.

PLN describes the barriers on the financial aspects as moderately significant, as shown in Figure 6.6. Based on our interview, the company relies on the local banks to collect the subscription fee or the deposits made by the end users. This model is similar with SunTransfer where the company also relies on the local MFIs to collect the payment of the systems. The difference is that SunTransfer employs a pay-to-own model and equip the third party with a PAYG systems. Moreover, SunTransfer' PV systems are equipped with a meter where the company could control the use of the electricity. The payment systems work like a pre-paid electricity credits until the end-users make the full payment of the systems. When the users do not buy the credits, they could not use PV systems. In contrast, PLN does not have such technologies for SEHEN systems. PLN relies heavily on the customers to pay the deposits to banks by themselves. There is also no automatic systems which suspend the use of SEHEN systems if the users do not pay for the systems. The only thing that PLN can do is that the company will take back the systems if the users do not pay for three months in a row. Moreover, the location of the banks often far from the villages where the end users live. In this way, PLN's revenue collection only relies on the customers' behavior whether they could pay for the systems on time or not. PLN's payment system did not work well because it did not meet the success factors in order to transfer the risk of the payment to the third party and collect the revenue passively as shown in Table 4.4.

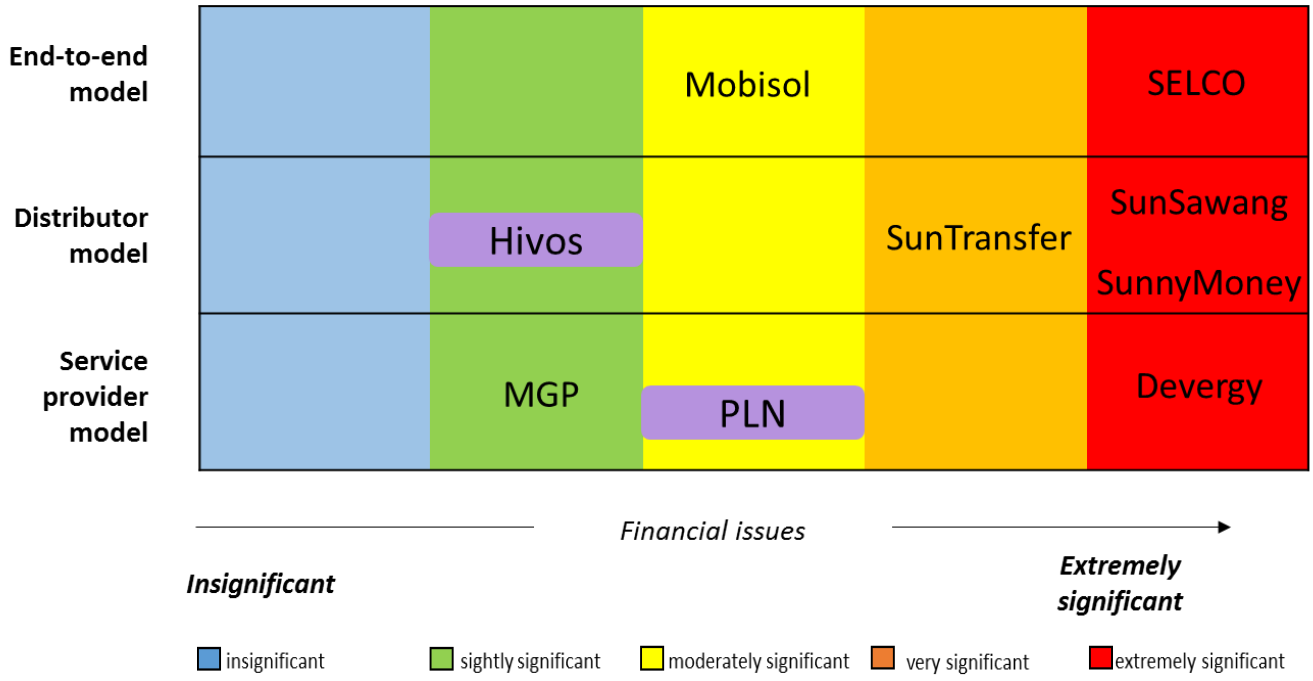

Figure 6.6. Financial barriers faced by PVCs, PLN, and Hivos

The situation in PLN's case could be fixed several ways. Firstly, PLN could hire local agents as a partner to collect the subscription fee actively. This model could work if the commission of the agents is worth it compared to the travel cost to the bank to make the deposit of the systems. Secondly, PLN could replicate SunTransfer or SunnyMoney's payment model. PLN could hire local agents who are equipped with a PAYG

device. A meter should also be added in SEHEN system to control the use of the electricity. In this way, the end-users could purchase electricity service just like a prepaid mobile credit and PLN could control its revenue collection remotely. Lastly, a good social engagement to educate the end-users regarding the payment scheme, as well as PV technologies, are essential to fix the customers' behavior to pay the subscription fee timely.

In the case of Hivos, the financial issues from the end-users are described as slightly significant. It is because Hivos has a rigid procedure to select the schools and the villages for the school programs. Hivos conducts a survey and community engagement before they decide whether the school and the village are suitable for the program. In this way, Hivos eliminates the risk of payment default from the beginning of the program. Hivos' main customers are the schools appointed for the school program. Nevertheless, Hivos also enables the school to operate the second layer of the business which is to sell the PV lamps and to rent the charging station. In this way, Hivos enables the school to have additional income to pay for the entire PV systems as well as the charging station. Since the barriers on the financial aspects are not high, Hivos collects its revenue directly from the school every month. This payment model is possible because currently Hivos only has one pilot project for the school program. Later, once there are more schools involved, another payment scheme should be arranged

6.1.3.4 Human resources

Figure 6.7 shows the significances of human resources barriers faced by PLN and Hivos compared to other PVCs. On the barriers related to human resources, PLN describes human resources issues as slightly significant while Hivos explains this type of barriers as moderately significant. Both PLN and Hivos relies on the third parties for things that the company or the organization could not do themselves due to unavailability of skilled human resources. PLN hires local sales agents and third parties to do the payment collection because of the company experiences a lack of numbers of people in its branch offices. Payment collection is an easy task, while PLN employees could do other technical things, PLN chooses to have other parties to have the payment collected from its customers. Hivos, as an NGO, has its main goal which is to enable knowledge transfer between Hivos, the villagers and other local NGOs. Thus, Hivos provides proper training and educations for local NGOs and the villagers. In this way, with limited numbers of human resources available at Hivos office, Hivos still work on its program with the help of the local NGOs as well as Hivos' partners such as RESCO and Winrock International.

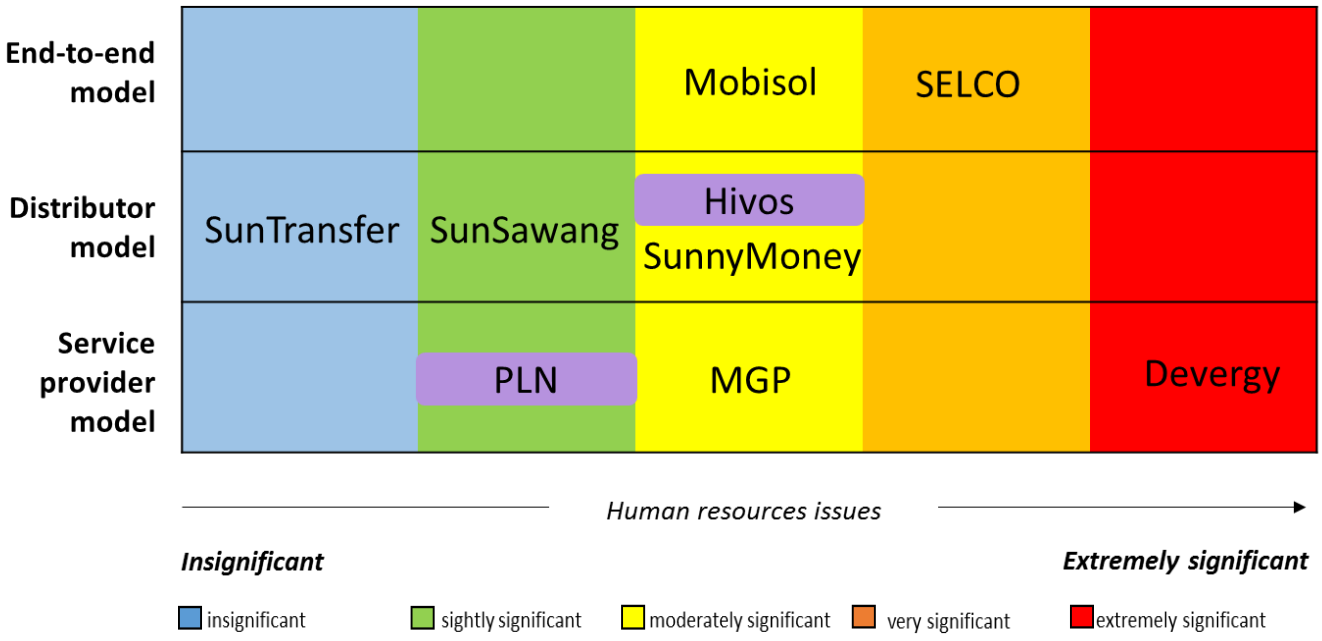

Figure 6.7. Human resources barriers faced by PVCs, PLN, and Hivos

This pattern aligns with our initial framework shown in Figure 4.15 where there is no specific correlation between the barriers significances with the business models employed by PVCs. The general correlation which could be derived from the significances of the barriers related to the availability of human resources faced by PVCs are using third parties, training, and increasing the pool of candidates for each position in the company.

6.1.3.5 Technical

The significances of technical barriers described by PLN and Hivos are shown in Figure 6.8. As explained in Chapter 5, PLN has a lower remark on the technical barriers compared to Hivos because all the technologies used in SEHEN program comes from the bidding process. The winner of the bidding will be responsible for the procurement of the technologies, the installation of the systems, and after-sales services based on the agreement with PLN, usually, the systems are equipped with six to twelve months warranty from the supplier. In this way, all the risks related to the technical aspects are transferred to the winner of the bidding process, or to the third party which is the systems' suppliers.

In contrast, Hivos, as the leader of the program, is responsible for making sure that the programs will run smoothly from the selection and the importation of the technologies, community engagement, installation, as well as monitoring and evaluations with the help from Winrock International and RESCO. Thus, Hivos possess to more technical issues compared to PLN. From our initial framework shown in Chapter 4, we conclude that there is no general correlation which can be drawn from the technical barriers faced by PV companies with the business model used by these companies to overcome technical issues which influence its business. The model is aligned with Hivos' situation since each of the technical issues have its own specific solution. Hivos or any other PVCs need to see each of technical issues one by one in order to develop suitable solutions for each of the technical problem they face during the implementation of the projects.

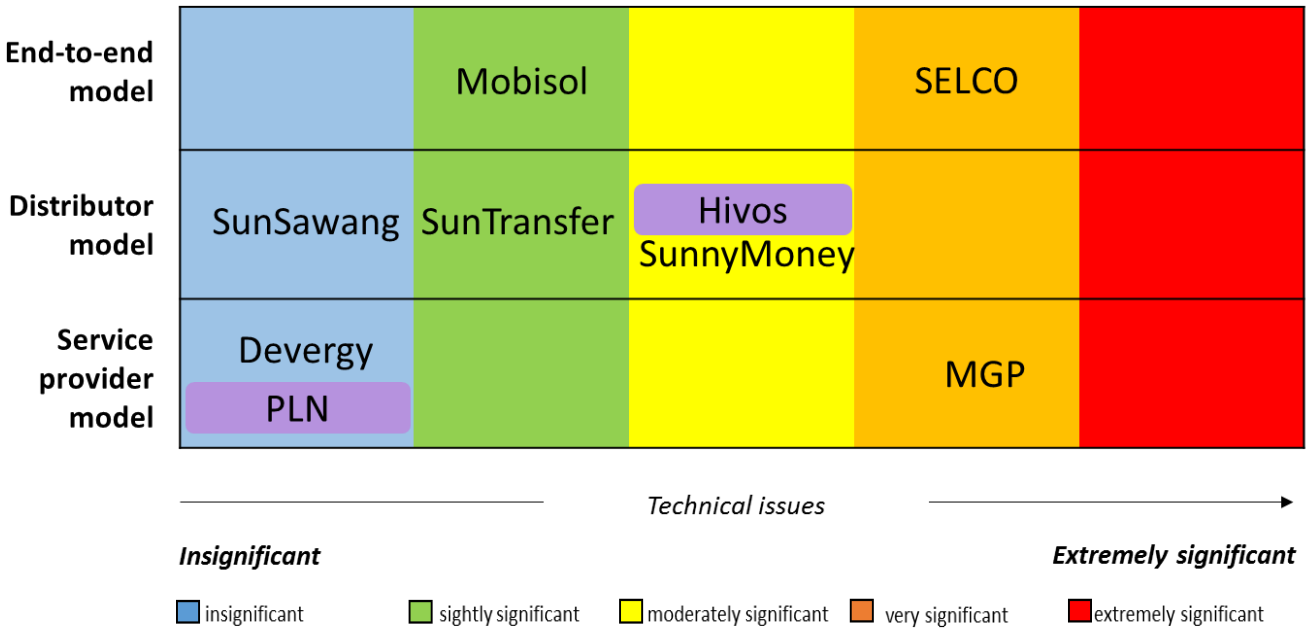

Figure 6.8. Technical barriers faced by PVCs, PLN, and Hivos

6.1.3.6 Market demand

Based on our initial framework in the previous chapter, the more significant the market demand barriers, the more key partners, and resources involved helping the company to stimulate demand in the companies' targeted customers. In the case of PLN and Hivos, both of the institutions describe the barriers they face on market demand aspects are slightly significant towards its business or the sustainability of its project, as shown in Figure 6.9. Both PLN and Hivos relies on minimum key partners to stimulate the demand for its products or services. Just like MGP and Mobisol, PLN relies on its own resources. As a state-owned utility company, it is PLN's duty to serve Indonesian with electricity services. Thus, the company relies on its sales

team and its employees in the branch offices across Sumba Island. PLN describes that to stimulate the demand for electricity in the remote areas is not difficult. Once PLN could encourage one family to use SEHEN systems, most of the time, other families will follow.

Hivos also relies on its own team to do proper socialization, educations, and training to introduce PV technology as well as to stimulate the demand for PV technology amongst the villagers. With the help from the trusted figure in the local school, Hivos together with local school educate the villagers about the benefit of PV technology as well as the danger of using Kerosene for a long time.

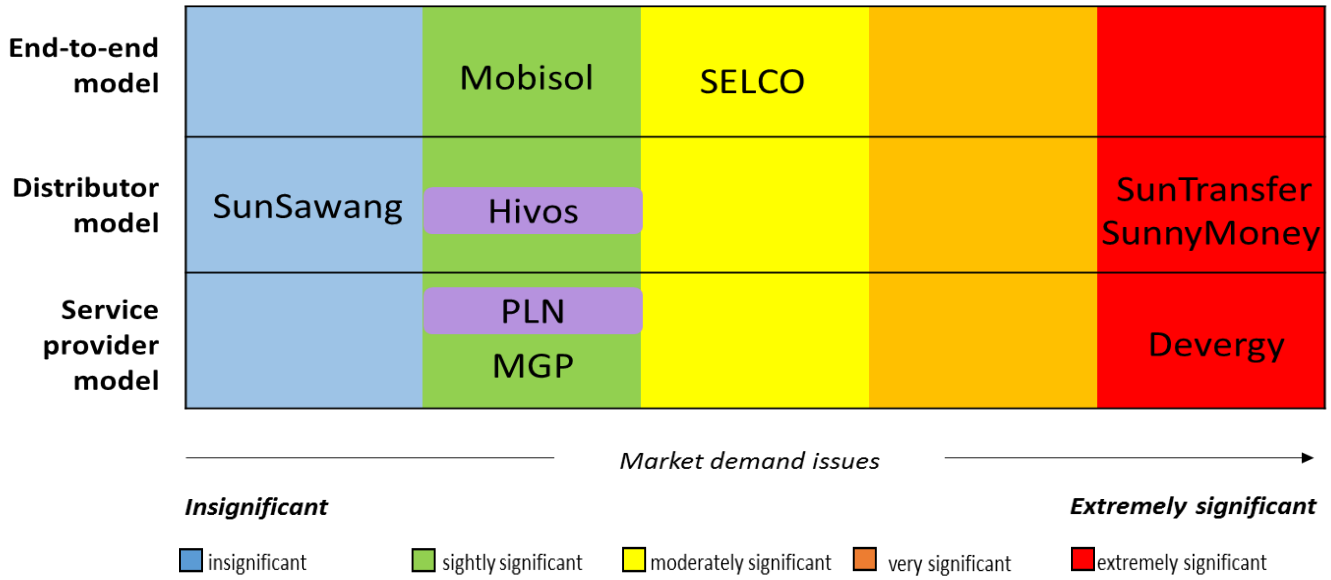

Figure 6.9. Market demand barriers faced by PVCs, PLN, and Hivos

6.1.3.7 Social, behavioral, cultural

PLN's business model works in between service and distributor model. While the company offers electricity service as its value proposition, dedicated SHSs are installed in each of the customers' house which leads to a misunderstanding of the ownership system. PLN describes this type of barriers as very significant towards its business, as shown in Figure 6.10.

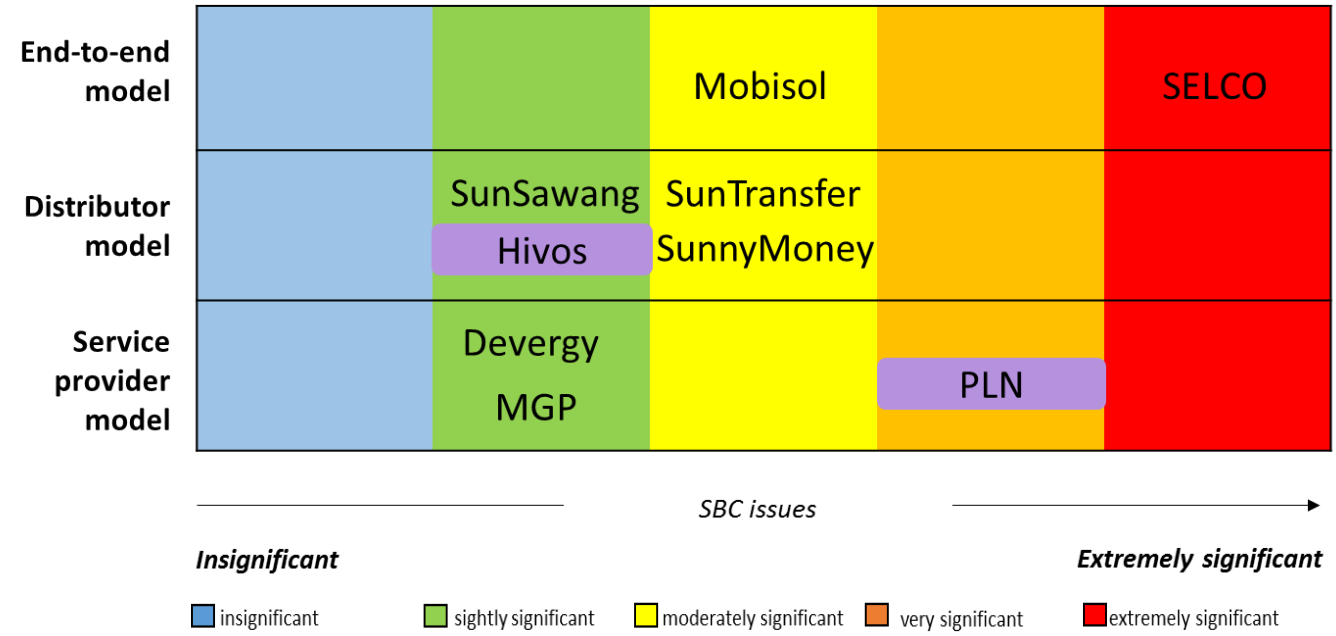

Figure 6.10. Social, behavioral, cultural barriers faced by PVCs, PLN, and Hivos

PLN explains that it is because people who live in the village do not get used to with banking systems. Although PLN claims that a proper education regarding the payment systems has been conducted, there are many villagers do not want to pay the subscription fee timely through the bank because of several reasons. Firstly, the location of the bank which is far away from the village. Secondly, the villagers still could enjoy the electricity service even though they do not pay for three consecutive months. It is because SEHEN systems are not equipped with a meter or control systems to shut the systems down when the customers fail to make the payment. Thirdly, PLN fails to provide proper after-sales services for the systems. When something happens to SEHEN systems, the customers need to call PLN customer service and bring the systems to the nearest PLN branch office if needed. There is no one from PLN who is in charge to check, maintain, and service the systems in the village. Thus, the barriers related to social, behavioral, and cultural aspects are not only caused by the behavior of the customers but also caused by unsuitable business models for its targeted market applied by PLN.

Hivos describes barriers related to social, behavioral, and cultural aspects as slightly significant towards its program. It is because Hivos, as an NGO, has done rigid surveys and proper customer engagement to determine its targetted village and schools for its program. Thus, for other technical and operational things, Hivos could rely on its partners, such as the local schools and RESCO, to earn trusts from the villagers and promote its products.

From PLN and Hivos cases, we could see that PLN relies on its own resources while Hivos relies on its partners to earn trust from the villagers and overcome other barriers related to social, behavioral, and cultural aspects. The failure of PLN's business model to overcome the barriers on social, behavioral and cultural aspects shows that the company could not rely only on its customers to make the payment without any control systems as well as to maintain the systems by themselves, especially, when the company offers services as its value proposition.

Based on our initial framework, elements of business models could be derived from the barriers' significances related to Social, behavioral, and cultural aspects faced by PV companies. For those PV companies who sell PV technologies as its value proposition, the more significant social, behavioral, and cultural issues, the more these PV companies tend to do all the operational activities by themselves. On the other hand, companies which offer services as its value proposition tend to handle at least the services and the maintenance by themselves since the ownership of the systems remains to the company for a lifetime. It confirms that PLN needs to involve more on the community engagement, the after sales services, and find a suitable payment scheme which enables more flexibility towards the customers as well as the company's resources. On the other hand, Hivos, which has lower remarks for the barriers on social, behavioral and cultural aspects could rely on its partners for operational things such as payment and services.

6.1.3.8 Governmental/institutional

Figure 6.11 shows the significances of governmental/institutional barriers faced by PLN and Hivos compared to other PVCs. Based on our interviews with the PVCs, the changes in regulations and policies on RETs, especially PV, play an important role in determining the success of PVCs' business. Since PLN is a state-owned utility company, most of the directions will come from the government. In the case of the implementation of SEHEN program, PLN gets full support from the local and national government. This is the main reason that PLN describes governmental issues as slightly significant. On the contrary, Hivos' program consists of several stakeholders, which include national and local governments, as well as private investors and donors. The changes in the regulations could affect the decision of private investors to put their money for RET in Sumba Island. Thus, just like other PVCs, we have interviewed, active lobbying activities, as well as good coordination and collaboration with all the key stakeholders, are important to sustain Hivos' program. In this case, the way of Hivos handles the barriers on the governmental/institutional are aligned with our initial framework shown in Figure 4.15.

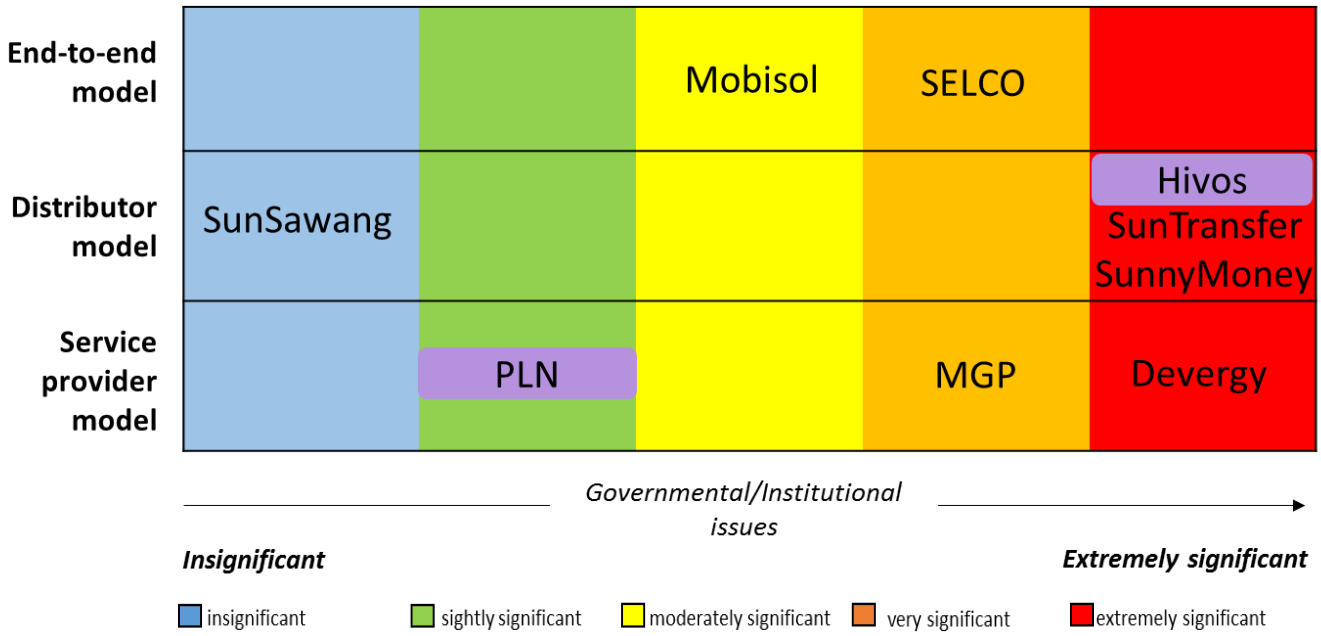

Figure 6.11. Governmental/institutional barriers faced by PVCs, PLN, and Hivos

6.1.3.9 Network/partnerships

Hivos and PLN describe that the barriers on having good networks or partnerships as insignificant and slightly significant towards their programs, as shown in Figure 6.12. Both of the institutions explain that all the key stakeholders needed to run the programs are very supportive. It is also influenced by choice of partnerships that Hivos and PLN made. All the technologies used in PLN need to pass the bidding process, so does the technology used by Hivos with the technical help from Winrock International. Through the bidding process, PLN and Hivos could make sure the quality of PV companies which are responsible for the programs, for instance, whether these companies are supportive towards Hivos or PLN programs.

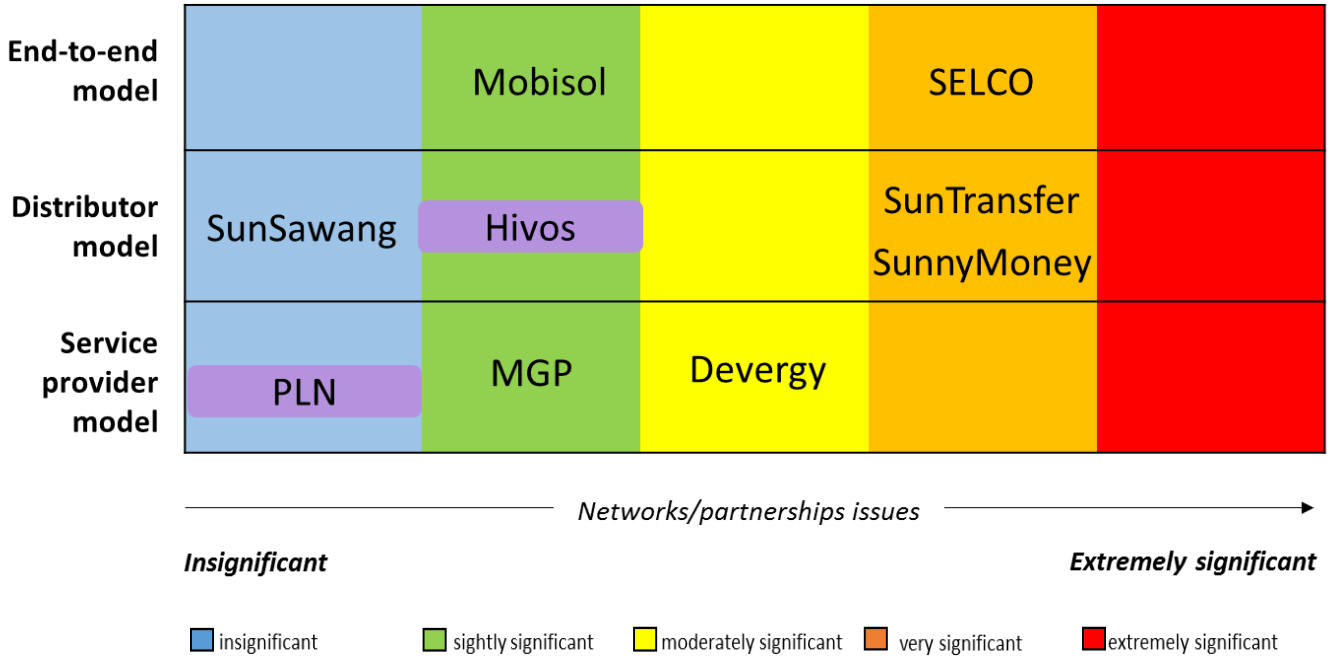

Figure 6.12. Networks/partnerships barriers faced by PVCs, PLN, and Hivos

Based on the initial framework shown in Figure 4.15, there are no specific elements of business models which could be derived from the barriers on the networking and partnerships aspects. All the PVCs we have interviewed explain that it is essential to have supportive partnerships with the key stakeholders in order to make sure the sustainability of the business. Nevertheless, PLN and Hivos add, *"Having supportive partners is*

good, yet it is even better if there are good coordination and collaboration between the company and the organization with all the key stakeholders involved in the projects." Thus, Hivos and PLN suggest that good coordination meetings with all the stakeholders involved in the projects are essential to make sure the sustainability of the programs or the business.

6.1.3.10 Environmental

Based on our initial framework constructed in Chapter 4, different elements of business model could be derived from the barriers faced by PVCs on the environmental aspects. Hivos and PLN describe that the barriers on environmental aspects as insignificant and moderately significant towards their programs, as shown in Figure 6.13. We conclude that the more significant the environmental issues faced by the company, the more responsible the company towards these issues. Just like Mobisol, SunSawang, Devergy, and MGP, Hivos sees the environmental issues as insignificant towards its program. Thus, Hivos transfers the risks on environmental issues to the manufacturers of the technologies to do the recycling process as well as to its partner, RESCO, to collect the waste of old and faulty products.

In the case of PLN where the environmental issues could be seen as slightly higher than Hivos, PLN is fully responsible for the waste collection as well as the recycling process. Nevertheless, PLN still does not have any recycling scheme. Thus, all the old and faulty SEHEN systems are stored safely in PLN warehouse.

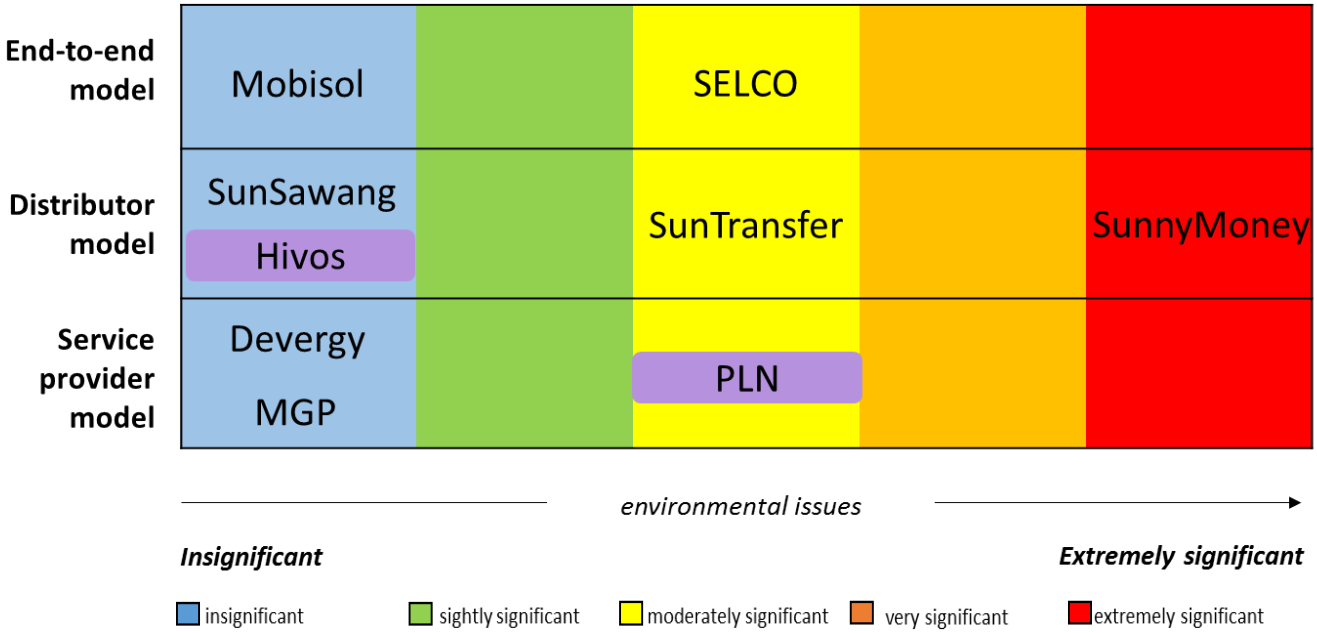

Figure 6.13. Environmental barriers faced by PVCs, PLN, and Hivos

6.2 Linkage between barriers to the adoption of PV electrification in the rural energy market and business model employed by the PVCs

In the previous section, we analyzed and compared our initial framework which was constructed in Chapter 4 with the case of PLN and Hivos' business model. From our analysis, we conclude that our initial framework could be used to develop a suitable business model in specific areas, for instance, Sumba Island, with minor additional remarks on the Networks or partnerships aspects. Finally, the updated framework which shows the linkage between barriers to the adoption of PV electrification in the rural energy market and business model employed by the PVCs is summarized in Figure 6.14.

6.3 Framework Validation: Expert interviews

Final validation for the framework is done through expert interviews. The interview was done in sixty minutes with Bahasa Indonesia and English as the main language. Firstly, the interview was conducted with

Mr. Hamzah, who is the Government Sales Manager from PT. Surya Utama Nuansa (PT. SUN). PT. SUN is an Indonesian company which focuses on providing renewable energy technologies for residential, industries, and governmental customers. The company's mission is to make renewable energy becomes accessible everywhere and to everyone which could lead to energy efficiency behavior and eventually reduce the production costs (SUN, 2017). One of its products is PV technologies for residential customers in rural areas. The second interview was conducted with Mr. Bart Fugers, who is the former CEO of RIWIK East Africa. RIWIK was a Dutch solar company which operated in East Africa market. In 2015, RIWIK was acquired by Greenlink Solar Africa, which is also a solar company which operates in Tanzania, Kenya, and The Gambia.

In general, Mr. Hamzah and Mr. Bart Fugers see the updated version of the framework which is shown in Figure 6.14 is too complicated for the readers. From the practitioners' point of view, this updated version of the framework could not be easily understood by the readers from the first look. Thus, it is suggested to make the framework in a simpler and more practical version, so that everybody could easily use the framework to develop suitable business models for PV companies which focus on the rural energy market. The practical version of the framework is shown in Figure 6.15.

From Figure 6.15, we could see that there are four steps to use the framework. Firstly, the customer's segmentation and the value proposition which the company wants to offer to the customers need to be determined. Secondly, one should define the levels of barriers indicated by the numbers and colors. Red means that a certain barrier is extremely significant towards the company business. Orange explains that the barriers are very significant towards the company's business. Yellow and Green represent barriers that are moderately and slightly significant towards the company's business. Lastly, Blue represents that the barriers are insignificant towards the company's business. After defining the levels of barriers, one could start determining the elements of business model needed for its business. Figure 6.15 shows each element of business models, indicated with remarks (V), plays an important role in overcoming the barriers faced by PVCs. One could define its elements of business models based on the guidelines and influencing factors shown in an updated version of the framework in Figure 6.14. Finally, the cost structure could be determined in the final step.

Despite the complexity of the framework, Mr. Hamzah and Mr. Bart Fugers confirm that the linkage between the level of barriers faced by PV companies and the elements of business model in the framework shown in Figure 6.14 is very well-connected. The details of expert interviews are shown in the Appendices.

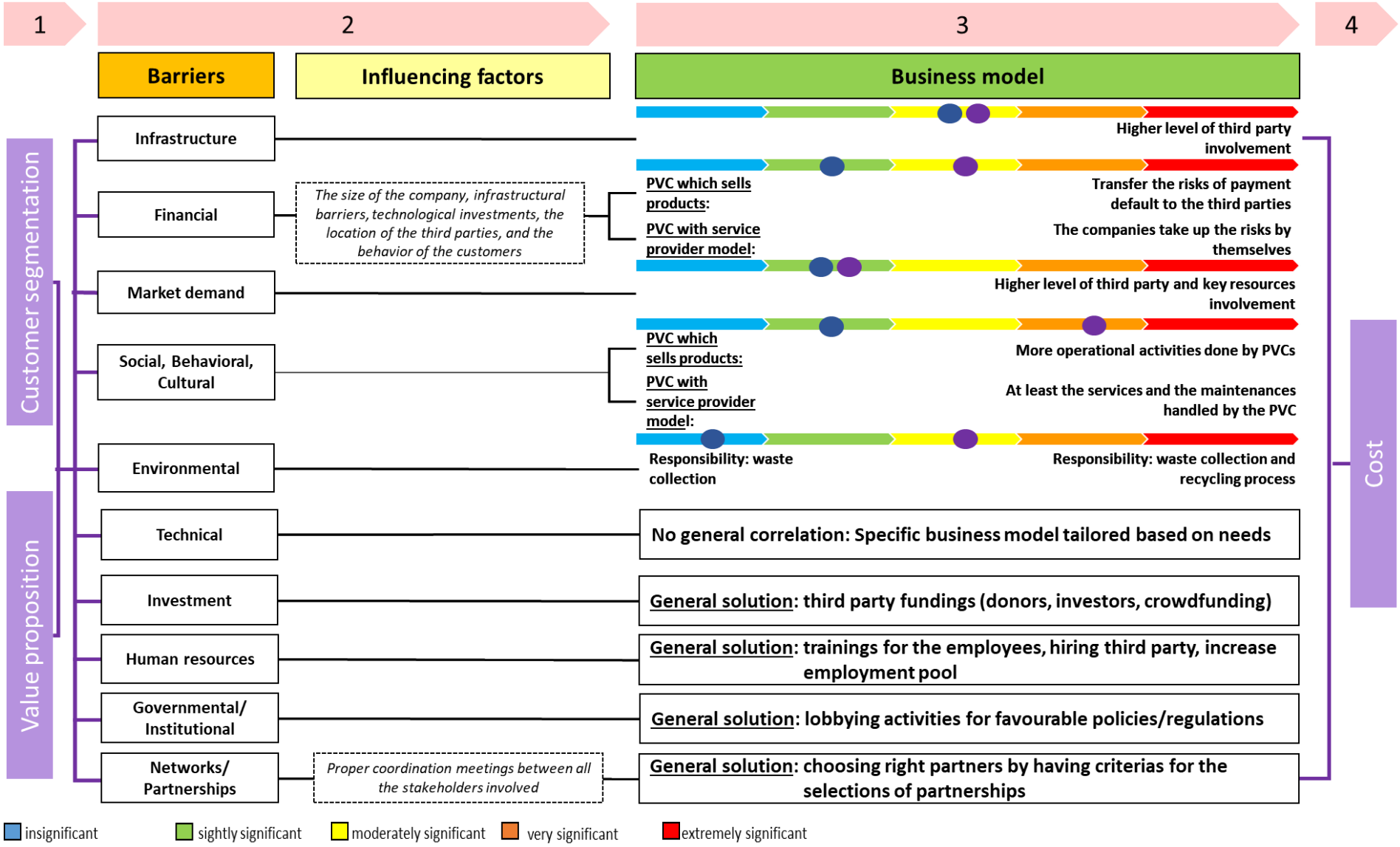

***Figure 6.14. Updated framework**: The linkage between the level barriers to the adoption of PV electrification in the rural energy market and characteristics of business model employed by PVCs derived from the barriers faced by PVCs which focus on the BoP and rural energy market*

Customer segmentation	Barriers	Level of barriers					Elements of business model						Cost structure
		1	2	3	4	5	Key partnerships	Key activities	Key resources	Channels	Customer relationships	Revenue	
	Infrastructure						V		V	V			
	Financial						V	V	V			V	
	Market demand						V		V	V			
	Social, Behavioral, Cultural						V	V	V		V		
Value proposition	Environmental						V	V	V				
	Technical						V	V	V				
	Investment						V	V	V				
	Human resources						V	V					
	Governmental/ Institutional						V	V	V				
	Networks/ Partnerships							V	V				

insignificant sightly significant moderately significant very significant extremely significant

Figure 6.15. Practical version of the framework: *The linkage between the level barriers to the adoption of PV electrification in the rural energy market and characteristics of business model employed by PVCs derived from the barriers faced by PVCs which focus on the BoP and rural energy market*

6.4 Recommended business model for PV adoption in Sumba Island

In this section, we would try to develop business models which are based on Sumba's conditions by using our findings on the linkage between barriers to the adoption of PV electrification in the rural energy market and business model employed by the PVCs. Before we determine specific elements for recommended business models for Sumba Island, it is important to define the company's value proposition as well as its customer segments since these two elements will also determine other elements of business models.

6.4.1 Business model elements: the choice of value proposition and customer segmentation

Different types of business model employed by PVCs interviewed in this research have been discussed in Chapter 4. Based on the current conditions and the availability of resources in Indonesia and Sumba Island, the most suitable model which can be employed for PVCs, which want to operate its business in Sumba Island, is distributor model. Moreover, to reduce any technical barriers, it is important to use local PV manufacturers or local suppliers. In this way, any importation issues which was experienced by Hivos, as explained in the Appendices, could be eliminated. Thus, the PVCs which operate in Sumba Island could focus on other operational aspects.

Regarding the value proposition, both products and services could be sold in Sumba Island depending on the PVC's targeted customers, the price of the technologies or the services as well as its flexibility of its payment. The lower segment of PVC's targeted customers the more the PVCs need to be able to offer simple and cheap payment. The only thing that the PVCs could be done to serve the lower bottom of BoP is to have a service provider model with a fixed fee to reduce investment in technology as well as operational costs, such as MGP. However, in order to serve a wider segment of customers, the PVCs could also invest on PAYG and smart meter technology, just like Devergy. Recommended business model for PVCs which operate in the rural energy market in Sumba Island could be seen in Figure 6.16.

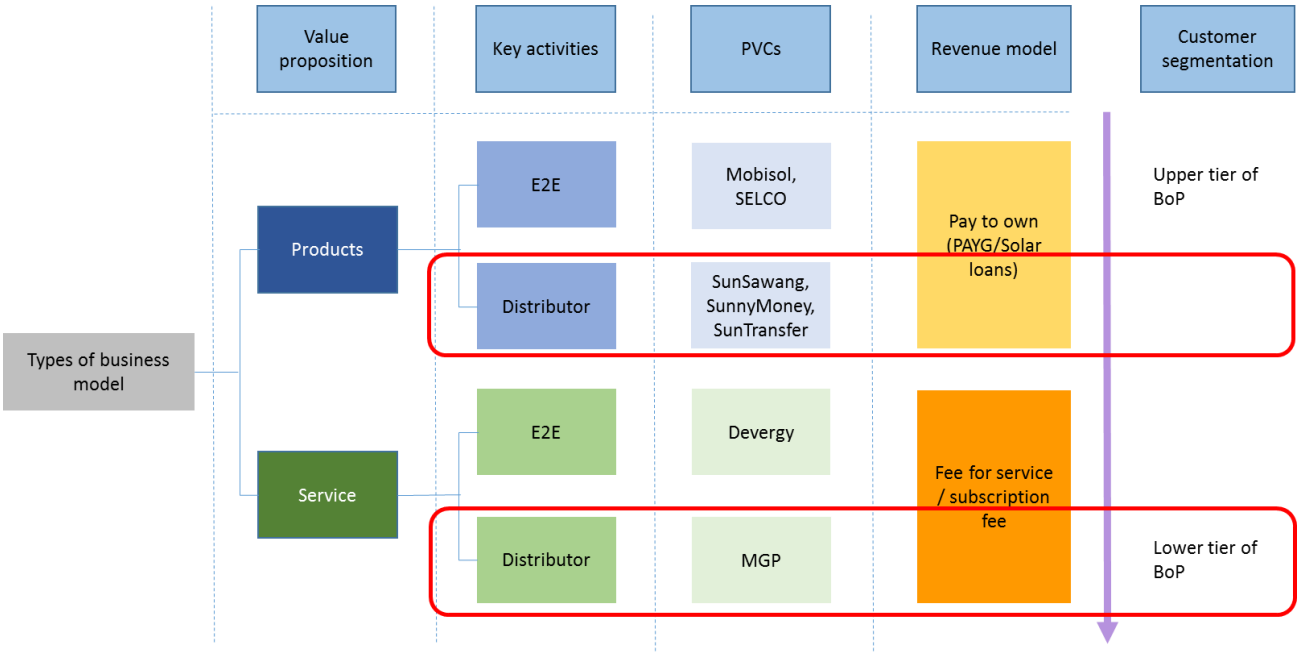

Figure 6.16. Recommended business models for PVCs which operate in Sumba's rural energy market indicated in red square

A business model like Hivos could also work on the lower segment of BoP as long as the PVCs could find the right partner to install a complete SHS to enable the charging station for the villagers. In the case of Hivos, the corresponding partner is the local school. Furthermore, affordable solar lanterns could also be offered to the lower segment of BoP, just like SunnyMoney and SunTransfer. An SHS could be offered to the

higher segment of BoP customers when it is equipped with a flexible and affordable payment scheme, just like SunnyMoney, SunTransfer, SunSawang, SELCO, and Mobisol.

In the next section, elements of business models which are suitable for Sumba Island will be developed based on the updated and practical version of the framework shown Figure 6.14 and Figure 6.15. Figure 6.14 will be used as a guideline to develop elements of business model for PVC which operate in Sumba Island which will be explained in the next section.

6.4.2 Sumba's business model 1: Distributor and products-focused model

In this section, the first recommended business model for PVC in Sumba Island is developed. The first business model aims to serve the middle and upper segment of BOP as the targeted customer by offering good SHSs followed by proper after sales services and flexible payment scheme.

Value proposition

The first recommended business model for PVC in Sumba Island be to offer good quality PV products, which could be SHSs, a solar lantern with its mini solar panel, or rechargeable PV lamps, followed by reliable after sales service at an affordable price by offering flexible payment scheme.

Customer interface

- ***Customer segments:***

  Based on our analysis, one of suitable customer's segments for PVCs which operate in Sumba Island with a distributor model is a middle up to the upper tier of BoP as shown in Figure 6.17. Moreover, based on the consideration of financial aspects of the end-users, as well as infrastructural barriers in Sumba Island, the most suitable customer target, is a cooperative unit or local sales agents. This cooperative unit could be school cooperative unit/Koperasi Unit Sekolah (KUS) or village cooperative unit/Koperasi Unit Desa (KUD). A cooperative unit is a unit established, organized and created by and for the members themselves. A school cooperation unit consists of all the school members and self-managed by appointed school committees. A village cooperation consists of the villagers who live together in rural areas, and it is also self-managed by appointed committees. These cooperative units support any trading activities such as craft production, agricultural products, fisheries, and other products depending on the villagers or its members' needs. These cooperatives also enable other economic activities such loans and marketing activities. In this way, these cooperatives also could be seen as local MFIs. In Hivos's case, it is important to work together with school cooperative units. It is because the national schools are not allowed to operate any businesses based on Indonesian's policy. Thus, the sales of Hivos PV lamps as well as its charging revenue should be managed under school cooperative unit. This model has been successfully employed by SunTransfer which has local MFIs as its first layer targeted customers.

  Another choice of the customer segments is local sales agents. These local sales agents could be the local entrepreneurs who already own its own shops and do economic activities in the villages. There are also some entrepreneurs who have their own shops in the town, but they come to sell their products in the village during the market day which happen once or twice a week. This model has been successfully employed by SunnyMoney.

  In order to reach the end-users of the technologies, the PVC's targeted customers, the KUD, KUS or the local sales agents should be able to have enough stocks of PV products. Thus, PVC needs to enable its partner easily stock up the technologies. Based on SunnyMoney and SunTransfer's business model, there are two ways which could be done in order to serve the first layer of customers properly. Firstly, partnerships with financial institutions need to be established to enable small loans for the local entrepreneurs or local sales agents to stock up the products. Secondly, the PVC could enable the KUD/KUS/local sales agents to pay back the systems based on its real sales. In this way, KUD/KUS do not have to pay for the technologies up front.

- ***Customer relationship:***

  From our observation on existing PVCs, good customer relationships could be the key for having low barriers on market demand and social, behavioral, and cultural aspects. Thus, it is important for the PVC which operate in Sumba Island to provide a dedicated customer service or customer care who is responsible for answering all the problems and doubts from both the end-users as well as the first layer of company's targeted customers.

  It is also important to educate the KUD, KUS, and its local entrepreneurs as the company's representatives. It is because the first layer of PVC's customer segment is the focal point of the PVC's end-users. Furthermore, the company should train KUD, KUS, and local entrepreneurs to do small repairs based on the company's guideline. Thus, the small repair could be done locally by people from KUD/KUS or the local entrepreneurs themselves based on the guidelines from the company's customer services. In this way, it will benefit the company in the operational cost point of view since not all cases need company's technicians to come to the villages and fix the systems.

- ***Channels:***

  The company could sell the products directly to KUS, KUD, and local entrepreneurs. By having marketing activities and strong community engagement, the PVC could stimulate market demand in the villages and promote its products to the villagers. At the same time, the company could establish partnerships with KUD, KUS, and local entrepreneurs to do the same based on commissions. In this way, the company could sell the products directly to its partners and reach the end-users through its' partners' networks to the rural customers.

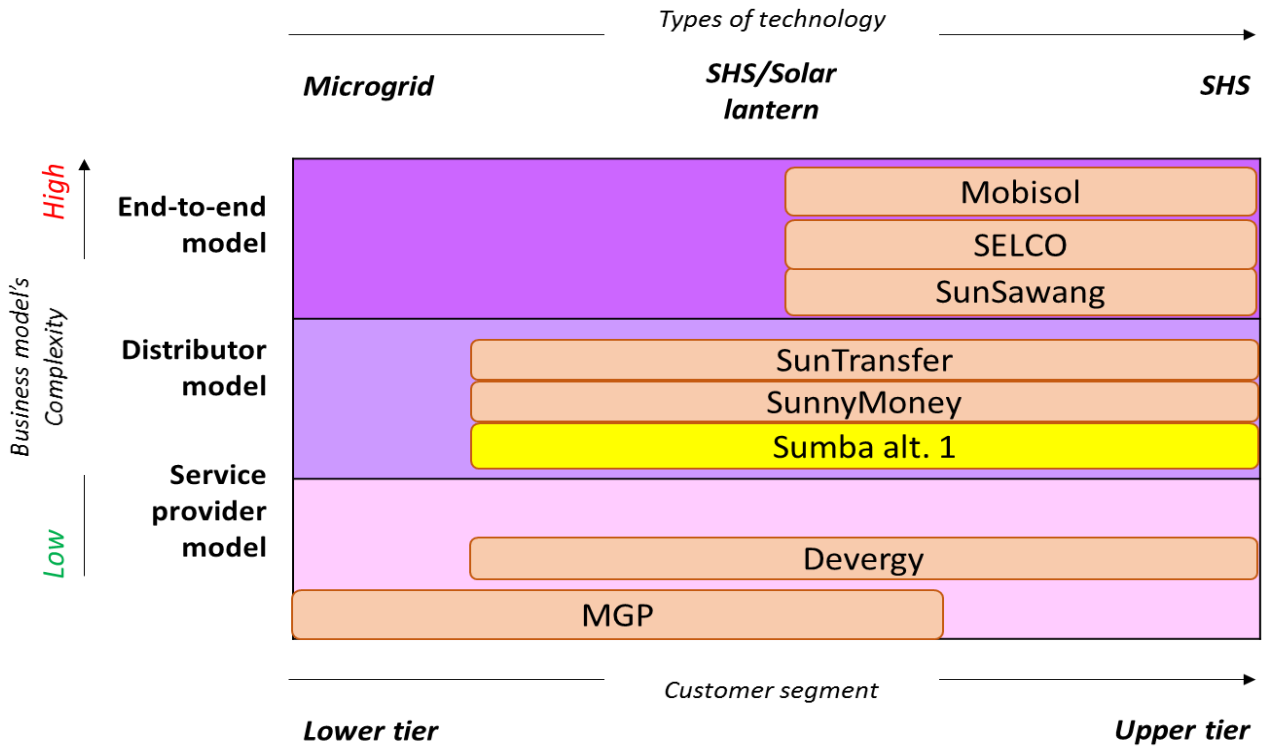

Figure 6.17. Customer segment of the first recommended Sumba's business model.

Infrastructure management

- ***Key partners:***

  One of the important elements in PVC's business model is having strategic partners. In order to enable to run the business with recommended value proposition and customer interface described above, the PVC should establish partnerships with cooperative units exist in the village as well as local entrepreneurs in order to reach its end-users. Moreover, to enable this first layer of targeted customers to sell the products

to the end users, PVC needs to have a partnership with financial institutions to enable small loans to local entrepreneurs to stock up the products.

As a company which employed distributor model, the PVC also need to establish partnerships with national PV suppliers. It is recommended to avoid the importation process because it will raise technical barriers if the company does not have any experience in importation procedures. It is better to have the PV suppliers who have all the technologies ready inside Indonesia and could be sent directly to Sumba Island.

A partnership with the local and national government also needs to be made to enable any lobbying activities on supportive RET regulations. Also, the company needs to establish partnerships with investors or donors in order to secure the investment, particularly in the beginning of the company's operations.

- ***Key activities:***

Based on the proposed value proposition described above the key activities which need to be done by the company in order to operate its business are distribution, sales, installation, services. Furthermore, based on our observation in Sumba Island, a community engagement play an important role in defining the success of business model.

Also, in order to manage the waste of the faulty and old products, the company needs to have waste collection procedure. If the company could make sure that there are no harmful materials in the products which are sold in the market, the PVC could rely on its partners such as KUD, KUS, or local entrepreneurs to collect the old or faulty products from the end-users. Then, the company could collect it from these KUS, KUD, and local entrepreneurs. The recycling process could be made through an agreement with the PV suppliers in the first place. Thus, the responsibility of recycling process is transferred to the third parties. Furthermore, a direct payment collection still needs to be made from KUD, KUS, or local entrepreneurs if there is no present of financial institutions at the first place.

- ***Key resources:***

Based on the PVC's recommended main activities, the key resources needed to operate the business in Sumba Island could be distinguished from human, technology, and assets. On human resources, the main team needed for the business are sales, logistics, and service team. In order to enable flexible payment scheme, a control system or a smart meter need to be installed in the SHS. In this way, the customers could pay flexible installments to KUD, KUS, or local entrepreneurs based on their needs until they pay for the whole systems for a certain period of time. A rechargeable technology, for instance, Hivos PV lamp could also be used to enable small charging fees.

To ensure that the company has good access to the national government, investors, strategic partners, good human resources as well as networks, the company needs to establish its head office in Jakarta, the capital city of Indonesia. Nevertheless, since the main operation will be in Sumba Island, it is important to have its own office and warehouse on Sumba Island.

Financial aspects

- ***Revenue streams:***

The source of the revenue of PVC will come from the sales of the products to KUD, KUS, or local entrepreneurs. For a big system such as SHS, if there is an existance of financial institutions, the local entrepreneurs could take a small loan to pay for the systems while the PVC will get the revenue in cash. Small installments will be made by the end-user to the local entrepreneurs, KUD, or KUS in exchange for the use of SHS. In this way, the company enables PAYG scheme for the end users controlled by a smart meter.

If there are no financial institutions involved, the PVC could collect parts of the installments made by the end users from KUD, KUS or local entrepreneurs as the payment of the systems. For small systems such as PV lantern or PV lamp, the payment should be made in cash.

- ***Cost structures:***

  Based on all the recommended key activities above, the most important costs incurred while operating PVC's business model are the costs of the products, operations, and distribution costs.

Finally, the elements of business model for the first recommended business model for PVC which operate its business in Sumba Island could be seen in Figure 6.18. Furthermore, the comparison of Sumba's first recommended business model with other existing PVC's business model could be seen in Figure 6.19.

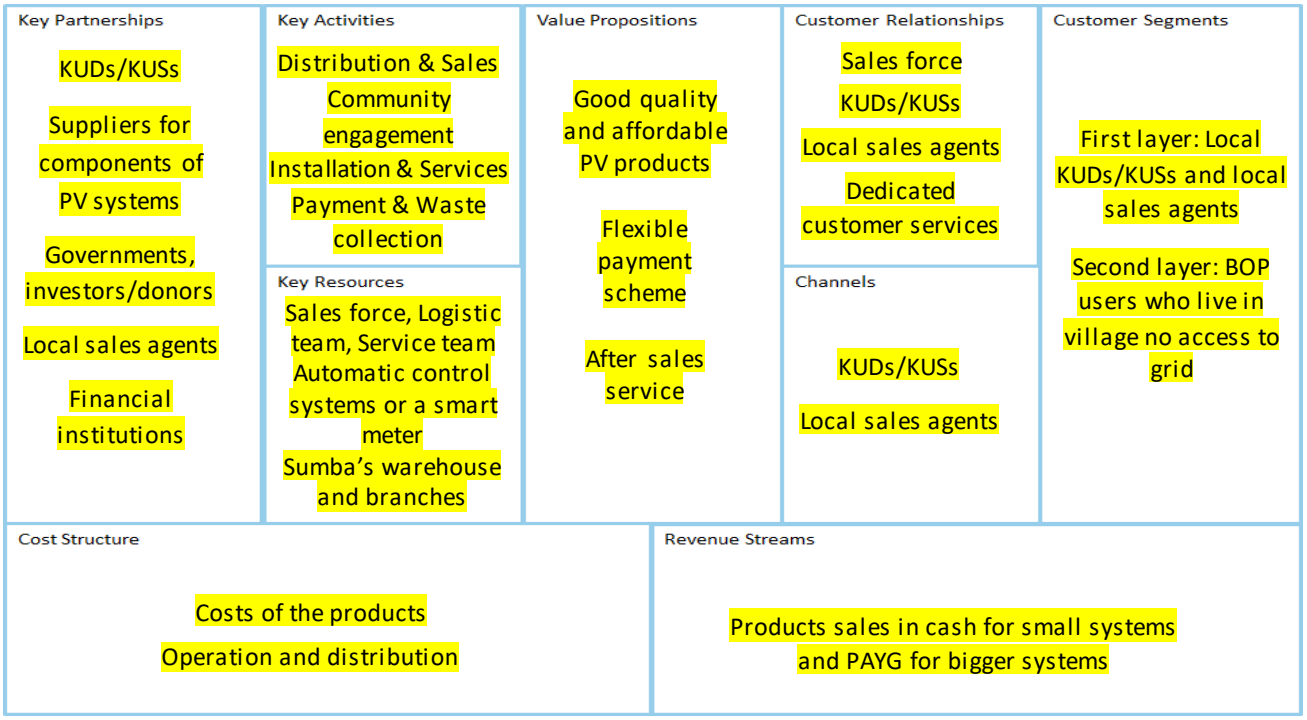

Figure 6.18. Sumba Business model 1

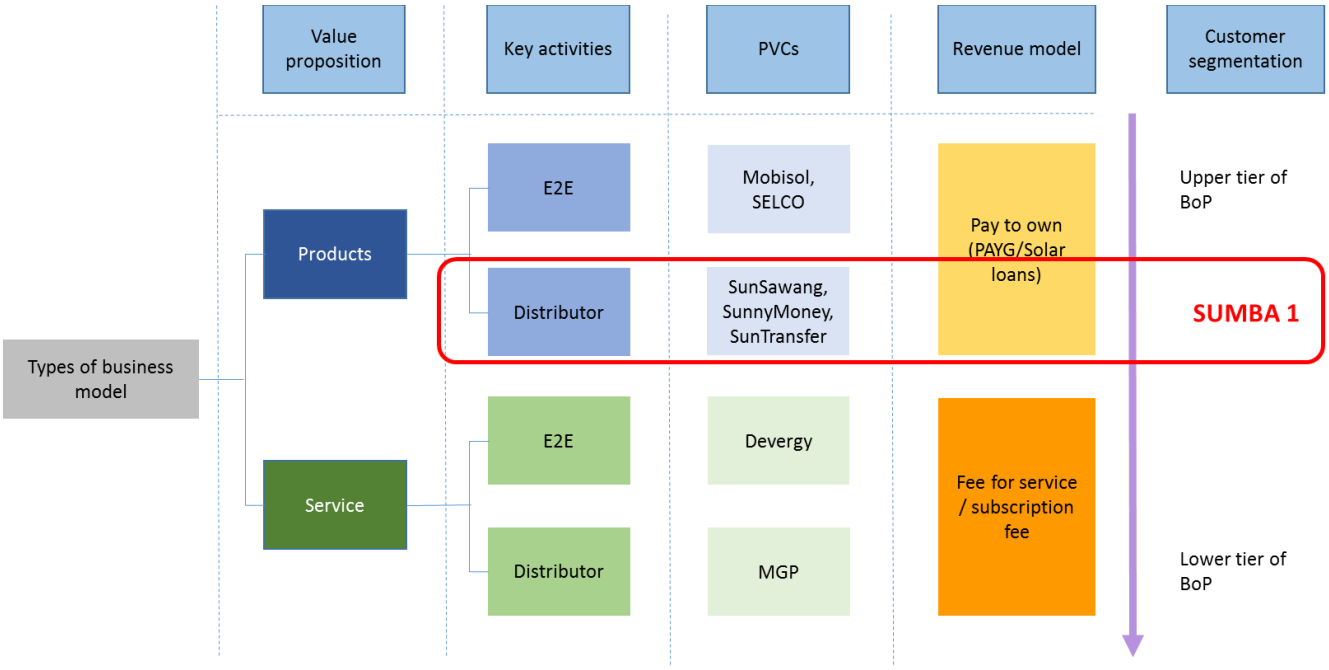

Figure 6.19 Sumba business model 1 vs. existing PVCs' business models

6.4.3 Sumba's business model 2: Distributor and service provider model

In this section, the second recommended business model for PVC in Sumba Island be developed. The second business model aims to serve a wider segment of BOP as the targeted customer by offering electricity services at affordable price. The business model which is focused on delivering reliable electricity services has been successfully applied by Devergy as an E2E model and MGP as a distributor model. For the second Sumba's business model, the distributor model combined with service provider model could work. Furthermore, both revenue models employed by Devergy and MGP could also work in Sumba Island depending on the technology used by the company which will influence the price of the services and leads to different customer segmentation.

Value proposition

The second recommended business model for PVC in Sumba Island be to provide reliable electricity services at affordable price. This can be done in two different ways. Firstly, the PVC could provide an electricity service with no upfront costs and no maintenance costs. The service comes with basic equipment needed for the villagers such as LED light bulbs and a mobile phone charger. The customers pay a fixed service fee, which is collected weekly, for a pre-set time of services, for instance, electricity service from 5 pm to 5 am or using a limited electricity quota which is renewed every day. In this way, the company only needs simple microgrid systems which could be set to serve the customers at a predetermined time. This model has been successfully applied by MGP.

Secondly, the PVC could invest in more advanced systems by using a smart meter which is installed in each of the customers' house. The electricity services could be bought based on the customers' needs through electricity credits using PAYG scheme. In this way, the company provides more flexibility in its electricity usage. Nevertheless, the investment on the smart meter could be a trade-off with the fees that the customers need to pay. Thus, it is most likely that the PVC which uses this model could not serve the lower segment of BoP market due to the higher price on the subscription fee compared to the fixed-fee scheme. This model has been successfully applied by Devergy.

Customer interface

- ***Customer segments:***

  As explained in above, the customer segments of the second alternative of Sumba's business model is influenced by the use technologies to deliver the electricity services to its customers or the value proposition offered to the customers. The use of simple technology will enable a low subscription fee in an exchange of limited or pre-set time of electricity services. This model will only work on the lower and middle segments of BoP since the higher income of the villagers, the more they want to use electrical equipment such as TV and radios.

  On the other hand, the use of smart meter will increase the flexibility of electricity usage as well as the flexibility of the payment systems. However, the use of a smart meter could also increase the cost of electricity services which need to be paid by the customers. Thus, this model will only work from the middle up to the upper tier of BoP since the subscription fee could be too high for the lower tier of BoP customers.

  In short, the customer segments could also be influenced by the company's choice of the technology used in order to deliver reliable and affordable electricity services to its customers. The customer segments of the second alternative of Sumba's business model is summarized in Figure 6.20.

- ***Customer relationship:***

  As the company sells a service as its value proposition, the company should be able to provide good customer services, or customers support in order to have good relationships with its customers. For instance, both MGP and Devergy enable 24/7 customer's support and control systems to ensure that the customers will get the adequate supports whenever there are technical problems related to the systems or the micro-grid.

The company also could employ local sales agents which also trained as technicians who could do small maintenance and services on the systems. Another way is to have partnerships with KUDs, KUSs and train people from KUD, KUS to be local technicians or agents. These agents operate based on commissions and operate under the company's sales force's supervision. If anything happens to the micro-grid systems, the customers could directly call the customer services or contact the local agents. Then, the local agents could see and do the small repair with the assistance from company's customer services. In this way, the company enables local presence at the villages as well as enable to do the services and maintenance locally from the villages, which lead to cost savings on operational aspects.

- ***Channels:***

  The company could rely on the company's sales and marketing team to do the survey as well as to promote and sell its services. Moreover, the sales and marketing team could also establish partnerships with KUD/KUS or local agents to promote its services to the villagers. The KUD/KUS or the local agents could receive small commissions in exchange of numbers of houses connected with the company's micro-grid systems.

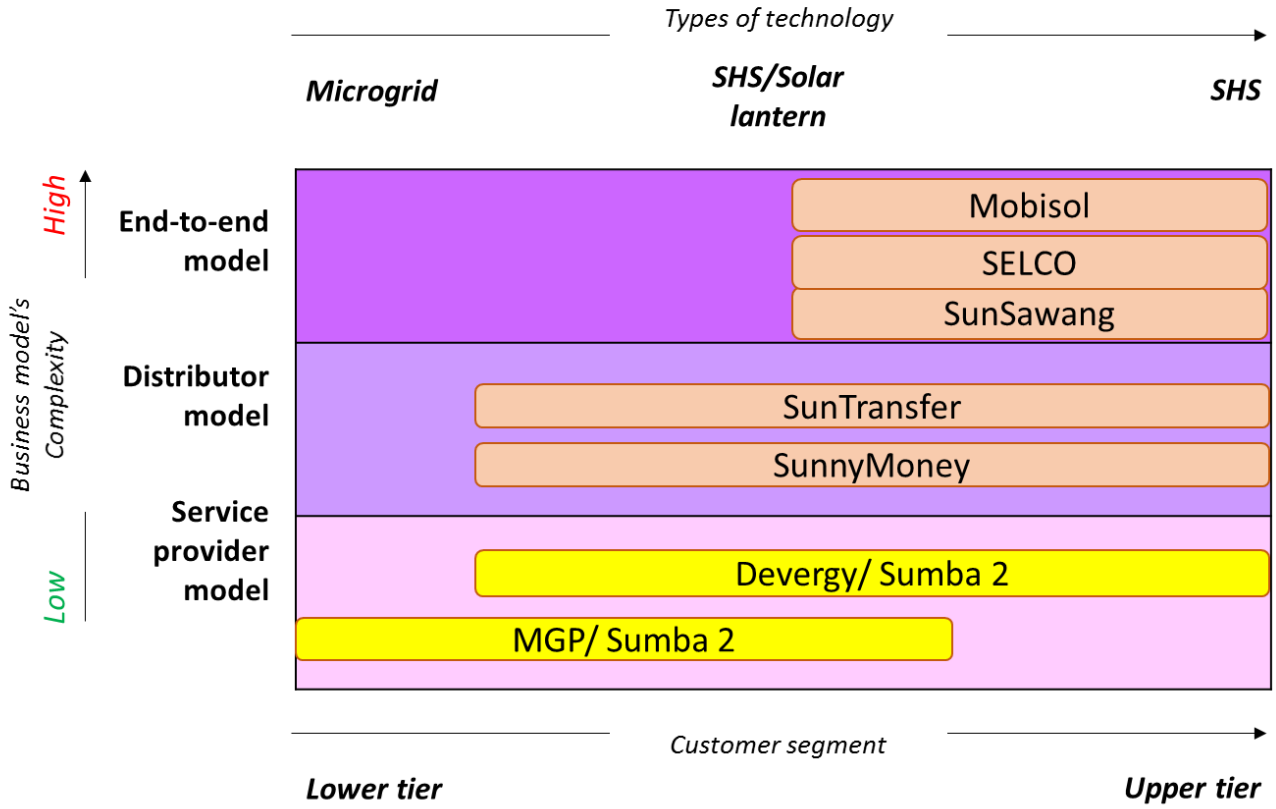

Figure 6.20. Customer segments of Sumba's business model 2 distinguished by the use of different technologies

Infrastructure management

- ***Key partners:***

  In order to be able to operate the business, the PVC needs to develop partnerships with national PV suppliers. It is better to rely on the PV suppliers which has the components inside the country, so the company does not have to worry about the importation procedures. Moreover, it is better to have all the components ready in Sumba Island. Thus, the PVC could avoid the shipping process from Jakarta to Sumba Island and could focus on the operational aspects in Sumba Island.

  The company also needs to establish partnerships with different investors, donors, financial institutions in order to secure investments for its business. The company also needs to develop

partnerships with the government to enable the company does any lobbying activities related to RET regulation, especially the regulation related to electricity tariffs, kerosene subsidy, and benefits for RET companies.

The company also should develop partnerships with KUDs/KUSs and local sales agents to help the company with the operational and technical aspects locally in the village.

- ***Key activities:***

  Based on the proposed value proposition described above the key activities which need to be done by the company in order to operate its business are sales and marketing, installation, quality control, maintenances, and services. From MGP and Devergy experiences, since the company sells electricity services, it is not that hard to promote its services, especially when the price they need to pay for the electricity services is the same as the price they need to pay for kerosene for each month.

  Furthermore, in order to manage the waste of the faulty and old products, the company needs to have waste collection procedure. The PVC should be able to collect the waste and faulty products itself since the company is the one who installs the systems. Thus, it is the company's responsibility to take down any fault systems and change them with new ones in order to deliver reliable electricity services to its customers. Nevertheless, the recycling process could be made through an agreement with the PV suppliers in the first place. Thus, the responsibility of recycling process is transferred to the third parties.

  Payment collection from the end users could be made weekly and collected through KUD, KUS or the local sales agents. The company's collection team could come once a month to collect the money from the company's representatives in the village. Nevertheless, if the company chooses to have a PAYG and meter systems installed in the customers' house, the payment will be made directly to the company through mobile money or credits which can be bought in any KUD, KUS, or the local sales agents. IN this way, there is no direct payment collection made by the company's staffs.

- ***Key resources:***

  In order to be able to operate its business, the PVC should provide supporting key resources such as sales and marketing team, the installation and service technicians, quality control engineer, as well as collection team. The company also needs physical resources such as branch office and warehouse in Sumba Island to support its operations on the island. If the company decides to use a meter in the systems, the company needs to have smart control systems and PAYG devices as their additional resources in order to enable flexible PAYG payment scheme.

Financial aspects

- ***Revenue streams:***

  The company's revenue comes solely from the service fee. As explain above, there are two ways to collect the service fee from the customer depending on the technology used by the PVC. The company could choose to have simple technology which enables to deliver electricity services at a pre-set time in exchange for a fixed fee which will be collected weekly by its partners, such as KUD, KUS, and local sales agents. Then, the company's collection team will collect this fee every month. In this way, the company could save up its operational cost. With this revenue model, based on MGP's experience, the payback period is from 2.5 up to 3.5 years per installation.

  Another way to collect the revenue is to have a meter installed in each of the customers' house, and develop smart control systems which could control and see the use of electricity as well as the works of the company's micro-grid remotely from the office. The company could invest in a PAYG system which enables the customers to buy electricity credits just like mobile phone credits. The credit could be bought directly through the company's partner such as KUD, KUS, and local sales agents or directly through their mobile phone. In this way, the company does not have to go directly to the village to collect its own revenue.

- ***Cost structures:***

  Based on all the recommended key activities above, the most important costs incurred while operating PVC's business model are the costs of the systems components, operations, services and maintenance costs.

Finally, all the elements of business model for the second recommended business model for PVC which operates its business in Sumba Island could be seen in Figure 6.21. Furthermore, the comparison of the second alternative of Sumba's business model with other existing PVC's business model could be seen in Figure 6.22.

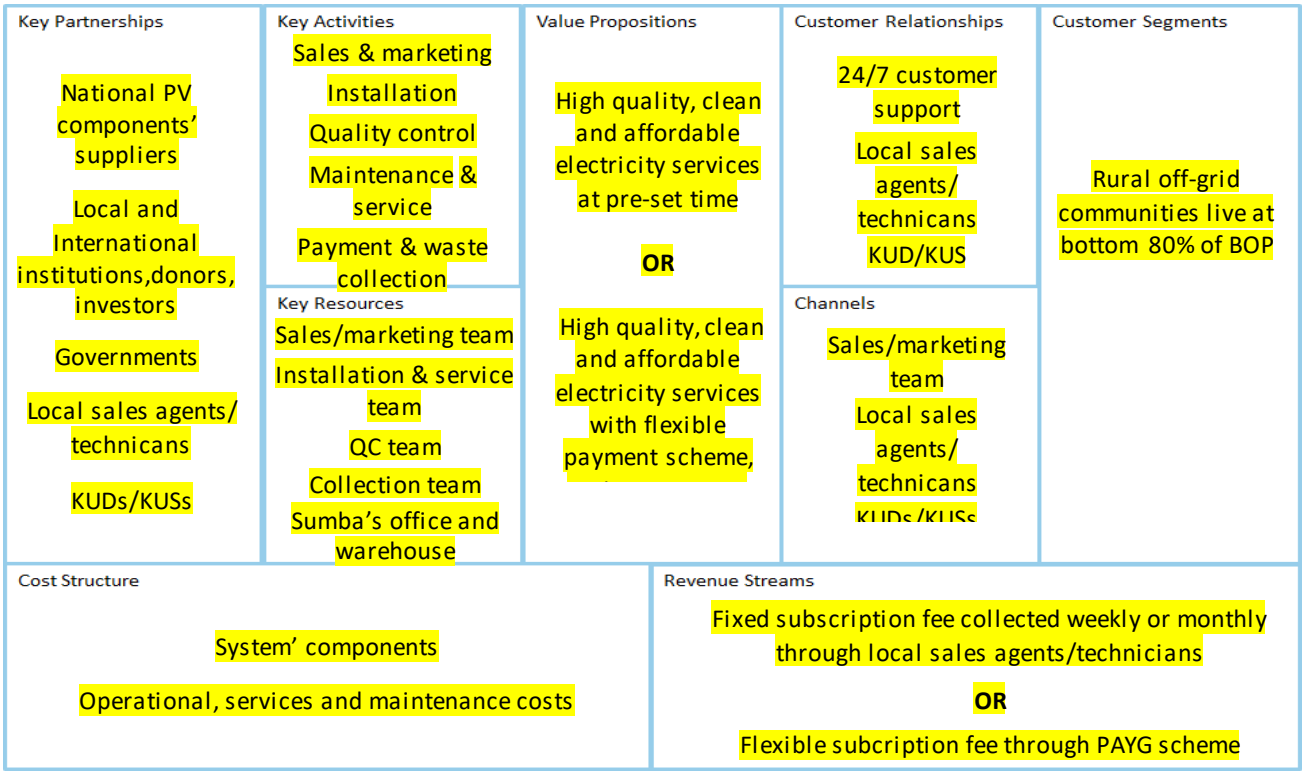

Figure 6.21. Sumba Business model 2

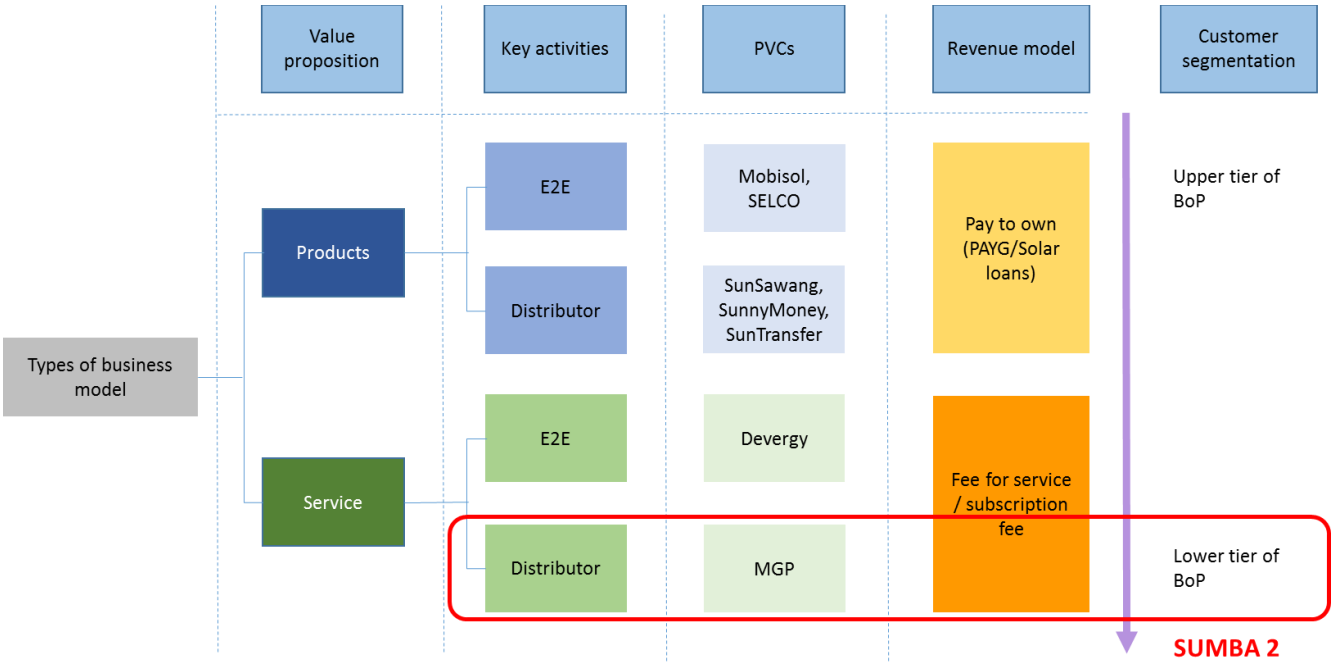

Figure 6.22. Sumba 2 business model 2 vs. existing PVCs' business models

7 CHAPTER 7: Conclusion, Discussion, Implication, and Recommendation

7.1 Preface

This research aims to develop the most suitable business model for off-grid PV electrification in Sumba Island, Indonesia. The aim of this research was accomplished by defining one research objective which is to understand how PV companies choose types of business models to address the challenges in the rural energy market. This research is divided into a four-phase study to accomplish the research objective. The previous chapters presented all the details of the four phases. The first chapter dealt with the background of the study, the identification of the knowledge gaps from the literature, as well as the problem statement which is the missing link on how a business model for off-grid PV electrification is designed to address barriers in the rural energy market in developing countries. Moreover, the research approach was explained in the first chapter. The second chapter was dealt with the theories in more details. A literature review was performed to get in-depth understanding on the barriers which influence the adoption of PV technologies in the rural energy market as well as the concept of business models and its usage to support PV electrification business in developing countries. In the same chapter, a set of barriers which influence the adoption rate of PV technologies was defined and used to develop interview questions on the case study which was performed in Chapter 3. The third and fourth chapter dealt with building an initial framework which explains the linkage between the barriers faced by PVCs in the rural energy market and the business model employed to overcome those barriers. Seven cases were chosen carefully to represent the domain of this thesis. The initial framework was developed through a cross cases analysis in Chapter 4. The fifth and sixth chapter dealt with the framework validation and business model construction for a specific condition in Sumba Island, Indonesia.

This chapter starts with the conclusion of this research where all the sub-research questions and the main research question will be answered. A discussion section will follow to discuss several interesting facts that are not linked to the research questions. Next, research limitation, as well as practical and academic recommendation, will be explained in detail. Finally, some of the reflections and insights from a personal level while conducting the research will be presented.

7.2 Conclusion

The objective of this research is to understand how PV enterprises choose types of business models to address the challenges in the rural energy market. Furthermore, the aim of this research is also to develop a suitable business model for off-grid PV electrification in Sumba Island, Indonesia. In order to meet the research objective, one main research question was formulated. To get the main research question answered, several sub-research questions were also developed. The answers of the sub-research questions were answered through literature, case study, field study and interviews, as well as cross cases analysis.

7.2.1 Sub-questions

1. **What are the different types of business models which implemented by the PV companies (PVCs) specialized in rural energy market?**

Incumbent literature: Different types of business model employed by PV companies in developing countries were presented in the literature. However, there is a lack of literature which explains specific business models and its elements employed by PV companies specialized in the rural energy market. Thus, we looked at the business models employed by PV companies in the developing countries and its descriptions in more detail to understand the types and elements of business model employed by PVCs in the rural energy market. Singh (2016) classified typology of business models for off-grid PV electrification in India into eleven different models, which are formal, informal, retail, direct marketing, sell-only, sell and service, full payment, rental, pay-as-you-go, community-managed, and entrepreneur-based. Tongsopit et al. (2016) described four

different business models for PV in Thailand which are roof rental, solar-shared saving, solar leasing, and community solar. Based on the description of the business model given by the authors, these business models could be classified based on its market, channels, value proposition, revenue model, and the ownership of the systems. Also, based on the description of the business models, the types of business models which implemented by the PV companies specialized in rural energy market could be determined.

There are eleven of those business models which are suitable for the rural energy market. Based on the market which the PVCs operate, both informal, and formal could be a suitable market for the PVCs. Also, there are two ways which PVCs could sell the products or services which are through retail and direct marketing. In terms of value proposition, the most suitable business model rural energy market is sell & service model. It is also supported by existing literature such as Karakaya & Sriwannawit (2015) and Palit (2013) who explain that after-sales service is a critical element in the diffusion process of PV technology in rural areas since it is a key to gain trust from the villagers, especially those who have had experiences with bad-quality PV products. In terms of revenue model, a monthly installment in the form of fee-for-service, solar loans, and solar rental could be the best model for the rural customers, which is also supported by the existing literature, such as Palit (2013). Based on the ownership of the systems, the business could be distinguished from the community, third party and individual or entrepreneur owned, which all of them could work in the rural energy market.

2. What are the barriers faced by the PVCs which hinder the implementation of off-grid PV electrification in rural areas in other developing countries? Moreover, What types of business models employed by the PVCs to address the challenges they are faced?

Literature: The barriers faced by the PVCs which hinder the implementation of off-grid PV electrification in rural areas in developing countries could be derived from the barriers to the adoption of other RETs for rural electrification (Wade, 2003; Zerriffi, 2011), barriers to the adoption of PV systems in a broad context (Karakaya & Sriwannawit, 2015), general barriers to PV adoption for rural electrification (Chaurey & Kandpal, 2010), barriers to the adoption of PV systems in the specific regions or countries (Ansari et al., 2013; Jeslin Drusila Nesamalar et al., 2017; Ohunakin et al., 2014; Wamukonya, 2007), and barriers to the adoption of PV systems in rural areas in a specific country (Pascale et al., 2016; Sharif & Mithila, 2013; Sindhu et al., 2016). We summarized all the barriers found in the literature and classified them into ten group of barriers which are (1) infrastructures, (2) investments, (3) financial of the end-users, (4) human resources, (5) technical barriers, (6) market demand, (7) social, behavioral, and cultural aspects, (8) governmental / institutional barriers, (9) networks / partnerships, and (10) environmental barriers.

Case study: From seven cases investigated, all of the PVCs agree on the list of barriers which were found in the literature. There are no additional barriers which are faced by the PVCs which influence the adoption of PV technologies in the rural energy market. Nevertheless, each of the PVCs describe the level of barriers they faced during the implementation of PV electrification in the rural energy market differently.

Based on the result of our interviews with the PVCs, different types of business models employed by the PVCs to address the challenges they faced in the rural energy market could be classified based on its key activities as well as its value proposition. Different types of business model employed by PVCs based on our interview results are the E2E model, distributor model, product-focused, and service provider model.

Based on its activities, the types of business model could be classified as the E2E model and the distributor model. This classification is derived from the key activities of the companies whether the companies produce or design its own products. The companies which employ the distributor model, such as SunnyMoney, SunTransfer, and SunSawang, rely on PV suppliers to supply the companies with good quality PV products. On the other hand. Mobisol and Selco, which design or produce its own products, are classified as companies which employ the E2E business model.

The business model employed by PVCs could also be classified based on its value proposition. According to our interview, companies such as Devergy and MGP act as utility companies instead of product companies. These types of companies could be classified as the service provider companies since Devergy and MGP focus on selling electricity services instead of PV technologies. This business model is different from the products-focused business model where the PVCs focus on selling various types of PV technologies. The choice of types of value proposition offered by the PVCs also play major role in determining companies' revenue model. The PVCs which sell PV products apply the pay-to-own scheme through installments, loans, or flexible PAYG systems. Thus, the rural customers could avoid the high up-front cost of the systems. On the other hand, the PVCs which offer services as its value proposition apply a service fee in exchange for the electricity services through fixed subscription fee or PAYG scheme.

3. How can characteristics of business models for off-grid PV electrification be derived from the barriers that are faced by PVCs in the rural energy market?

Cross cases analysis: From our investigation, the types of business models employed by the PVCs are highly influenced by the choice of the customer segmentation and its value proposition offered to the customers. It is due to the fact that the choice of customer segmentation and value propositions lead to various levels of barriers faced by the PVCs in the rural energy market, which at the end will influence the choice of business models employed by PVCs in the rural energy market, which is shown in Figure 7.1.

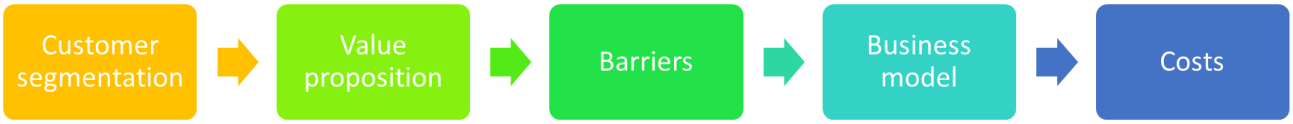

Figure 7.1. The flow diagram of business model development

Based on the result of our cross cases analysis, not all elements and characteristics of business models for off-grid PV electrification could be derived from the barriers that are faced by PVCs in the rural energy market. From our analysis, only five out of ten barriers found in the literature earlier influence the elements of business model employed by PVCs. These barriers are (1) infrastructure, (2) financial, (3) market demand, (4) social, behavioral, and cultural, as well as (5) environmental. Our analysis shows that the levels of these particular barriers influence elements of business models employed by the PVCs, such as the key partnerships, key activities, key resources, customer relationships, channels, and revenue streams. Nevertheless, there are also several other factors which determine the elements and characteristics of business model employed by the PVCs. These factors are derived from the levels of financial barriers. These factors are (1) the size of the company, (2) infrastructural barriers, (3) technological investments, (4) the location of the third parties, and (5) the behavior of the customers it selves.

From our analysis, it could be concluded that the other four barriers which are faced by the PVCs do not play any roles in determining specific elements of business models employed by the PVCs. The different levels of barriers faced by the PVCs on the (1) investments, (2) human resources, (3) governmental/institutional aspects, and (4) networks or partnerships, do not lead to specific elements of business model employed by the PVCs. All of the PVCs have a general solution for each of those barriers regardless of its level of significances towards its business.

Based on our interview results, each of PVCs experience different levels of technical barriers. However, these different levels of technical barriers were influenced by various reasons which could not be generalized such as lack of innovation, lack of standardization of PV products in the country, and lack of project management. Each of these issues was addressed with specific elements of business model which are tailored

based on the needs. It could be concluded that each of the technical barriers will lead to specific elements of business model.

Finally, the choice of elements of business models will eventually influence the cost required to operate PVCs business as shown earlier in Figure 7.1.

4. What is the potential off-grid PV electrification in Sumba? What are the barriers that impede the implementation of off-grid PV electrification in Sumba?

Literature: According to the literature, Sumba Island has an average insolation of 5kWh/m^2/day, which means that the island gets a solar radiation of 1000 Watt/m^2 for five hours a day (Alphen et al., 2008). Thus, the total solar energy potential in Sumba Island could be calculated by multiplying its solar insolation with the areas of Sumba Island, which is about 44,260 GW.

In general, all locations in Sumba Island are suitable for on-grid and off-grid PV electrification. However, the literature suggests that considering all the infrastructure and access to the locations such as the conditions of the road and the grid availability, the technical potential of Solar energy in Sumba Island is only 10 MW (Hivos, 2014b). Thus, the technical potential of off-grid PV electrification in Sumba Island could reach up to 10 MW since the availability of the grid could be neglected.

Field study: Based on our field study and interviews with several actors in Sumba Island, it could be concluded that currently there are three main actors which influence the adoption of PV technologies in Sumba Island. These actors are Hivos, an NGO which owns several off-grid PV projects in Sumba island, PLN, a state-owned utility company which offers an electricity service through SHSs in exchange of subscription fee, and the governments which own donor-driven projects across Sumba Island. Each of these actors experiences different levels of barriers which impede the implementation of their projects.

Hivos, as an NGO which acts as the National Secretariat of SII program, needs to cooperate with various stakeholders which include the national and local governments. Moreover, just like many other NGOs, Hivos operates its projects based on grants from donors. Thus, Hivos also needs to attract investors and donors to secure investments for the SII program. Hivos describes the most significant barriers which impede the implementation of Hivos projects are the governmental/institutional barriers. The change of regulations in RET, especially in PV, affect the attractiveness of SII program to the investors. The more regulations in favor of RET, the more investors want to invest in SII program. Nevertheless, until now, there are only a few regulations which support RET in Indonesia. Thus, Hivos also experience difficulties to get investments for both its own projects as well as for SII program. Hivos also experience technical problems during the importation of PV technologies. It is because Hivos has no experiences and knowledge in importing technologies from abroad. Barriers to infrastructure and human resources are also considered moderately significant for Hivos. Thus, Hivos relies on its partners such as RESCO, and Winrock international for the technical aspects while Hivos focuses into social and community engagement to stimulate market demand and address any social, behavioral and cultural issues. In this way, Hivos has a lower level of barrier on the social, behavioral and cultural aspects compared to the one described by PLN and the government.

On the other hand, PLN and the government are the programs which are fully supported by national and local governments. Thus, the programs carried by PLN and the government has lower barriers to the investment and technical aspects compared to Hivos. On the government projects, the financial, market demand, and environmental barriers are considered insignificant. It is because all the programs carriers by the government are donor-driven programs where the villagers receive the PV systems for free. The most significant barriers for the donor-driven's government projects is related to the governmental aspects and followed by social, behavioral and cultural aspects. It is because the donor-driven projects are executed by the local government based on the instruction from the national government. Thus, there is nothing that the local government could do when the national government erases the program. Moreover, there was a gap between the government's intention and the expectation of the villagers on the ownership of the systems as well as

the one who is responsible for the services and maintenance of the systems. This misunderstanding could happen because there is a lack of programs' socialization and transfer of knowledge from the government to the villagers in the form of educations or training.

SEHEN program which is carried by PLN also experiences a high level of barriers on social, behavioral and cultural aspects. PLN describes that people who live in the village do not get used to with banking systems. However, from our observation, the high level of barriers on social, behavioral and cultural aspects is also influenced by the location of the village and limited access to the nearest town. Furthermore, PLN installs complete PV systems on each of the customers' house without any automatic control for the usage of the electricity and the payment of the systems. Thus, it leads to misunderstanding on the ownership of the systems. In this way, PLN has enabled the customers to enjoy the electricity services without paying any subscription fee. This condition is also worsened by the fact that PLN fails to provide proper maintenance and after-sales services for the systems. Hence, currently, from about 24,000 systems distributed in Sumba Island on 2011, there are only 1,800 systems used by SEHEN customers.

5. How could the existing business models help to address the barriers that impede the implementation of off-grid PV electrification in Sumba?

Cross-case analysis: The different types of business model employed by PVCs in this research have helped us to understand various ways of PVCs to overcome challenges in the rural energy market. To be able to develop a suitable business model for PVCs which operate in the rural energy market in Sumba Island, the initial framework developed in Chapter 4 was validated with the real conditions in Sumba Island and through expert interviews. Then, the final framework is defined. Moreover, the four different types of business models, which are the E2E, distributor, products and service provider model are compared. A suitable business model for PVCs which operate in the rural energy market in Sumba island then could be developed based on the comparison from different business models which are used by the PVCs in the developing countries. The specific elements of business models also could be developed by looking at the final framework which was constructed after the validation with the current conditions on Sumba Island.

7.2.2 Main research question

"What is the most suitable business model for off-grid PV electrification in Sumba Island, Indonesia?"

To be able to answer the main research question, first, we should look at the updated version of the framework developed earlier in this research. Furthermore, several data obtained from the field visit in Sumba Island and the expert interviews are used as an input in the framework to develop the most suitable business model for off-grid PV electrification in Sumba Island. From the final framework and the data obtained during the field study in Sumba Island, it could be concluded that there are two business models which are suitable to be applied to support the adoption of PV technologies in the rural energy market in Sumba Island.

The choice of business model could be influenced by the customer's segmentation which the PVCs want to cater. Firstly, for the middle up to the upper tier of BoP customers, there are two available types of business model which could be employed by the PVC. The first business model is the combination of the distributor and products-focused business model which offer various products from a solar lantern with its mini solar panel, or rechargeable PV lamps up to bigger systems such as SHSs, followed by reliable after sales service at an affordable price by offering flexible payment scheme. The second business model which could be employed for the middle and upper tier of BoP customers is the combination of distributor and service provider model which offers the electricity services delivered by micro-grid which equipped with a smart meter to control the electricity usage. This model offers the electricity service which could be paid flexible based on the customers' needs.

Secondly, the type of business model which could be employed by the PVCs to serve the lower tier of BoP market in Sumba Island is also the combination of distributor and service model. However, the electricity service is delivered through a much simpler microgrid technology. The use of simple technology enables a limited amount of electricity delivered to the customers. The electricity services are determined at a pre-set time or daily quota in exchange for small fixed subscription fee which could be collected weekly or monthly.

7.3 Discussion

In this section, we will look into several other things that are not covered in the research objectives but was a consequence of this research. This section will not yield answers to the research questions but enables a discussion on the result of this thesis.

7.3.1 Exploration on business model canvas

The business canvas which was used for this research was based on the business model generation from Osterwalder & Pigneur (2010). This business model canvas was used due to several reasons. Firstly, it has complete elements which could be used for the purpose of this study. Secondly, the canvas is simple and easy to construct as well as it has been tested in practice and successfully applied in the renewable energies' field. Nevertheless, there are other business model canvases which also could be used to support this research as well as to provide a deeper understanding of how a business model for off-grid PV electrification is designed to address several barriers in the rural energy market in developing countries. These business model canvases were composed by Joyce & Paquin (2016) on The Triple Layered business model canvas (TLBMC) and by Maurya (2012) on The Lean Business Model. Although both of these canvases were less used in the literature compared to the one from Osterwalder & Pigneur (2010), it is still interesting to discuss on how these canvases could influence the result of this research.

The Triple layered business model canvas developed by Joyce & Paquin (2016) is essentially the extension of business model canvas from Osterwalder & Pigneur (2010) which is only economically and profit focus. The TLMBC compliments the business model canvas from Osterwalder & Pigneur (2010) by integrating environmental and social canvas layers from lifecycle and stakeholder perspectives. By integrating these three elements, which are economic, environmental, and social impacts, in a business model, the TLMBC enables the ones developing more sustainability-oriented business model innovation. In the case of this research, it is important that PVCs which operate in the rural energy market focus not only in the profit but also in the social and environmental impacts of its business. It is because the nature of the business which operates in the BoP market and in the RETs' field which should take into account the social and environmental values given to the societies. By using the second and the third layer of TLMBC, ones could have a better understanding of the PVCs business model, especially in the environmental and social aspects. The TLMBC is summarized in Figure 7.2.

The second option of business model canvas tool comes from Maurya (2012) which is The Lean Business Model Canvas. The lean canvas is the adaptation of Osterwalder & Pigneur Business model canvas (Osterwalder & Pigneur, 2010). The author changes several things from Osterwalder canvas such as Problem, Solution, Key Metrics, and the Unfair Advantage which could be seen in Figure 7.3. The lean canvas focuses on the problems which need to be solved on the targeted customer segment. Thus, from the figure, we could see that the first step in building the Lean business canvas starts from defining the top three problems, followed by choosing the right customer segments and setting up a unique value proposition.

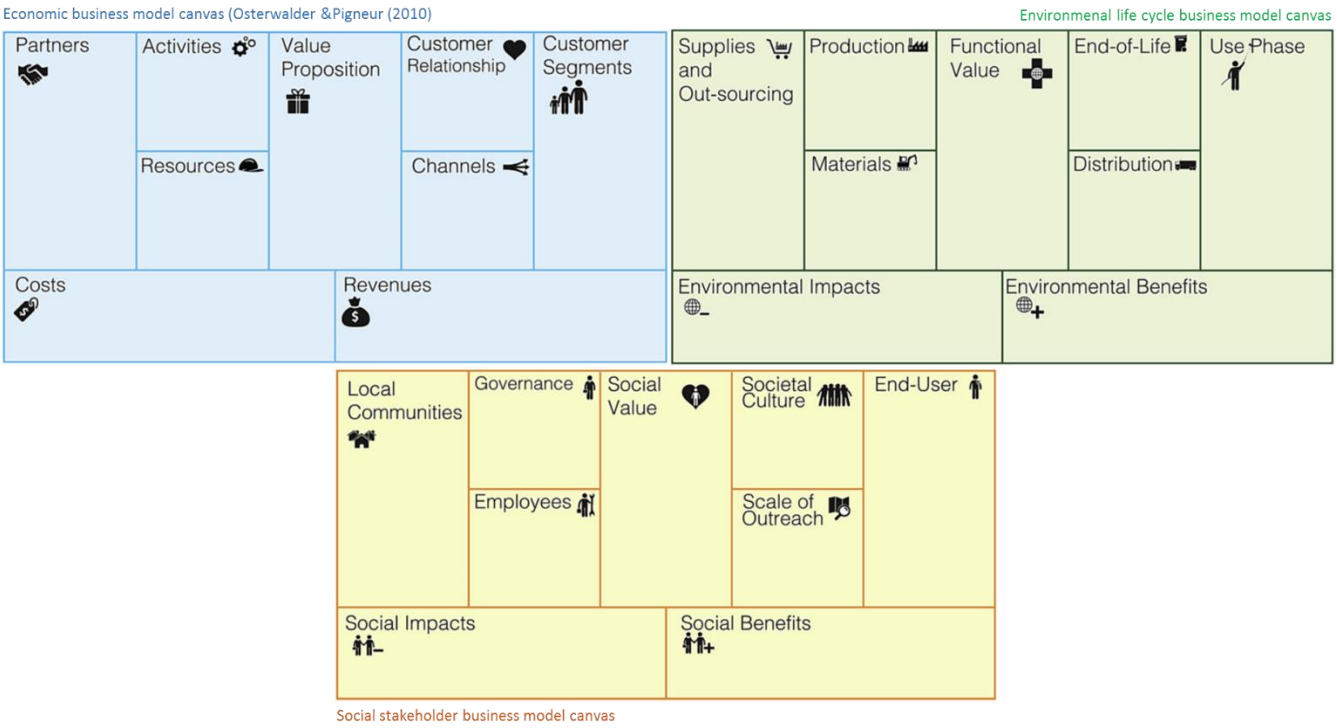

Figure 7.2. Triple Layered Business Model Canvas (Joyce & Paquin (2016))

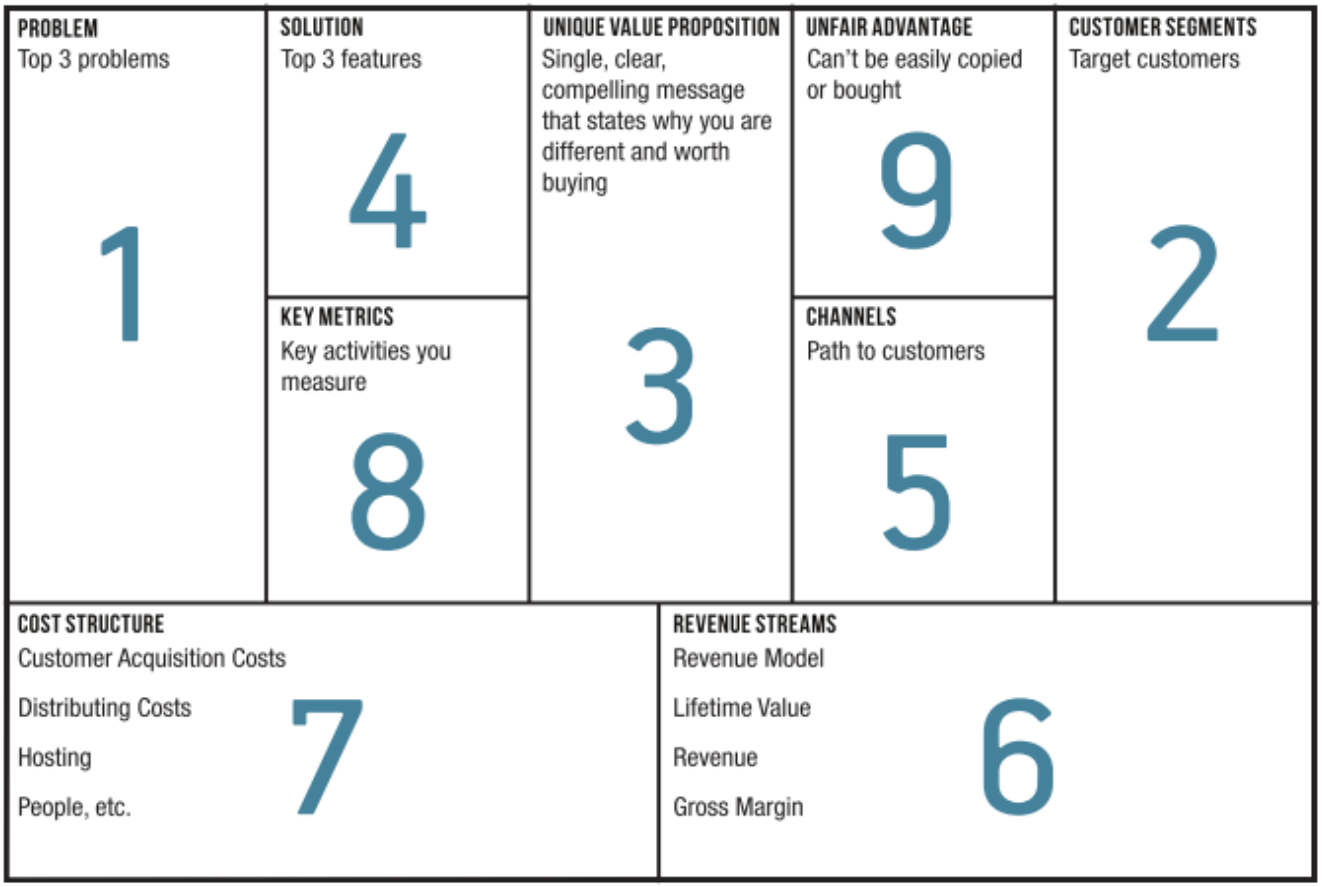

Figure 7.3. Lean Business model (Maurya, 2012)

In the case of this research, the lean canvas provides the right elements to capture the problems and barriers which need to be solved in the BoP market, as the targeted customer's segment of the PVCs. Then, a

unique value proposition could be defined based on the problems in the chosen customer segments. After that, other elements of lean business model canvas could be determined based on the steps shown in Figure 7.3. The Lean business model canvas is different from the Business canvas developed by Osterwalder & Pigneur where the steps could be started anywhere in the canvas. Furthermore, Osterwalder' canvas does not have elements to capture the problems directly on its canvas. Thus, in this research, the linkage of the barriers faced by the PVCs in the rural energy market and the business model employed by the PVCs to overcome those challenges could not be drawn directly on the Osterwalder's canvas.

Both business model canvas developed by Maurya (2012) and Joyce & Paquin (2016) seems to be promising to be used in the future research. It is because the elements of the lean canvas could capture the most important barriers or problems faced by the PVCs which could lead to the right solution provided by the business model. Also, the layers on the TLMBC could lead us to get more in-depth understanding and more details on the sustainability of the business models employed by the PVCs in this research. Different frameworks or business model might be obtained from this research if the lean canvas or the TLMBC were used as the research tool in this study. Although the lean canvas and TLMBC seem to be promising to be used for this particular research which focuses on the problems area, these canvases are less used in the literature, especially in the field of renewable energies. Thus, validation of these canvases' usage in the renewable energies field is still required.

7.3.2 Factors influencing the choice and the success of business model employed by PVCs in the rural energy market

At the time of interviewing and after carefully analyzing the data as well as constructing the framework, it was found that not only the level of barriers' significances but also several other factors influence the choice of elements of business model and the success of business model employed by PVCs. These factors are the size of the company, infrastructural barriers, technological investments, the location of the banks, and the behavior of the customers it selves. These findings were also mentioned in the existing business model literature which also points out several factors which influence the choice of business model employed by the organizations. These factors include customer behavior, technology, market opportunity and competition (Chesbrough, 2007; Magretta, 2002, as cited in Kujala et al., 2011). Other factors also affect the performance of business models such as the complexity of the project as well as its organization (Hobday, 1998; Wikström et al., 2009, the experience of organization in delivering services (Wikström et al., 2009), the project size and the risks involved in the projects (Cova et al., 2002) all cited in (Kujala et al., 2011).

In the case of this research, the factors which were found during the interview session play major role in determining the choice of payment scheme or revenue collection method. The success of payment scheme or the revenue collection method will affect the revenue streams of PVCs. Thus, it plays a major role in the success of business model employed by PVCs in the rural energy market.

In PLN case, the business model employed by PLN did not work well. It could be seen by the numbers of SEHEN systems installed at the beginning of the program compared to the current situation. From our observation, this failure was caused by PLN's revenue collection method was not followed by the supporting factors such as customer behavior, technological investments, the infrastructural barriers, and the location of the banks.

That said, it was found that aside from the level of barriers faced by the PVCs, there are other factors which influence the choice of elements of business model and the success of business models employed by the PVCs. Nevertheless, this finding still needs to be validated in the future research.

7.3.3 Understanding BoP customer segmentation

At the beginning of this study, it was explained that the focus of this study would be the BoP market which is the largest but the poorest socioeconomic group in the global income pyramid living less than $2 a

day (Prahalad & Hart, 2002). Nevertheless, the BoP market consists of different tiers of customer segmentation which could be classified based on their income, as it can be seen in Figure 7.4. The lower tier of the BoP customers is considered as the poorest of the poor. Although all the PVCs we interviewed targeted the BoP market and the rural customers, not all of the PVCs could cater the lower tier of the BoP or the poorest of the poor. MGP is the only company which could serve the lower tier of the BoP and the company prides itself in covering this market. It is because the choice of its simple payment method and the technology used by MGP which enable the company to offer low service fee to its customers. Compared to Devergy which also offers electricity service to the customers, the company chooses to have a flexible usage of electricity, in exchange for higher fee. Devergy tries to serve a broader segment of BoP by offering the flexibility of payment and electricity usage.

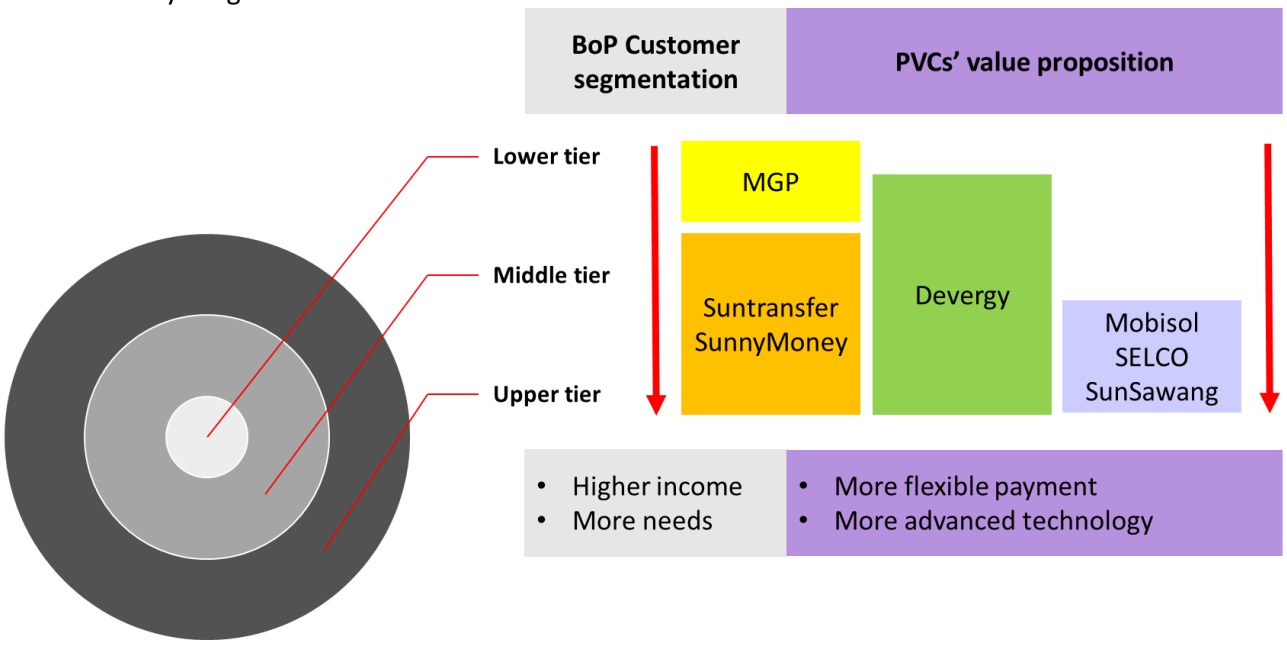

Figure 7.4. BoP customer segmentation

Other companies which focus on serving the middle and upper tier of the BoP market tend to have more products' options compared to those which focus only in the upper tier of BoP market. For instance, SunTransfer and SunnyMoney provide solar lantern and SHS to cover a broader range of BoP customers. On the other hand, SunSawang, SELCO, and Mobisol only sell SHS to the upper tier of BoP Customers.

It was found that the higher income of the targeted customers, the more they are willing to pay for the use of electricity. Thus, it has to be followed by the bigger systems which could deliver the electricity based on the needs of the customers. MGP, which is the only company which serves the poorest of the poor customer segment, offers a limited amount of electricity services in exchange of fixed price. On the other hand, Devergy offers the more flexible electricity services supported by a smart meter in exchange for higher fee compared to MGP. Other companies which offer products also have the same behavior. The upper level of BoP customers tends to purchase bigger systems to fulfill their electricity's needs, while the middle tier of BoP customers has to be satisfied with solar lanterns since they could not afford to pay for a bigger systems.

Without neglecting the fact that the PVCs still serve the BoP market which has limited financial resources. The PVCs also need to enable installments for the payment of the systems. The lower income of the customers need to be followed by smaller installment and simpler payment scheme. For instance, MGP collects the subscription fee directly from the villagers in the form of cash. It is because its customers do not have access to the banks and only have cash in a limited amount of time. Thus, it is important for MGP to collect the cash as often as possible. In this case, MGP collects the subscription fee weekly. On the other hand,

other companies which cater the higher income of BoP Customers enable flexible payment schemes through PAYG, installments or loans through the third parties such as banks or local financial institutions

To conclude, the choice of customer's segmentation within the BoP market will influence the value proposition offered by the PVCs, especially in terms of technologies and the flexibility of the payment schemes. However, further research needs to be done to validate this finding.

7.3.4 End-to-End (E2E) business model Vs. Distributor business model

From this research, we found that the types of business model could be classified based on the key activities done by the PVCs. These types of business model are the E2E and the distributor business model. The PVCs which employ the E2E business model are SELCO, Mobisol, and Devergy, while the rest of the PVCs in this study employs the distributor model.

The distributor model relies on the other PV suppliers to supply the companies with good-quality PV products and its components. On the other hand, the E2E model involves the PVCs in designing its own PV technologies. The choice of PVCs to employ one of these types of business model will influence the cost the PVCs need to be incurred in order to operate its business. Ideally, the more activities are done by the PVCs themselves, the more costs need to be incurred, which at the end might also affect the profitability of the PVCs. Since this was the unexpected outcome of this research, further study needs to be done to look into the linkage between the choice of business model's types and the profitability of the PVCs.

7.4 Research limitation and Recommendation

This section will present research limitation and academic recommendation for further studies. The recommendations made in this section are based on the results obtained from this research.

From this study, we discovered there are two types of business model which can be distinguished based on its key activities, which are the end-to-end and distributor model. Since this study only involves seven PV companies, other types of business model employed by PV companies might not be captured in this study. There is a possibility that PV companies only focus on the research and development of the products or the technologies without involving any further in the distribution and selling process. This type of PV companies has its own brand and types of technology. However, this type of PV companies is highly dependent on its local partners to distribute and sell the products to the end users. This type of business model is failed to be captured in this since there are no PV companies we have interviewed run this business model. Thus, it would be wise to have more PV companies involved in the study to capture variations in business model employed by PV companies which focus on the rural energy market in the developing countries around the world.

Secondly, this study looks at seven different cases which mainly located in Asia and Africa. Furthermore, the companies we interviewed operate its business in the countries which are located on the continents or operate only in specific regions in one country. Thus, the framework developed from this study might not be representative enough for the whole world. The framework we developed in this research might not be suitable for companies which want to operate its business in the island or archipelago nations when the operational areas are located on different islands from the companies' head-quarter. It is because of different market characteristics as well as resources required to do the business in those locations. In the case of this research, although Indonesia is an archipelago country, the business models we developed in this research focus only on one specific island which is Sumba Island. The framework might be no longer suitable to develop business model for PV companies which want to cater greater areas of Indonesia. Thus, it would be wise to extend the regions and countries where the PVCs operate its business to obtain a greater generalizability of the framework. More case studies should be done in PV companies which operate its business in Archipelago or Island Nations, such as Maldives, The Philipines, and Fiji.

Thirdly, most of the cases chosen for this research are relatively new companies, except for SELCO which have been selling PV technologies for 22 years. Hence, these companies themselves are trying out different business models and yet to validate themselves. Furthermore, most of the companies have not been

able to generate profit yet. Furthermore, the result of the interview could be very subjective. Although a experts interview was done to validate the framework developed in this research, a field testing and quantitative research could be other options to avoid the bias and subjectivity of the interview results as well as to make the frameworks and the business model more robust.

Next, the validation of the framework which was done through expert interviews was solely depending only on two interviewees. One interview was done with Mr. Hamzah from an Indonesian company while another interview was done with Mr. Bart Fugers. The interview with Mr. Hamzah lasted for more than one hour and all the questions were essentially answered during the interview process. On the other hand, the interview with Mr. Bart Fugers much focused on the structure of the framework and its future usage. Although both of the interviewees agree ion the framework developed in this study, it is better to have more experts from PV industry or academia to validate the framework.

Lastly, further research needs to be done on the reason behind the choice of value propositions. The PVCs in this research offer a different value proposition to its customers. Some companies offer products while some others offer services. There are also variations on the products the PVCs offered to the customers. For instance, solar lantern, solar home systems, and rechargeable PV lamps used in Hivos program. Further study should be done to understand the factors which influence the choice of value proposition offered by the PVCs to the rural BoP customers. The most interesting and highly relevant recommendation for the future research would be: ***"What are the factors influencing the choice of value proposition offered by the PVCs to the rural BoP customers in the developing countries?"***

More recommendations for further research could be derived from the discussion sections as well. Please refer to the discussion section for further inspirations.

7.5 Reflection

The research process had four phases which start from the knowledge gap identification phase, identification of barriers and the business model, initial framework construction, framework validation and business model construction. The first two phases were carried out through a literature review, while the last two phases were done mostly through case study and cross cases analysis. With the respect of the availability of literature, the search of the literature was quite challenging, especially at the beginning of the research. Firstly, much literature mainly discussed the barriers to the adoption of PV technologies in developing countries and how to overcome those barriers. Nevertheless, limited literature was available when it comes to the use of business model to overcome challenges to the adoption of PV technologies especially in the rural energy market in developing countries. Moreover, several literatures have mistaken the concept of business model and revenue model which make the searches of the literature becomes a challenge. Secondly, the decision of using the research tool from Osterwalder & Pigneur (2010) was made quite early in the research process. It is because the business model generation from Osterwalder & Pigneur (2010) has complete elements for this study as well as has been tested in practice and successfully applied in the field of renewable energies (Richter, 2013). However, during the search of the literature on business model, other business model canvas were found such as The Triple Layered business model canvas (Joyce & Paquin, 2016) and The Lean Business Model (Maurya, 2012). These two types of business model canvas were essentially less used in the literature. Nevertheless, it is still interesting to see how these models could also be used to support and to give deeper insights in this research compared to the one from Osterwalder & Pigneur (2010).

Secondly, with respect to the execution of the study, several challenges were faced while contacting the PV companies as well as while performing the interview. Based on the previous experiences, it is known that it is quite hard to find the companies which are willing to be interviewed, especially when there is no personal contacts available from the companies. Thus, at the beginning of the search of PVCs, all possible options were tried to contact all the targeted companies. It turned out that most of the companies gave positive responses to the interview requests. Hence, seven cases need to be included in this research. Although

it seemed too many cases, these seven cases studies from the PVCs essentially provided different insights which were used for this research.

Thirdly, it was a challenging task to perform a one hour interview with the companies, especially with two questionnaires which have been designed for this research. Three of the seven companies which have been interviewed could not finish the questionnaire. One of the reasons was because I need to share the time with another student from Delft University of Technology who also did an interview for her master thesis. The other two companies which I failed to finish the interview was caused by the limited amount of time the PVCs gave for the interviews which last less than one hour. Hence, several questions and unclear answers need to be asked through emails. It would be great if the interview time was not shared with other students and it was planned to be one hour precise. Other challenges were faced during expert interviews. It is quite challenging to explain the aim of the inteview and the newly developed framework which has never been seen before through phone interview. Thus, the expert interviewwhich aim to validate the framework is better done through a face-to-face meeting.

Fourth, it was found that some of the PVCs were confused about the questions related to the barriers. This research was focused on the barriers faced by the PVCs, especially at the beginning of its operations, and how they use a business model to solve those barriers. However, some of the PVCs were found that they have a low level of certain barriers because they have applied their current business model, which was not the answer needed for this research. Hence, some of the questions need to be repeated and explained to the PVCs so that proper answers could be obtained for this research.

Fifthly, it was quite challenging to organize a field study to Sumba Island. There was no exact schedule for the field visit until one day before I departed from the Netherlands. Thus, the choice of the villages for the field study was made by Hivos team with the respects of the villages' criteria I made for this research. A literature review for these villages could also not be done since the decision of the villages that we wanted to visit were also made once I arrived on Sumba Island. It would be nice if I could prepare a literature review on these villages to get some insights before I came for the field visits. Moreover, the field visit was done during Indonesian's national holiday, which affected the available time to conduct interviews with the government and PLN officials.

Sixth, at the beginning of this research, it was planned that the final framework and the business model for the PVC which operate in Sumba Island developed in this research would be validated by the government officials. However, in practice, it was not possible to perform such validation once I got back to the Netherlands. It was challenging to contact one of the government officials from the MEMR, although I got a personal contact with the department. It was impossible to ask their opinion on the final framework as well as the business model developed in this research through SKYPE or emails. Hence, the validation of the framework was done through a cross-case analysis with the current conditions in Sumba Island and practitioners from PV industries. Unfortunately, there was no validation provided for the business model developed in this research. It would be better if the final framework and the business model developed in this research could be reviewed and validated.

Lastly, this research consisted of the combination of theoretical and practical parts which were done in limited time. Although it is an interesting topic which combines theoretical and practical research, it was found that the data that was obtained from the literature and the case study was very dense and rich with no proper orientation to it. Hence, it was quite a task to summarize and narrow down all the data from the literature and seven cases study. It would be better to focus on performing one of those theoretical or practical research.

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9 APPENDICES

9.1 The initial list of PV companies

No	Name of PV company	Justification for elimination or insertion for case study analysis	Status
1	Afghan Solar	for profit but focus on bigger market and systems	Excluded
2	Azuri	for profit operates at the rural energy market	Included
3	Barefoot college	not for profit	Excluded
4	BBOX	for profit operates at the rural energy market	Included
5	Bennu Solar	not relevant	-
6	Clay Energy	for profit renewable energy company	Excluded
7	Contained Energy	for profit but focus on bigger market and systems	Excluded
8	d.light	not relevant	-
9	Devergy	for profit operates at the rural energy market	Included
10	Eight19	not relevant	-
11	ENVenture	not relevant	-
12	Essmart	not relevant	-
13	Good Return	not for profit	Excluded
14	Gram Power	not relevant	-
15	Grameen Shakti	for profit operates at the rural energy market	Included
16	Kamworks	for profit operates at the rural energy market	Included
17	Kopernik	not for profit	Excluded
18	Little Sun	not relevant	-
19	LUTW	not for profit	Excluded
20	Mainstream Renewable Power	for profit but focus on bigger market and systems	Excluded
21	Meragao Power	for profit operates at the rural energy market	Included
22	M-KOPA Solar	for profit operates at the rural energy market	Included
23	Mobisol	for profit operates at the rural energy market	Included
24	Nizam Energy	for profit operates at the rural energy market	Included
25	Onergy	for profit operates at the rural energy market	Included
26	Orb Energy	for profit but offers solar thermal systems	Excluded
27	PicoSol	not for profit	Excluded
28	Pollinate Energy	for profit operates at the BOP for slum communities in town	Excluded
29	Practical Action	not for profit	Excluded
30	Rural sparks	for profit operates at the rural energy market	Included
31	SELCO	for profit operates at the rural energy market	Included
32	Shidulai Swanirvar Sangstha	not for profit	Excluded
33	Simpa Networks	for profit operates at the rural energy market	Included
34	Solar Universe India	for profit but focus on bigger market and systems	Excluded
35	SolarNow	for profit operates at the rural energy market	Included
36	SRE Solutions	for profit operates at the rural energy market	Included
37	Sunlabob Renewable Energy	for profit but focus on bigger market and systems	Excluded
38	SunnyMoney	for profit operates at the rural energy market	Included
39	SunSawang	for profit operates at the rural energy market	Included
40	SunTransfer	for profit operates at the rural energy market	Included
41	Surana Ventures Limited	not relevant	-
42	Waaree	for profit but focus on bigger market and systems	Excluded
43	Zularistan	for profit but focus on bigger market and systems	Excluded

9.2 The final list of PV companies

No	Name of PV company	Responded positively
1	Azuri	No
2	BBOX	No
3	Devergy	Yes
4	Grameen Shakti	No
5	Kamworks	No
6	Meragao Power	Yes
7	M-KOPA Solar	No
8	Mobisol	Yes
9	Nizam Energy	No
10	Onergy	No
11	Rural sparks	No
12	SELCO	Yes
13	Simpa Networks	No
14	SolarNow	No
15	SRE Solutions	No
16	SunnyMoney	Yes
17	SunSawang	Yes
18	SunTransfer	Yes

9.3 Questionnaires

9.3.1 Case study interview

9.3.1.1 Business model related questions

Products

Value propositions

1. What kind of products or services do you offer to your targeted market (people in rural areas)?
2. Do you develop your own products?
3. If you develop your own products, is it locally made or do you have any production houses abroad? If yes, where are they?
4. If you do not have your own products, where do the products come from? Can you specify the name of the companies?
5. Is there any reasons on choosing the manufacturing companies as your partner?
6. What quality control systems do you apply to ensure the quality of the products?
7. What does your company offer differently compared to other competitors in the targeted market? Is that what makes you unique compared to the competition?
8. Are the local cultures, values, norms considered in your products/services/ marketing strategy? What are they?
9. How do you elaborate these cultural values into your products/services?

Customer interface

Customer segments

1. Who are the users? End users or other business entities?
   questions for end users
2. What is the occupation of the majority of the users? (farming, entrepreneurs, etc.)
3. How much (roughly) the monthly income of the targeted users?
4. How far are the targeted users live from the city?
5. How far is (approximately) the targeted users from the nearest grid connection?
6. What is the current source of their electricity?
7. Can you specify how much the users spend on energy in daily/weekly/monthly basis?
8. Do they have access to credits? If yes, how much is the interest rate?
9. Do they live close to each other? Alternatively, are they dispersed?
10. If the targeted user live dispersedly, how far is the distance from one house to another?
11. What is the average number of people living under one roof?
12. How do the users interact in the community or in the villages? Do they have a village leader?
13. How do you reach your customers/users? Is it through a village leader or do you have any other strategies?
14. Do the users familiar with the technology before your company came? If not, how do you increase awareness of your product?
15. Could you please describe the willingness to pay of the users for your proposed technologies or services?
    questions for other business entities
16. How do the other business entities operate? Distributor? Financial institutions? Alternatively, both?
17. Currently, how many business entities cooperate with your company? Are they private or government owned?
18. How does your relationship with your current partners can help to increase the use of PV in the targeted market?

Channels

1. In general, how do you raise awareness about your company's products/services to you targeted users? Do you provide education or training to your targeted market?
2. How do the customers purchase the products? Is it through local agents? or do you have any other methods?
3. How do you distribute or deliver your products to the end users? Do you have branch office? If yes, can you please specify the position needed for one branch office?
4. Do you provide any allowance (transport and communication) for your employee?
5. What is the maximum distance or radius is the branch office with the furthest targeted users?
6. How do you employ your team? Full-time employment, contract or commission-based?
7. How do you collect the products after the end of its life cycle? Moreover, what will you do with them?
8. Do you provide services and maintenances after the sales? If yes, for how long?
9. How do you provide the after sales services?
10. If you transfer the responsibility of the after sales service to your partners, how do you make sure of their services and performances?
11. Are the spare parts available /accessible to the users? How do you make it accessible?

Customer relationship

1. How do you build the customer trust?
2. Do you provide any customer services?
3. How do the users/customers contact you if anything happens with the products?
4. How do you get evaluations or feedbacks of your products/services from the customers?
5. What do you do with the feedbacks from the customers? How do you use it to improve your products/services?

Infrastructure Management

Key resources

1. Do you own patents which could generate licensing fee?
2. How do you hire your people? Do you have any qualifications for the sales and technicians team?
3. How much is the percentage of local people currently working in your company?
4. Do you face any difficulties in finding the right talents for right positions? If yes, how do you face those challenges?
5. Do you provide training for your employees?
6. How does local community can involve further in the design, planning, and implementation of the project?
7. Does your company benefit from current Government policies and regulations (incentives/tax/easy bureaucracy, supportive environment) for rural electrification? Can you mention the incentives scheme if any? If yes, could you please explain how you are benefited from current regulation?
8. Do you have any interaction with the government? Do you involve in the lobbying activities for the policies in favor of your companies?
9. How do you influence the government in favor of you side (to support rural electrification)?

Key activities

1. What do you see your company as according you main activities? For example: service provider, distributor, manufacturer, R&D, marketing, sales, services and maintenances, financing

Key partners

1. Could you please specify the partnership you make with other companies? What are the things that you outsourced from other companies?
2. How do you select favorable partners?

Financial aspects

Revenue streams

1. PV technology is known for the high upfront cost, and rural communities are known for limited financial access, Can you please specify your company's revenue model to overcome these challenges? Ownership or service revenue model and why do you choose it?
2. How does your revenue model work? Daily/monthly subscription or loans with how many interest rate?
3. How do you collect your revenue? Moreover, why do you choose this model?

4. What are the risks of the chosen revenue model faced by your company? Do you have any mitigation plan in the case of financing risk or users default?
5. Are there any revenue streams besides from the sales, subsidies/incentives?
6. Is your current model commercially viable? Able to generate enough profits? Is the current financial scheme able to maintain O&M company?
7. What is your source of funding? Do you get any loans or grants?
8. What have you done in order to secure loans (grants) from the bank (investor)?

Cost structure

1. Could you please specify roughly the three biggest cost structure of your company? (for example the cost of marketing, operation, manufacturing)

9.3.1.2 Barriers related questions

Below **(Table 1)** are some of the barriers to the implementation of off-grid PV technology in rural areas which I found from various literature, can you please rate how relevant these barriers with your early or current condition on a scale of 1 to 5:

- 1 = Not significant
- 2 = Slightly significant
- 3 = Moderately significant
- 4 = Very significant
- 5 = Extremely significant

And **HOW** do you take those barriers into your business model?

Table 2. Questions related to barriers of off-grid PV technology in rural areas for PV companies

Classification of Barriers	Description of Barriers	Scale	HOW do you overcome these barriers with your business model? [Solution]
Investment	Issues related to company's access to funding (loan or grants). Uncertainties of the funding process, the requirement of high investment cost and long payback period resulting difficult or lack of access to the funding		
Financial	Issues related to the absence or limited financial access for the end users. This includes lack of access to rural credit and financial support for the poor		
Human resource	The unavailability of skilled and trained local technicians which could cause ineffective quality control. Unavailability of well-educated candidates for specific positions in the company		
Infrastructure	The unavailability of infrastructure or access that are required for the distribution and the usage of the services or technologies. Such as difficult road access, lack of access to information, knowledge,		

	communication, channels, and technical assistance		
Technical	Issues related to the technology and services. This could occur due to lack of standardization of the technology, lack of R&D culture in the country, unavailability of proper solar radiation data, ineffective project management as well as the system integration which resulting in poor customer services and poor quality of the products		
Market demand	The issues related to the potential customers for the products or services. This could occur due to the situation where there is a lack of consumer awareness and information of the technology, ineffective marketing approach, and education campaigns, and a widespread issue on customer dissatisfaction or customer mistrust leading to unwillingness to buy the products or services or when the price of the product/service offered is considered too high		
Social, Behavioral, Cultural	Different norms and culture in regards to the use of the product. For instance different consumption pattern of the poor, growing skepticism of the technology's users, reluctance and ignorance of people to the new technology. All of these issues could occur due to poverty and low-income level as well as a lack of trust to the 'outsiders'		
Governmental/Institutional	Laws, policies, and regulations that hamper the diffusion of the product. Lack of supporting policies or incentives, subsidies on the conventional fuel, bureaucratic complexity, lack of institutional transparency, lack of innovation strategy, no political commitment on rural electrification, lack of support on the entrepreneurial and R&D activities		

Network/Partnerships	The absence of actors which are directly involved to supply or distribute necessary product or service as well as lack of collaboration and cooperation within key stakeholders such as government, industries, users, financial institutions (banks), and academia		
Environmental	The issues related to the production process as well as the afterlife cycle of the technology, especially those technologies which contain harmful or toxic material such as storage device		

Are there any other barriers/challenges that are relevant to your current or earlier conditions? and **HOW** do you take those barriers into your business model (Solution to overcome those barriers)?

9.3.1.3 Field study interview

Village name:

Estimated distance from the grid:

Types of technology:

Year of technology introduced in the village:

Table 2. Questions related to barriers of off-grid PV technology in rural areas for villlagers

Classification of Barriers	Village leaders	Villagers (PV users)	Villagers (non PV users)
Infrastructure	1. How far is the village from the grid connection? 2. How far is the village from the closest trade center?	1. How many times do you go out to the trade center? 2. Do you think is it accessible to go to the trade center every week?	
Investment	[none]	[none]	[none]
Financial	3. What's the occupation of the majority of the villagers?	4. How many people you live within one house? 5. What's your occupation? 6. How much do you earn from your current job per month? 7. What did (do) you use as the source of lighting? 8. How much did (do) you spend to buy your previous source of lighting? 9. How much is your monthly saving/excess? 10. Do you have access to banks/financial institutions? If yes, what is it? if not, why? 11. Do you have access to loan/credits? If yes, at what interest? if not, why? 12. How do you pay for the system? Please explain	
		13. explain the payment flow 14. How do you buy the systems? 15. Do you think the systems is affordable for you? Yes/no Please explain 16. Do you have any difficulties to pay for the system? Yes/no Please explain	
Human resource	[none]	[none]	[none]
Technical		17. What do you think about the technology? 18. Does the current technology satisfy your needs/demands? Yes/no Please explain. 19. Do you have any difficulties to use the system? Yes/no Please explain 20. Have you ever face any problems with the systems? 21. Do you know whom to contact if anything happens to the system? Yes/no Please explain. 22. How long does it take to fix the systems (if anything goes wrong)?	

		23. What will you do while waiting for the systems maintenance? Do you use your previous source of lighting again?	
Market demand	4. How do you know about HIVOS/PLN program? 5. How do you know about PV technology at the first place? 6. How do the villagers feel about the technology?	24. How do you know about PV technology? 25. How do you know about HIVOS/PLN program? 26. When did you start to use the technology? 27. What makes you want to use PV technology? 28. What do you think needs to be improved from current programs or the technology?	1. Do you know about PV technology? 2. Do you know about HIVOS/PLN Program? 3. Do you have any problem with your current source of lighting? 4. Are you satisfied with your current source of lighting? Yes/no please explain 5. What should we offer you so that you want to use PV technology instead of your current source of lighting (fossil fuels)?
Social, Behavioral, Cultural	29. How long have you been a village leader? 30. How did you become the village leader? Elected by the people or based on the family? 31. How many people live in this village? 32. How is the technology change your village? 33. Do you see that the technology can be accepted with the local culture/norms?	28. How long have you lived in this village? 29. How does the technology change your life /your family? 30. Will you recommend the systems to other people/relatives in this or the other villages?	6. What are the reasons you do not use PV technology? 7. Do you see or have any relatives using the technology? 8. What are the reasons you do not join HIVOS/PLN program? (in case the villagers aware of the program) 9. Is there any chance that you want to change your current source of lighting to PV technology?
Governmental/Institutional	31. Are there any regular meetings with the villagers to discuss PV technology? 32. Are there any regular meetings with HIVOS/PLN team?		
Network/Partnerships	[none]	[none]	[none]
Environmental	[none]	[none]	[none]

9.3.1.4 *Experts interview*

1. As a PV company, do you face barriers as seen in the framework? Please refer to the classification and description of the barriers.

2. How do you rate the levels of barriers?

    - 1 = Not significant
    - 2 = Slightly significant
    - 3 = Moderately significant
    - 4 = Very significant
    - 5 = Extremely significant

- **Infrastructure: 1/2/3/4/5**

- How do you see the barriers on infrastructure affecting your business?
- How is the involvement of key partners in solving infrastructural barriers?
- Do you think that it is necessary to hire third parties or to have partners to solve infrastructure barriers?
- How important are the partners to solve infrastructure barriers and continue your business?
- Can you do your business without them?

- **Financial barriers: 1/2/3/4/5**

- How do you see financial barriers affecting your business?
- How do you collect your revenue?
- Why don't you / why do you collect the revenue by yourself?
- Is it because of high risk of payment default / is it because of part of service provider model?
- How do you see the risk of default payment by the end users in your customer segmentation?
- How do you solve these problems?
- Is it necessary to transfer the risk of payment default to the third party? Why or why not?

- **Market demand: 1/2/3/4/5**

- How do you see the barriers on stimulating market demand amongst your customers?
- How is the involvement of the third parties or your partners in stimulating the market demand amongst your customers?
- Can you stimulate the demand without having your partners?

- **Social, Behavioral, Cultural: 1/2/3/4/5**

- How do you describe the barriers on Social, Behavioural, and Cultural?
- How do you build your relationships with your customers? Is through Call center, Customer care, or Energy center?
- How do you do your operational activities? Do you rely on your partners to do the operational activities? Such as: *marketing, distribution, sales, installation, maintenance, and services*

- **Environmental: 1/2/3/4/5**

- How do you describe the environmental barriers?
- How do you manage your old/faulty products? Do you recycle the products yourself ? or do you have any partners to do it?
- Why do you choose to recycle yourself?

- **Technical: 1/2/3/4/5**
- Do you think that every company has its own unique technical barriers? Do you think that these barriers need to be solved with specific solutions?

- **Investment: 1/2/3/4/5**
- How do you describe the level of investment barriers?
- Is it true that the only way to solve it is to find the donors/investors/grants? Is there any other way to solve it?

- **Human resources: 1/2/3/4/5**
- How do you describe the level of human resources barriers?
- Do you face barriers on human resources only in technicians or also in managerial level? How do you solve it?
- Is it true that training, hiring third-party for training, and increase the employment pool are the only solution to solve this barrier? If not, can you add any other solutions?

- **Government/institutional: 1/2/3/4/5**
- How do you describe the level of governmental/institutional barriers?
- Do you think lobbying activities are the only solution to overcome this barrier? If not, can you add any other solutions?

- **Network/partnerships: 1/2/3/4/5**
- How do you describe the level of network/partnerships barriers?
- Do you think to choose the right partners by having criteria for the selection are the only solution to overcome this barrier? If not, can you add any other solutions?

3. Any other barriers that you would like to add?
4. In general what do you think about the framework? Is there anything that needs to be improved?

9.4 Details of the case study

9.4.1 SunnyMoney

9.4.1.1 SunnyMoney's barriers

In this section, we will look deeper into the significance of each of the barriers which obtained from the literature earlier, in the context of SunnyMoney's business. SunnyMoney describes on each of the barriers and how the company overcomes those barriers as the following:

Infrastructure

SunnyMoney deems barriers in the infrastructure as an extremely significant towards its business. SunnyMoney quotes, "*Majority of their customers lives in remote areas with limited infrastructure development which could be a challenge for their business operations, such as distribution*". In order to face these challenges, SunnyMoney focuses their business model in a strong distribution channel by using the local agents. These local agents are independent local entrepreneurs which interested in selling SunnyMoney's solar products. Currently, SunnyMoney supports over 600 agents across East Africa whose income has increased by 30% on average. In this way, SunnyMoney makes its products to be available even in the remotest area.

SunnyMoney describes, in the case of Malawi which has up to six regions at the moment, there are two salespeople, fully employed by SunnyMoney, who handle up to three districts per person to go out to the village and recruit local agents. Each of one district could have up to five local agents which are located in the

trading centers surrounded by the villages. The sales team is responsible for selling a business package to the agents, delivering and distributing the products to the agents, and promoting the agents during marketing activities in the village. In short, the SunnyMoney's sales team is responsible for managing the agents. These agents are important for SunnyMoney business model since these are the ones who make the products available and close to the end users. These local agents are responsible for the sales of SunnyMoney Products.

Investment

SunnyMoney considers the issues related to the access of investment to be very significant in the beginning. SunnyMoney quotes, *"Currently there is much interest from the donor community to come and help. However, before then, it was difficult to get direct investment support."* SolarAid, as SunnyMoney parent's charity organization, is responsible for SunnyMoney's source of funding. It means SunnyMoney does not have to search their own funding. All the donors intended for SunnyMoney needs to go to SolarAid first.

Financial

SunnyMoney deems the financial barriers as extremely significant. Quoting SunnyMoney, *"Financial barrier remains the greatest challenge in the adoption of new technology. There is much interest from customers to switch to PV technology, but they cannot afford the system".* It happens because of two reasons. Firstly, the majority of SunnyMoney's targeted users live less than one dollar per day. Secondly, the interest rate provided by the banks is high, which could reach up to 40% interest rate per month. This great interest could be barriers for SunnyMoney's local sales agent to stock up and distribute the products to the end users. Thus, financial innovations are required to overcome these barriers in order to tap into these types of market.

To overcome the financial barriers for the end users, SunnyMoney provides a Pay-As-You-Go (PAYG) scheme for bigger systems. The PAYG scheme applied by SunnyMoney, gives the end users to have a more flexible payment. The payment is made with cash through the sales agent. Each payment done by the end users will give 30 days of light. The payment could be made up to five installments which means it gives the end users time to pay the systems up to five months. SunnyMoney uses a centralized system to save all the customers data. If the end-users fail to make the payments, the systems will automatically switch off.

For the financial barriers faced by the local sales agent, Sunny Money works with a financial institution named FINCOOP to provide soft loans for the agents. Quoting SunnyMoney, "*FINCOOP offers a soft loan with 3.5% interest rate per month calculated on reduced balance, which is 42% per year, while other banks offer 40% interest rate per month with the straight-line method."* In this way, it enables the local sales agents to take soft loans to buy SunnyMoney's products with so much lower interest rate from FINCOOP.

Human resources

SunnyMoney considers human resources as a moderately significant barrier towards its business. SunnyMoney quotes,*"Most of production and technical capacity is centralized in the countries with manufacturing capacity."* To overcome this challenge, SunnyMoney manufactures its products in China, where the manufacturing capacity is more advanced than in Malawi. SunnyMoney also imports the products from different brands which have good quality with an affordable price to avoid manufacturing process complexity.

Another thing that SunnyMoney does to overcome this challenge is by having a centralized repairing process which happens only in SunnyMoney's headquarters. It means that any systems which require a big repair will need to be sent back to the office. This could be an advantageous procedure since the number of skilled and trained technicians will be limited as well as it will make the quality control much easier.

Technical

SunnyMoney considers technical barriers as moderately significant. Lack of standardization in the country resulting a lot of cheap and low-quality products available in the markets, which could lead to the disadvantages for the end-users. In order to overcome these challenges, SunnyMoney only sells the products

that are approved by Lighting Africa. Lighting Africa is an organization founded by the World Bank to support the implementation of PV technology in Africa (Africa, 2017). One thing that this organization does is to protect consumers from poor-quality products by developing quality standard and testing methods. They also publish the products which qualified based on their standards which help PV companies, like SunnyMoney, to choose good quality products at an affordable price to be sold to the market so that it will not lead to the users' disappointment because of the poor quality of the products.

Market demand

SunnyMoney sees barriers in the market demands as extremely significant towards its business. SunnyMoney believes that the demand could be created after effective promotion and education of the available products are being done to the end-users SunnyMoney quotes, *"Most of our targeted users have an idea that solar exists as the source of energy, but they do not have much information about it. We need to educate them first, get their interest and desire by providing knowledge about the product before we sell the products."*

In order to provide enough information about PV technology, SunnyMoney includes education and effective marketing activities as key elements in its business model. Education to the end-users is done through the SunnyMoney school campaign programs. SunnyMoney works together with Malawi Ministry of Education to collaborate with the school head teachers, as a trusted person in the community, to be the agent of change for PV technology. The head teachers help to connect any development coming to the area, which includes PV technology, to the community. SunnyMoney quotes*, "The teachers, help us a lot in providing education to the community members through educative community meetings."*

Effective marketing activities are done through community meetings in collaboration with the village leaders as the trusted person in the community. These village leaders have a major role in helping SunnyMoney sending the right message to the community. Not only that marketing activity but also education about PV technology was provided during the community meetings. SunnyMoney believes that once the education and the products are properly introduced, there is a true understanding of the community on the benefits of adopting PV technology. Often, the price is no longer a major problem as long as the products meet the expectations of the customers regarding quality, such as lighting time, brightness, and durability of the products.

Social, Behavioral, Cultural

SunnyMoney considers social, behavioral, and cultural barriers as moderately significant towards its business. Currently, Malawi governments do not have the capacity to trace or to stop fake products being sold in the market. This could influence the growing skepticism towards PV technologies and PV companies even those who provide good-quality PV products. However, SunnyMoney believes that what matters most are the awareness messages and the communication channels used in introducing the technology to the community. SunnyMoney adds that it is important to use structures that already exist and are trusted by the locals. The role of village leaders, as well as the head teachers, are considered important in SunnyMoney business models since those are the people who help SunnyMoney to secure the users' trusts on SunnyMoney's products. SunnyMoney quotes, *"We drive our business based on trust, which is difficult for other companies to manage to get into this model."*

Governmental/Institutional

SunnyMoney sees the issues related to the government and other institutions as extremely significant towards its business. SunnyMoney describes that the flexibility of the government policy and the perce ption of the political leaders on PV technology are critical factors in doing PV business. If these two important factors are not friendly enough, it will be challenging for PV technology to diffuse into the current market.

To overcome these barriers, SunnyMoney actively participates in the lobbying activities to encourage the government in developing energy policies in favor of PV technology. The lobbying activities are done through three different ways. Firstly, SunnyMoney actively involves in the lobbying activities through formal meetings. Secondly, together with other solar players, SunnyMoney submits a recommendation to the department of solar energy to show them solutions for energy poverty in Malawi. Thirdly, SunnyMoney collaborates with the organization which works closely with the government to use this organization's ability to speak to the government on behalf of SunnyMoney. As a result, SunnyMoney helped to maintain zero VAT in Kenya and Tanzania, while in Malawi, SunnyMoney successfully made the government to exempt the duties for PV technology. Currently, SunnyMoney works on the exemption of 16.5% VAT in Malawi.

Network/Partnerships

SunnyMoney considers the problems related to the networks and partnerships as very significant for its business. SunnyMoney describes that there are only a few dedicated actors who are interested in PV technologies, especially for rural electrification. It is because investing in PV technology is considered complicated and risky. Moreover, there are only a few examples of business models that are able to generate profit and attract big investors, especially in developing countries. Therefore, the strategic partnership needs to be developed in order to overcome these problems. SunnyMoney quotes, "*Strategic partnership is a critical component that can accelerate adoption and distribution of the products."*

In order to have a strategic partnership, SunnyMoney has certain criteria for the companies which are chosen as SunnyMoney's partners. Firstly, SunnyMoney sees if the partnering companies could fit into SunnyMoney's objectives, which one of them is to drive sales through the agents. Secondly, SunnyMoney considers the location of the partnering companies. It is important because SunnyMoney does not have the capacity to go everywhere. Thus, a partnership with companies which are located in the districts or much closer to the end-users is important to support SunnyMoney's activities. Lastly, SunnyMoney considers the experiences of the companies to choose them as SunnyMoney's favorable partners.

Environmental

SunnyMoney deems environmental issues as extremely significant barriers towards its business. In order to overcome the barriers related to the environmental issues, SunnyMoney only uses high-quality materials for their products. As SunnyMoney quotes, *"It is important to have high-quality lamps with long battery lifespan which works positively to the environment."* Moreover, together with SunnyMoney's partnering company, they established local recycling process in Malawi for all old and faulty products in SunnyMoney's warehouse.

9.4.1.2 SunnyMoney's business model

Value proposition

SunnyMoney focuses on providing rural families in Africa with clean and affordable energy access through good-quality solar products. These good-quality and affordable solar products are obtained from different PV brands as well as SunnyMoney's products manufactured in China which is certified and approved by Lighting Africa. SunnyMoney focuses on selling solar lantern with the price from $5 to $10 to a bigger solar home system with the price range of $87 to $141.

Customer interface

- ***Customer segments:***

  SunnyMoney's customer segment is the local entrepreneurs who own shops and interested in selling PV products. These entrepreneurs later called the local sales agents. These agents are located in the trading center surrounded by the villages. Thus, these agents are easily accessible by people who live in the villages.

Although SunnyMoney does not sell the products directly to the end users, SunnyMoney needs to understand the main targeted users of the products. It is important because SunnyMoney is responsible for promoting the products as well as the agents to the remote villages to increase the awareness of the users of PV technology. The main targeted users for the products are the rural customers who live in the rural villages and do not have access to the grid. Most of these users are farmers who earn less than one dollar per day. They use Chinese torches powered by dry cells battery as the light source since kerosene becomes scarce. These targeted users spend about three dollars per month on batteries.

- ***Customer relationship:***

  SunnyMoney develops a personal customer relationship through dedicated customer services and call centers for both local agents and the end users. Moreover, a dedicated salesperson is assigned to manage a group of agents. A personal connection is also established through the sales team. The sales team is employed by SunnyMoney. This team is responsible for recruiting, maintain, and service these agents. Every once in three weeks, the salesperson visits the agents to stock up the products, to collect or fix faulty products, and to collect payment. Moreover, this team is also responsible for doing marketing activities in the village to introduce SunnyMoney products to the targeted users. The sales team could collect feedbacks from the users during the community meetings or through the agents to develop SunnyMoney's services and products.

- ***Channels:***

  SunnyMoney uses three different channels to sell and distribute its products. Firstly, SunnyMoney uses sales team to promote the products to the targeted users as well as to recruit local agents who will be an important distribution point for SunnyMoney's products. Secondly, SunnyMoney relies on local sales agents to sell the products to the targeted users. These agents are responsible for providing the right amount of SunnyMoney's products based on the customers' needs. Lastly, SunnyMoney's school program and community meetings help the company to introduce the products and services to the targeted users through highly trusted person such as the head teacher or the village leader.

Infrastructure management

- ***Key partners:***

  In order to overcome barriers to SunnyMoney's business and to have a sustainable and profitable business. SunnyMoney has established strategic partnerships with different companies and institutions. SunnyMoney works with different PV companies to provide different products with different brands. SunnyMoney also collaborates with a PV manufacturing company in China to develop its own products which currently is in the introduction phase. The company has established partnerships with Lighting Africa to make sure all the products are certified. Furthermore, SunnyMoney works together with SolarAid to get the investment needed for the business.

  SunnyMoney collaborates with a local company for its recycling process. It also has established a partnership with a local financial institution named FINCOOP to provide soft loans with much lower interest rates to the local sales agents.

  To promote SunnyMoney's products and services, SunnyMoney works with local agents, NGOs, local schools and the government (Malawi Ministry of Education). The company also relies heavily on the agents' networks for the distribution of its products. The partnerships with other institutions are important since these institutions could help SunnyMoney to educate and increase the awareness of the targeted users on the advantages of solar technology.

- ***Key activities:***

  SunnyMoney's business solely relies on seven main activities which are importation, distribution, sales, marketing, sales, and services, as well as recycling.

- ***Key resources:***

  Based on the SunnyMoney's main activities, SunnyMoney's key resources are sales team, distribution channel, and service team. These key resources are important in SunnyMoney's business to sell, distribute, and promote the products as well as to provide the after-sales services to the users.

Financial aspects

- ***Revenue streams:***

  SunnyMoney's revenue streams solely depend on the sales of the products. The revenue is received in cash from the sales of the products made by the local agents. However, since SunnyMoney's revenue is highly dependent on the agents, SunnyMoney is also responsible for these agents' revenue. Thus, SunnyMoney, in collaboration with FINCOOP, provides a soft loan with 3.4% interest rate per month. This loan is expected to help the agents' cash flow and maintain the stocks of SunnyMoney's products based on the market demand. SunnyMoney also provides a PAYG system for the end users to have a flexible payment scheme through the agents. Thus, SunnyMoney is indirectly ensuring its revenue streams in two ways which are by ensuring payment of the end-users to the agents and by ensuring the local agents could afford to buy enough stocks in the shop.
- ***Cost structures:***

  The most important costs incurred while operating SunnyMoney's business model are operation and distribution cost, product cost, and importation cost

9.4.2 SunTRansfer (Ethiopia)

9.4.2.1 SunTransfer (Ethiopia)'s barriers

In this section, we will look deeper into the significance of each of the barriers which obtained from the literature earlier, in the context of SunTransfer Ethiopia's business. SunTransfer describes on each of the barriers and how the company overcomes those barriers as the following:

Infrastructure

SunTransfer considers issues related to the infrastructure is moderately significant towards its business. SunTransfer describes that there is a lack of access in many rural homes due to poor road and infrastructure, especially during the rainy seasons, many roads are not easily accessible by car. Moreover, some of the people who live in rural areas do not have enough information regarding the use of solar systems. Thus, it could be a challenge for SunTransfer to distribute and deliver its products to the end users because it becomes too costly to reach these remote customers.

To overcome these challenges, SunTransfer works together with the local microfinance institutions (MFIs) which operate in rural areas. These MFIs have experience on handling rural customers since they are also selling and lending other products based on the rural customers' needs such as fertilizers and seeds for the farmers. SunTransfer relies on the networks of MFIs to promote SunTransfer's products as well as to make them available for the targeted users. An agreement is made between SunTransfer and MFIs on the list of products as well as its discounted prices. Most of these institutions are located in the marketplace and cover an area with the distance up to 30 km or two hours travel from the village. With this method, SunTranfer is able to cover an area with a distance up to 350 km away from the head office in the capital city with a minimum cost.

Investment

SunTranfer deems issues related to the investments as very significant barriers towards its business. SunTranfer quotes, *''There were limited grant opportunities and limited access to loans locally due to collateral requirements."*

In order to have enough investment to run the business, SunTranfer enlarged its networks to the international partners and donor to secure some funding or grants. SunTranfer works together with a German

NGO named Stiftung Solarenergie or Solar Energy Foundation as well as other international institutions to secure some loans and grants.

Financial

SunTranfer looks at the financial barriers as very significant towards its business. Quoting SunTranfer, *"Majority of our products' users are people who live in the rural areas, they have very limited lending or credit access from the financial institution."*

To be able to sell the products to the targeted users, SunTranfer relies on the MFIs to assess users' financial condition in order to buy bigger systems. For the bigger systems, SunTranfer provides a Pay-As-You-Go scheme with a flexible payment or installment method. The payment is made by cash through the MFIs. The MFIs handle a SunTranfer device which could generate unique code after the payment is made by the users. The users then could input the code to the systems to have the systems work. The payment scheme could be made flexible based on the agreement between the MFIs and the users. Currently, the most common method is the quarterly installment. If the users do not pay, the systems will be turned off. The systems could be taken out after 15 days since the systems go off. However, this payment default is not yet happened in the case of SunTransfer business.

Human resources

SunTranfer sees the issues related to the availability of skilled human resources is insignificant. SunTranfer quotes, *"The minimum requirement for the technicians is to have a diploma or certification in the basic electricity."* Currently, there are enough candidates for technicians available locally. Nevertheless, SunTranfer could not employ them due to its current business size and financial constraints.

Technical

SunTransfer deems technical barriers as slightly significant towards its business. SunTransfer quotes, *"There are a lot of low-quality and illegal products in the market, yet there is limited capability on quality assurance/assessment and quality verification from the government to standardize the solar products in the market."* In order to overcome these barriers, SunTransfer works together with Solar Association to address these issues to the corresponding government officials.

Market demand

SunTransfer looks at the issues related to market demand as extremely significant barriers towards its business. SunTransfer quotes, *"The targeted users are quite familiar with solar technology since the government is doing similar activities. Some of them already have some knowledge about the technology. However, we still need to introduce our products, the types of technologies, its lifetime and how to use it. In general, we still need to demonstrate it."*

In order to increase the awareness of PV technology to the targeted users, SunTransfer reaches the rural communities by working together with the MFIs to promote its products through community gatherings, market days, or any of the MFIs events. Moreover, other organizations such as Lighting Africa and Lighting Global help to promote solar energy in general. In this way, it helps to educate the targeted users about the benefits of solar technologies and creating the demand for solar products.

Social, Behavioral, Cultural

SunTransfer considers social, behavioral, and cultural barriers as moderately significant towards its business. As explained earlier, there are a lot of low-quality and illegal products in the market due to lack of standardization in the country. This condition could lead to the users' disappointment and lack of trust in solar technology. As SunTransfer quotes, *"Sometimes, people who live in the rural areas do not care much about the quality of the products. They just buy the cheapest products available in the market which are not equipped*

with the maintenance and after-sales service. Often, after two or three months the systems are broken. This is dangerous for the market because these customers will see that the solar products will not work. In the end, it will influence our revenues although we provide much better products, warranty, and after-sales service."

In order to overcome these challenges, SunTransfer reaches the targeted users through the MFIs. SunTransfer approaches the MFIs and educates them that SunTransfer provides different products and services from those illegal products in the market. SunTransfer integrates four key elements which are top-quality products, PAYG scheme, technical installation, two years warranty and after-sales service which are important elements in its business model to be able to operate in the rural energy market. In this way, SunTransfer earns trust from the MFIs as well as from the end users towards its products and services.

Governmental/Institutional

SunTransfer looks at the issues related to the government, or other institutions are extremely significant towards its business. Currently, there are some existing policies in favor of solar technologies, such as duty exemptions. However, the implementation of this policy is another issue. There are this some challenges related to the implementation of the policy. SunTransfer quotes, *"Currently we are still struggling to get the duty free. The government asks several requirements that are not easy to fulfill to be able to get the duty exemption."* This condition could be an issue towards SunTransfer business because it could delay the importation process.

To overcome this issue, SunTransfer, together with other solar companies, establishes Solar Association. This organization is expected to push the government to develop and implement the policies in favor of solar technologies. The solar association initiates meetings or workshops with the government officials to explain the problems they faced related to solar technologies and rural electrification. However, at the moment, this organization is still not strong enough to influence the government in favor of its side.

Network/Partnerships

SunTransfer deems the problems related to the networks and partnerships as very significant for its business. SunTransfer describes that currently there is a lack of collaboration among the key stakeholders. It is worsened by newly initiated Solar Association which still do not have enough power to influence the government in favor of its side. To overcome this challenge, SunTransfer keeps pushing the solar association to send this issue to the responsible government.

Another thing that SunTransfer have done to overcome this challenge is by establishing a strategic partnership with both local and international partners. SunTransfer selects these favorable partners based on SunTransfer's previous experiences working with these companies or organization, such as current assembly partner, manufacturing partners, and, Solar Foundation. SunTransfer also looks at the ability of its partners to reach rural customers who are its targeted users. MFIs are chosen to be SunTransfer's distribution partner since it could provide SunTransfer, access to the rural customers.

Environmental

SunTransfer considers the environmental issues as moderately significant barriers towards it business. It is due to the fact that the systems are still new and SunTransfer's products are not yet at the end of its lifetime. However, SunTransfer realizes that this could be problems in the near future. Thus, currently, SunTranfer collects the old batteries during the replacement time and keeping them in the office while searching for the solution.

9.4.2.2 SunTransfer's business model

Value proposition

SunTransfer's mission is to reduce the issues related to lack of energy access by providing electricity to rural communities with high-quality solar power at an affordable price. SunTransfer offers an energy solution which includes special flexible payment schemes, installation, warranty, as well as reliable maintenance and services even in remote areas

Customer interface

- ***Customer segments:***

  SunTransfer's customer segment is the local microfinance institutions. These MFIs acts as SunTransfer's main focal distribution points which connect the company with the end users in rural areas. Most of these institutions are located in the marketplace. The distance of this institution to the village could reach up to 30 km or two hours travel time. SunTransfer also heavily relies its marketing activities as well as end-users' assessments on the MFIs.
- ***Customer relationship:***

  SunTransfer develops a semi-personal customer relationship with its customer. At the moment, there is no dedicated call center which connects the company with the end-users. However, SunTransfer shares its office phone number and contact address to communicate with its end-users. SunTransfer relies on the MFIs networks for its customer relationships. In this way, SunTransfer is able to collect feedbacks from the end-users through either direct calls or the MFIs to improve their products or services.
- ***Channels:***

  SunTransfer sells the products through the MFIs which has huge networks to rural customers. The MFIs stock up small systems such as lanterns. Thus, anytime the end-users want to buy the lanterns, they could come to the MFIs and directly get the products. The bigger systems, such as solar home systems, are available based on request through the MFIs. SunTransfer is responsible for delivery and installation for bigger systems. When the end-user is interested in buying an SHS, the MFIs could request the systems to SunTransfer's office. Then, SunTransfer will deliver and install the systems directly on the customer's house.

Infrastructure management

- ***Key partners:***

  One of the important elements in SunTransfer's business model is having strategic partners. *SunTransfer quotes, "In the off-grid energy sector which is dominated by multinational companies, close business relationships with strong and well-connected international partners are very important."* SunTransfer was able to grow because of the support from Stiftung Solarenergie (Solar Foundation).

  Moreover, SunTransfer has established partnerships with different companies, institutions, and organization to support its business and operation. SunTransfer collaborates with Solar Technology Manufacturing (STM) to assemble solar products from NIWA, a Hongkong-based company which produced solar lantern and small plugs for SHSs. SunTransfer also imports several parts for bigger systems from different companies in various countries, such as China, Bangladesh, and Germany. SunTransfer also works together with Solar Association in Ethiopia to overcome some issues related to the government or any lobbying activities.

  The local microfinance institutions could be the most important partners for SunTransfer. MFIs have connected the company with the end-users who need SunTranfer's technologies and services the most. The MFIs could act both as SunTransfer's distribution channel and marketing partner.

- ***Key activities:***

  SunTransfer's business solely relies on five main activities which are importations, distribution, sales, installation, services, payment and waste collection.

- ***Key resources:***

  Based on the SunTransfer's main activities, SunnyTranfer's key resources are sales force, and service team. These key resources are important in SunTransfer's business to sell, distribute, and promote the products as well as to provide the after-sales services to the users in remote areas.

Financial aspects

- ***Revenue streams:***

  SunTransfer's revenue streams solely depend on the sales of the products. The revenue is received in cash from the sales of the products made by the MFIs. The revenue is received after the products in the MFIs are sold to the end users. Thus, the MFIs do not need to pay for the products upfront. In this way, the MFIs could stock up SunTransfer's products based on the market demand without having capital up front.

- ***Cost structures:***

  The most important costs incurred while operating SunTransfer's business model the imports of the products, as well as operation, and distribution costs.

9.4.3 SunSawang

9.4.3.1 SunSawang's barriers

In this section, we will look deeper into the significance of each of the barriers, which obtained from the literature earlier, in the context of SunSawang's business. SunSawang describes each of the barriers and how the company overcomes those barriers as the following:

Infrastructure

SunSawang considers the issues related to infrastructure as extremely significant. SunSawang describes that its targeted users live in the mountainous areas and they do not have access the grid. Some areas require the people to travel up to two hours to the grid areas, and some others might be even further.

To overcome the infrastructural barriers, SunSawang's business relies on the local networks of village leaders, sales representatives, local technicians, and local government officials which are accessible by the people who live in rural areas as well as by SunSawang team. One local sales representative is assigned in each of the sub-districts. Each of the sales representatives covers an area of a maximum distance of two hours travel time. These sales representatives operate based on commission. Local technicians are also available in the village which is employed based on commission. By having the local technicians, SunSawang ensures a year-round service, creates jobs, lower its travel overhead costs, and gain trusts within the community.

Investment

SunSawang looks at investment barriers as extremely significant. Based on History, SunSawang was established as a social enterprise to overcome the challenges of BGET which require the organization to keep raising additional funding. However, SunSawang has currently not generated profit yet. SunSawang also describes that it is not easy to get the funding. SunSawang quotes, *"Currently, there are no commercial loans from the banks that we are able to get, because of the nature of SunSawang's business."* Therefore, SunSawang still relies on grants and philanthropic funding to operate its business while keep maintaining the direction of the business to be financially independent in the future.

Financial

SunSawang deems the financial issues for the end-users as extremely significant barriers towards its business. The main targeted users of SunSawang's SHS are mostly the low-income people who live in rural

areas and earn approximately $2.50 per day. This type of customers do not have access to credits, and it is worsened by the fact that the MFIs are almost non-existent in Thailand. Thus, most of the targeted users could not afford to buy the systems in cash.

To overcome this challenge, SunSawang provides five years payment plan for the restored SHS with existing solar panels from the government as well as the complete new SHS. The payment is made once in a year in a flexible time through SunSawang sales representatives or the local technicians.

Human resources

SunSawang sees issues related to the availability of human resources as slightly significant. SunSawang describes that the main qualifications to be able to be on the company's team are to be able to speak the local language. Moreover, SunSawang explains that the company does not necessarily look at the education level, but it also considers the work ethics, especially for the technicians. In order to have good human resources for the company, especially the technicians, SunSawang provides effective in-house training for its employees. The training is important in order to ensure the quality of its products and services. Also, SunSawang tries to balance out the number of male and female in its team.

Technical

SunSawang considers technical barriers as insignificant. SunSawang describes that it is important to have an organizational leader with a good engineering background to handle any technical issues the company faces in the field. SunSawang quotes, *"Our team has strong technical knowledge and experience to handle any technical issues which could influence or business."*

Market demand

SunSawang sees the issues related to market demand as insignificant. It is due to the fact that majority of the targeted users are aware of solar technology. They have been exposed to large solar home systems from the Thailand's government's program since 2004. Thus, the lack of awareness of the technology from the users' side is no longer an issue for SunSawang. SunSawang quotes, *"We do not have to make the targeted user' aware of the technology. But, it is important to make them aware of our system and services to let them compare with other competitions and other options that they have".*

In order to make sure that SunSawang is ahead of the competition, the company elaborates its marketing and promotional strategies. SunSawang promotes its products through villages and school. SunSawang goes to the villages to promote its products and services with permission from the village leader. Moreover, SunSawang offers a promotional price for the first five customers who signed up for the systems in the new areas. Sales representatives or local technicians also help to promote SunSawang's products since they receive commissions for getting people to register for SunSawang's system. In this way, SunSawang maintains the demand for the products high in the market.

Social, Behavioral, Cultural

SunSawang considers social, behavioral, and cultural barriers as slightly significant towards its business. In 2004, the Government of Thailand (GoT) invested $250 million to install SHSs for off-grid communities for free. The system was designed to electrify two 10-Watt fluorescent lamps for six hours and a 14-inch television for two hours per day. However, United Nations Development Programme (UNDP) reported that 80% of the systems were outdated or broken because of low-quality products and the failure of the GoT to have and implement a maintenance plan.

SunSawang describes that the main issue for the company is the customers' trust. In order to gain trust from the customers, SunSawang relies on local leadership of village leaders as well as the local networks of local sales representatives and local technicians to promote its products and services. Moreover, SunSawang products are equipped with warranty. The solar lantern is equipped with two years warranty which

if anything happens to the systems, the customers will get the replacement for free. For the SHS, SunSawang offers installation and a five-year maintenance contract to reconcile the villagers and SHS after the failure of the government's program. The company makes sure that it delivers its promises to the targeted users after the installation of the system. This could be achieved by having proper maintenance and services networks in the village, as well as, collecting any feedbacks from the targeted users to improve SunSawang's products and services.

Governmental/Institutional

SunSawang describes the issues related to the government and other institutions as insignificant towards its business. SunSawang describes that the company does not receive any incentives from the government. It is even worsened by the fact that SunSawang could not register the company as a social enterprise with a lower tax since there is no policies offer this benefit. SunSawang adds that the company does not involve in any lobbying activities because it is not the company's expertise. In general, although the company does not receive any benefits from the government, SunSawang sees this condition as an opportunity for its business which could be developed in the future. For now, the lack of favorable incentives does not give any impacts towards SunSawang's business.

Nevertheless, SunSawang sees the government program could be one of its threat. It is because the government could provide free RET or SHS in rural areas. SunSawang quotes, "*It is not the policy which affects our business. It is the free renewable energy program in rural areas which could have an impact on our business negatively.*"

Despite all of these challenges, SunSawang keeps the relationship good with the government. It is due to the fact that SunSawang could not reach new markets without an agreement with the GoT.

Network/Partnerships

SunSawang deems the problems related to the networks and partnerships as insignificant. SunSawang believes that it is important to have local networks and good partnerships in order to make its business possible. SunSawang describes that all the supports have been secured from the key stakeholders.

Environmental

SunSawang looks at the issues related to environmental as insignificant. It is due to the fact that SunSawang does not manufacture the systems and components by itself. It leaves SunSawang with the responsibility to collect and reuse the waste of its systems. At the moment, SunSawang collects the old batteries and old inverters. For the components that could be fixed in-house, SunSawang will sell these refurbished components back in the market at a lower price. For the components that are broken and could not be fixed, SunSawang collects and sell them to local secondhand shops.

9.4.3.2 SunSawang's business model

Value proposition

SunSawang offers clean and affordable energy through solar technology for low-income people who live in rural Thailand by providing five-year warranty and payment plan.

Customer interface

- ***Customer segments:***

  SunSawang sells the systems to the end-users through the local sales representatives or local technicians who receive a commission for every sales they made. The majority of the users are farmers who live in a family which consists of five family members and earns about $5.000 per year per households in average. It means that the targeted users live in average $2.50 per day per person. The targeted users

do not have access to the grid as well as to the credits or financial institutions. The targeted users live closely. One village could have 20 up to 100 houses. Villages with 80 or more houses or customers interested in SHS will be first targeted and evaluated to be put in SunSawang's service area. In other areas, where there is less than 80 houses or customers interested in SHS, SunSawang will promote smaller systems such as solar lanterns to the areas.

- ***Customer relationship:***

  SunSawang offers a personal customer relationship through dedicated local technicians which responsible to maintain the systems as well as through customers' surveys and interviews. If anything happens with the systems, the local technicians who are operate based on commissions are the ones responsible for the systems in the village. Surveys and interviews are actively conducted to the customers after one year of installation to see if the customers are happy with the systems.

- ***Channels:***

  SunSawang sells the products directly from its office in the town and through local technicians or sales representatives in the village who receive commissions for every new customer registered for SunSawang's system. After the targeted users register for SunSawang systems, the installation will be done by the installation technicians who are based in the town and fully employed by SunSawang.

Infrastructure management

- ***Key partners:***

  SunSawang develops three different partnerships to help the company run its business. Firstly, SunSawang has established a partnership with the local/international investors and donors as the source of funding. Secondly, SunSawang offers volunteer activities to help the company with specific issues. Lastly, SunSawang develops partnerships with the collaborators to promote the company and give SunSawang national as well as international exposures through the collaborators' networks.

  Moreover, SunSawang relies on both local and foreign manufacturing companies and suppliers to provide SunSawang with good-quality components for its system. SunSawang supplies its components from local companies such as solar panels and batteries, Chinese companies for some of the solar panels and inverters, and the US Company for the charge controller.

- ***Key activities:***

  SunSawang combines many activities in order to make its business model works. SunSawang main activities consist of several tasks which are QA and importation, sales and marketing, installation and services, payment collection and training.

- ***Key resources:***

  Based on SunSawang's main activities, SunSawang needs several key resources which are the sales representatives, installation team, and local technicians. These key resources are valuable for SunSawang's business and operation to assess the quality of the products, sell, install and maintain the systems as well as to make sure about the revenue collection from the users.

Financial aspects

- ***Revenue streams:***

  SunSawang's revenue stream solely comes from the sales of the products. The customers who are interested in SunSawang's products could come to the office in the city or order the products through the local technicians or local sales representatives in the village. SunSawang provides two types of the payment system. Firstly, the new and complete SHS could be paid in cash at a lower price, which is $780. Secondly, SunSawang also provides a five-year payment plan. The new and complete SHS systems could be paid $240 per year in a five-year installment, and the restored SHS with solar panel from the government could be paid $128 per year in a five-year payment plan. The payment is collected once a year through the local technicians or the local sales representatives in the village. SunSawang and these local technicians or sales

representatives have the list and payment contract of the people who are in the payment plan. SunSawang keeps the connection with these local technicians or these local sales representatives on a regular basis and maintains the good relationship with them to ensure the payment of the systems to SunSawang's team. If the customers fail to pay for the systems on time, SunSawang gives an injury time up to two months. After that, the system will be taken out. However, it rarely happens at the moment.

- ***Cost structures:***

  The most important costs to be incurred to operate SunSawang's business are the cost of the equipment or the products because SunSawang needs to pay everything upfront and the operational costs

9.4.4 Devergy

9.4.4.1 Devergy's barriers

In this section, we will look deeper into the significance of each of the barriers, which obtained from the literature earlier, in the context of Devergy's business. Devergy describes each of the barriers and how the company overcomes those barriers as the following:

Infrastructure

Devergy looks at the issues related to the infrastructure as slightly significant barriers towards its business. It is because most of the locations where Devergy operates its business are reachable by buses. Devergy has a massive network around the country which connects the company's logistics with the public transport to reduce the cost of the shipments. Moreover, Devergy explains that the penetration of mobile network increases on a daily basis which leads to fewer and fewer communities are off the network. Having fewer communities that are off the network is good for Devergy's business because the payment of Devergy's electricity bundle solely depends on the mobile network by using mobile money. Thus, it is nice to have mobile signal reaches the rural areas. Also, by using mobile money, Devergy enables the cost saving for the company because there is no need to collect the payment all the way to the village.

The physical infrastructure, such as road access to the village, does not affect Devergy's business much because Devergy has good network close to the targeted customers. Devery has regional logistics hubs which located in every region in Tanzania. Moreover, Devergy has warehouses which are located even closer to the village to store the system's components as well as its spare parts. The company also employs local maintenance technicians and local sales agents based on commissions. While the technicians are responsible for providing regular maintenance to the systems, the sales agents are responsible for promoting the Devergy's service to the community. In this way, if anything happens to the systems or new installation is needed to the village, it could be done by local people which lead to the cost reduction.

Investment

Devergy sees the issues related to the investment as extremely significant for the company. Devergy quotes, *"It is almost impossible to get loans from the banks for this type of business because the rural electrification industry in most cases is not mature enough to get access to commercial loans".* Devergy describes that at the early phase, the company secured the early funding through the crowdfunding by using its social networks. This crowdfunding allowed Devergy to build the first project and showed it to the investors. Currently, Devergy operates based on the grants secured from Finnish government and other international investors and donors. The company believes that grants are good tools to reduce risks and to finance new high risks projects. However, Devergy emphasizes that it is important to have right investors who know this type of business. It is due to the fact that rural electrification's business will need a longer period of return of investment. As quoted by Devergy, *"It is a matter of not only having the investors to choose you but also having you to know and understand the investors. Because the returns of this types of business are not only money but also positive impacts on the society."*

Financial

Devergy considers the financial issues of the targeted customers as extremely significant. Devergy focuses its business on serving people in the rural areas. Currently, about 80% of Devergy's customers are in the BOP who earn less than $2.50 per day and have limited access to the financial institutions or commercial banks.

In order to overcome the financial issues of the targeted customers, Devergy provides a flexible payment through mobile money. It is a Pay-As-You-Go scheme which the customers could buy the electricity in a bundle using their mobile phone. Mobile money is quite popular in the rural areas in Tanzania, for the customer who does not own mobile phone, they could go to any shops who offer mobile money service and ask this shops to buy Devergy's bundle for their systems. In return, the customers will pay the shop in cash. The electricity bundle could be bought based on the customers' needs. In this way, Devergy has enabled very flexible payment scheme which allows the customers to pay $0.20 per day or up to $7 per month.

Human resources

Devergy looks at the issues related to human resources as extremely significant. Devergy explains that it is easy to find trained technicians as vocational schools provide a wide pool of candidates. However, sales force and general middle management level positions are rather hard to recruit as the number of candidates with university title are in most cases insufficient. Devergy quotes, *"To find good candidates for some positions Devergy is quite challenging since education in Tanzania is not good. It is worsened by the fact that there is a lack of role model of the well-educated and successful person in Tanzania. This condition results in huge forces that are unqualified for the positions on Devergy".*

To solve this issue, Devergy increases the pool of candidates for a position offered by the company. Then, specific training and supports are provided for the candidate who meets the criteria of the position.

Technical

Devergy deems the technical barriers as insignificant towards its business. It is due to the fact that Devergy does not sell the products, yet it sells the electricity as services. It means that the ownership of the systems belongs to Devergy and the company is responsible for managing the systems to be able to generate electricity based on the customers' demand.

Devergy puts high standards of the systems since the goal of the company is to make the customers happy. There are two things that need to be done in order to achieve this goal. Firstly, Devergy explains that it is important to understand the targeted customers. Devergy builds and designs its own technology which allows the company to analyze, monitor, and control the performance of the grids in two ways of communication. Devergy quotes, *"we secure all the information related to the customer, such as the pattern of the energy usage and how much power the customers' needs, in order to have a very clear understanding of what our customers want. Then, we use this information to make decisions."* Secondly, Devergy maintains a good quality of components that are used in the microgrid systems by having top quality products from the manufacturers and suppliers, as well as having two different level of quality control. The quality control is done in the assembler by having another company operates on behalf of Devergy and in-house quality control when the company receives the components in Tanzania.

Market demand

Devergy considers the issues related to market demand as extremely significant. Devergy explains, although many off-grid communities are already acquainted with solar energy, not all people in the community could afford to buy the solar equipment. It leads to several challenges on Devergy's service penetration especially for those who have lower income. Despite the fact that Devergy provides a flexible payment term through PAYG mobile money, the PAYG schemes might not be adequately understood in the community. Thus, education and persistent training of its customers are important.

Social, Behavioral, Cultural

Devergy sees the issues related to social, behavioral, and cultural barriers as slightly significant towards its business. Devergy explains that it is important to listen to the targeted customers and sell the services based on their emotions, such as safety and longer hours to study at night. Devergy quotes, *"we take feedbacks from the customers proactively through our call center. We listen to what our customers' like and dislike about our services to improve our services."* Devergy also adds that it is important to prove to the community that the company is not a scam by keeping the company's promises, managing the customers' expectations, and providing good customer care.

Governmental/Institutional

Devergy looks at the issues related to the government and other institutions as extremely significant towards its business. Devergy explains that in the last three years, there have been many changes in the policies especially those which are related to solar energy and rural electrification. Devergy quotes, "*The policies were better some years ago compared to the policies today. Today, the regulations are not good enough, but they are also not bad enough to reconsider."*

Currently, Devergy only receives the benefit of import duties' exemption for solar technologies. Since the majority of the components of Devergy's system are imported, it is important for the company to keep this policy being implemented by the government. Moreover, Devergy believes that it is also important to study all the permits needed to keep the business running as well as the electricity tariffs from the public grids. Devergy solely depends on the other organizations or institutions, such as the World Bank, to do the lobbying activities to the government on behalf of the solar industries in Tanzania.

Network/Partnerships

Devergy deems the problems related to the networks and partnerships as moderately significant. Devergy explains that it is rather complex to build the entire department, which ranges from logistics, human resources, training, installations, maintenance, sales, and marketing, for the company. Devergy quotes, *"It is nice to have partnering companies to do the works for us since we could focus on what matters for the company."* However, the business to business in Tanzania is not developed yet, especially in rural areas. Thus, it forces the Devergy to build all the departments and to do the works by itself. In order to overcome this challenge, Devergy explains that it is important to hire one good manager for each of the departments and provide the training needed for this specific position.

Environmental

Devergy considers the environmental issues as insignificant barriers towards its business. It is due to the fact that all the system components are tested for the safety before they are installed in the village. Moreover, Devergy does not manufacture its own systems. It leaves Devergy with the responsibility to collect the waste of broken and faulty components in the village. Currently, Devergy collects all its broken components from the village in the office. The company waits for a bigger collection to send the waste to the recycling companies abroad since there is no company in Tanzania does not offer such a service. Devergy needs to wait for bigger collection because the shipping fee is the same as long as it is within one container. Thus, it is much more financially friendly to wait for the waste to fill up the container and have them to be sent to the recycling companies.

9.4.4.2 Devergy's business model

Value proposition

Devergy offers clean, affordable, and reliable energy services to low-income people who live in rural villages, do not have access to the grids and financial institution, and live at the BOP. Devergy develops a solar microgrid to provide clean energy service. The company maintains reliable electricity access by using

expandable systems and a smart meter to control and monitor the system 24 hours a day. These expandable systems and the smart meter allow the customers to use the electricity as much as they want at any time they want. Whenever there is a shortage of energy, Devergy's team could easily add up the systems. Devergy also provides flexible top-up Pay-As-You-Go payment scheme which enables the customers to buy the electricity in a bundle by using mobile money

Customer interface

- ***Customer segments:***

  Devergy believes that it is important to select the customers' base and understand whom the company is targeting. Because, it is impossible to serve 100% customers at the BOP, especially those who are in the extreme level of BOP. Devergy also emphasizes that trying to serve 100% BOP customers will sink a company and it is better to have impacts on certain group of customers rather than having no impacts at all. Currently, Devergy looks at about 80% of people who live at the BOP as its customer segments.

- ***Customer relationship:***

  As an energy service provider, Devergy's main goal is to make the customers happy. To achieve this, Devergy provides a dedicated customer care team to understand its customer base by doing its market studies as well as proactively asking the customers if the system goes well through Devergy call center. Moreover, Devergy develops a system which runs on adaptive capacity and is monitored 24 hours a day through Devergy smart meter. This device allows Devergy to monitor the energy usage of its customers and enables to control the grid. Thus, whenever there is a lack of energy supply, energy could expand the grid to the exact location where it is needed. In this way, Devergy keeps the customers' freedom to use the energy as much as they want and proves the system works which lead to the happy customers.

- ***Channels:***

  Devergy promotes and sells its services through both local sales agents in the village who operate based on the commission and dedicated sales and marketing team who are fully employed by the company. The dedicated sales and marketing team organize roadshows from villages to villages to introduce its services to the community. The local sales agents help the company to promote the services locally in the village. The customers could register themselves for Devergy's services during the roadshow or anytime through the local sales agents. The Devergy's systems could be installed when there are enough houses to be connected. The minimum requirement of the number of houses to be connected is 80 houses. However, this number could be adjusted based on a wealth of the village. If the village is interesting and offers good prospects for the future, Devergy could start easy on this kind of village. Also, Devergy is currently developing systems which could connect starts from 10 houses and generate enough profits for the company.

Infrastructure management

- ***Key partners:***

  Devergy has established key partnerships with different institutions and organizations to support its business. Devergy's partners consist of manufacturing companies, suppliers; local and international financial institutions, donors, and investors; and mobile network operators.

  To provide good services, Devergy needs good-quality system's components at an affordable price. Thus, Devergy has established strategic partnerships with various manufacturing companies and suppliers to manufacture all the hardware and to provide other components for Devergy systems. Devergy designs all the hardware which are not available in the market, such as the PCBs as well as the metering and the controlling systems. These parts of the system are manufactured in Thailand. Other components are imported from different companies in China and Tanzania. The company also hires a QA company to make sure all the products made abroad match Devergy's standards.

  Other strategic partners are the local and international financial institutions, donors, as well as investors. It is important to have a strong connection with these types of strategic partners since these

partners help Devergy to expand its business. Devergy acquired funding from several partners such as Acumen, OPES Impact Fund, and HERi Africa which are significant funds and help Devergy to expand its operations.

To be able to deliver its services in the rural areas, Devergy has established its partnership with the local transportation network (local bus). Devergy relies on local sales agents to promote its services in the rural areas. It relies on the local technicians for the maintenance of its grid. In addition, to be able to sell the electricity in a bundle through a mobile phone, Devergy works together with mobile networks operator to enable flexible payment through mobile money. The company has also established a partnership with recycling company abroad to handle the faulty and old products to be recycled.

- ***Key activities:***

  Devergy combines many activities in order to make its business model works. Devergy has its own integrated supply-chain system and uses the local forces to operate its business. Devergy main activities consist of several tasks which are product designs, and importation, sales and marketing, installation, maintenance and services, waste collection, as well as training for its employees.

- ***Key resources:***

  According to Devergy's key activities, the company needs several key resources which are the R&D team, the sales forces, logistics team, as well as installation and service team. For the physical resources, the company needs to have regional hubs and warehouses close to the villages. These key resources are valuable for Devergy's business and operation to design, test, promote, and sell Devergy's services as well as to install and maintain the systems to enable the system to deliver energy services to the targeted customers.

Financial aspects

- ***Revenue streams:***

  Devergy's revenue stream solely depends on the sales of its services in the form of electricity bundle. Devergy enables PAYG scheme by selling the energy services in a bundle which can be paid through mobile money.

- ***Cost structures:***

  The most important costs to be incurred while operating Devergy's business are the cost of the marketing and sales, hardware or the products, the service operation and the administration staffs.

9.4.5 Meragao Power (MGP)

9.4.5.1 MGP's barriers

In this section, we will look deeper into the significance of each of the barriers, which obtained from the literature earlier, in the context of MGP's business. MGP describes each of the barriers and how the company overcomes those barriers as the following:

Infrastructure

MGP looks at the issues related to the infrastructure as slightly significant barriers towards its business. MGP describes that it is not difficult to access the remote communities where the company operates. MGP has its branch offices which located close to the hamlets. Each of the branch offices covers an area with a maximum travel distance of 20 km to the community. All the hamlets are accessible with motorbike from MGP's branch office.

Investment

MGP sees the issues related to the investment as extremely significant for the company. MGP quotes, *"So far, banks have not been interested in lending us money. We also do not receive many grants as most of the grant-making organization is more interested in the non-profit organization or companies providing larger loads to customers."* However, MGP describes that the company still manage to get some loans, which were

secured through crowd-lending institutions, and investments from local and international institutions. Also, several grants are secured through project competitions.

Financial

MGP considers the financial issues of the targeted customers as slightly significant. The typical MGP's customers are rural off-grid households who are isolated from the local town. They earn less than a dollar a day per person. Some of the customers might also have seasonality in their income. MGP's customer base does not have access to the credits and bank accounts because they simply could not meet the requirements set up by the government in order to set up a bank account. Besides, these customers could live up to 20 km away from the banks and the ATM which result to another problem. These rural communities have only cash on hand.

MGP needs to adjust its revenue collection in order to serve this type of customers. MGP's collection team goes to the hamlet every week, at a scheduled time and place, to make the payment collection. The collection also could be made collectively through Joint Liability Group (JLG), which is a self-help group organized and formed by the community in the hamlet. The JL G model allows MGP to be more operationally efficient and ensures regular payments from the subscribers. The customers pay less than $0.50 for a week of MGP's service in cash. MGP keeps the service fee small so that it will not affect the seasonality of income which happens to some of the villagers. In this way, MGP solves the problem of high upfront investment costs and limited access the banks from the customers' side as well as high operational costs from MGP's side.

Human resources

MGP looks at the issues related to human resources as moderately significant. MGP explains that the company does not import labors outside Uttar Pradesh. MGP explains that it is rather hard to have trained and well-educated workforce locally. However, the company provides regular training for its employees. MGP quotes, *"Our typical employees are our customers too. They are trained by our company and help the company to grow."*

Technical

MGP deems the technical barriers as very significant towards its business. MGP describes that it is important to have good quality control of the company's services and good management response towards the problems. MGP explains that the company faced problems related to the payment collection in its first district in 2011 due to poor quality control and lack of management responsibilities.

To overcome this problem, MGP develops mobile apps to control the quality of its services and its payment collection. The company has a quality control (QC) team which consists of control engineers. This team is responsible for visiting the hamlet after the installation of the system. MGP develops a mobile app which includes several questions to be answered by the QC team. These answers will be sent to the branch manager to shows the branch manager whether the installation has been done properly based on the MGP's technical specification for systems' construction. In this way, any problems related to MGP's services and installation could be detected earlier.

A mobile app is also used to control the payment collection done by MGP's collection team. When the customers pay in cash, the collector has to fill in the customers' payment on customers' cards and the mobile apps which consist of the customers' data. Later in the day, the data from the mobile apps could be synced with the database in the computer to record the daily collections done by the collectors. In this way, any problems related to the payment issues could be known and quickly resolved.

Market demand

MGP considers the issues related to market demand as slightly significant. MGP is a utility company which does not offer any products. MGP's customers' base is rural communities who use subsidized kerosene

or candles as the source of lights. These targeted customers know and familiar about electricity, yet they do not have access to the national grid. MGP quotes, *"Everyone knows about electricity. It is something that people want."*

MGP explains that the demand for lighting and electricity in these rural off-grid communities are pretty homogeneous. MGP describes market demand is not a problem for the company because MGP provides electricity to people who currently do not have electricity in their house. Thus, the portion of the population from the off-grid communities that want MGP's services is high. Moreover, MGP is able to provide electricity which costs cheaper than kerosene and the grid. MGP's customers used to spend about $0.60 to $0.70 for kerosene per week. With the services provided by MGP, the customers only need to pay less than $0.50 for lighting and mobile phone charging services. MGP quotes, *"The demand of our service package is pretty strong within the community we enter to. Some people might still not be able to afford our services, yet we found that the demand for our services is consistent in the communities."*

Social, Behavioral, Cultural

MGP sees the issues related to social, behavioral, and cultural barriers as slightly significant towards its business. MGP describes that sometimes, religions, castes, and political view play a role in the way the company serves the communities. MGP explains that the company used to face some constraints related to the invisible division line within the community because of religions, castes, and political view. *MGP quotes, "Sometimes, we could not connect households within the community because they have different religions, castes, or political views. Thus, we put small instead of the big microgrid to serve both communities without crossing the line."* MGP explains that it is important to understand and review the communities before starting to serve the communities. Thus, when a targeted hamlet is identified, MGP sends out its team to survey the hamlet and identify any social issues in the communities before conducting any formal engagement and install the system.

MGP also faces some issues related to the local leadership in the community. Most of the companies and NGOs start by organizing village meeting with a village leader in order to introduce themselves. Nevertheless, MGP tries to stay away from this approach. MGP quotes, "*we tried to reach the community leader in the past, but in some cases, these leaders are the ones who hold us back to offer our service to the community. Sometimes, they even ask some money in order to have them supporting us, and this is wrong."* MGP bypasses the community leader to reach and serve the communities which in need of affordable and clean electricity services. MGP explains, *"We provide services, and we are legally there. Just like mobile services, they do not have to go to the local leader in order to sell its services. The customers are allowed to make their own choice. Thus, we do not need any permission from someone in the community to serve what they want and what they need."*

Governmental/Institutional

MGP looks at the issues related to the government and other institutions as very significant. MGP explains the electrification acts in 2003 has allowed MGP to do what the company does right now, which is to provide electricity services directly to rural off-grid communities. However, there are no policies which offer any incentives or subsidies for MGP for doing its business. Moreover, MGP needs to compete with subsidized kerosene. The subsidized kerosene is available for some low-income households for 2 liters per month.

MGP also faces several constraints from the local bodies for doing its business. Some prominent NGOs complained that MGP should not operate for profit, some politicians convinced and encourage people in the communities to not pay for the service, and several local judges even threatened MGP to shut down the company. Those are just small examples of the institutional issues faced by MGP. Nevertheless, MGP has strong and positive relationship with its customers. Thus, the customers could decide whether they want the services from MGP or not.

Network/Partnerships

MGP deems the problems related to the networks and partnerships as slightly significant. MGP explains that the company does not have any partnering companies or institutions aside from the suppliers of the systems and the investors. MGP relies heavily on the local suppliers. 80% of MGP system's components are supplied by Indian companies. Thus, it is easy to have any cooperation's and collaborations with local companies.

Environmental

MGP considers the environmental issues as insignificant barriers towards its business. It is due to the all the faulty and old components, which need to be replaced, could be sent back to the manufacturers which most of them are located in India. MGP also has the QC team which makes sure that all the components installed in the hamlet are being properly protected and connected, so they do not cause any harm to its surroundings.

9.4.5.2 MGP's business model

Value proposition

MGP offers a pure energy service to rural off-grid households or communities who live in the bottom 80% of BOP level. The company offers electricity by building, owning, and maintaining solar microgrids as well as investing in energy-efficient appliances. Thus, MGP provides a service with no upfront costs and no maintenance costs. MGP's services come with two LED light bulbs and a mobile phone charger. MGP offers low service fee, which is collected weekly, for a pre-set time of services.

Customer interface

- ***Customer segments:***

  MGP's customer segment is rural off-grid households or communities who live in a hamlet, a settlement which consists about 50 households. They tend to live few kilometers away from the paved road and the local town. Thus, they are isolated from local economies. Typical MGP's customers work in agricultural sectors. The average income ranges from $50 to $80 per month per households, which consist of up to six people. It means, they live less than a dollar a day. MGP looks at minimum ten households to be connected to the microgrid systems. Some people still could not afford MGP's systems since the system represents cost increase for those who rely on 2 liters of subsidized kerosene per month from the government. Thus, MGP looks at the bottom 80% of BOP as its customer base.
- ***Customer relationship:***

  MGP develops its customer relationship through 24/7 customer support. The customer service number is available on the customer card. If the community or the customers have a problem, they could call the customer support and alert the branch office manager if something happens with the systems. Then, the branch manager could send a technician to solve the problem. These technicians are trained and employed full-time by MGP. MGP does not get regular feedbacks from the customers. Feedbacks are gathered through technicians or collection staffs who are in touch with the community.
- ***Channels:***

  MGP sends a team to find the targeted hamlets, yet sometimes the communities are the ones who find MGP and request the company to set up the systems for their community. Once the hamlet is identified, MGP sends someone to a survey to understand the community and identify any social issues. Then, MGP conducts formal engagement where the company holds formal questions and answers sessions. This is when MGP does its real marketing activities. The MGP team brings brochures, some pictures, and explains how the services work and how the company provides the services. At this point, MGP expects the community to sign up and pay the first connection fee which cost about $1.50 and registered as three

weeks payment fee. After the first connection is paid, the microgrid system is constructed on the following day.

Infrastructure management

- ***Key partners:***

  MGP develops partnerships with other companies which supply all the components needed to build the MGP's microgrid systems. MGP trusts the local Indian suppliers to supply 80% of the components needed for the systems, while the other 20% of the components come from China.

  MGP also has established with local and international investors and institutions to secure loans and funding. USAID is the first institution which invested in MGP back in 2010. At the same time, the Energy and Resources Institute also helped MGP to expand its operation into over 100 hamlets in Sitapur District though OASYS project. The first loan was secured from Intellegrow, which provides customized debt finance to small and growing social enterprises in India. Some other loans were secured through crowd-lending online platforms called Milaap and Sunfunder. Several investments were secured through investors such as ENERGIE, ICCO, and Insitor Impact Fund. MGP also acquired investment from Terra Watt Prize to build 140 microgrids which serve more than 17,000 people in 2014.

  The company also develops partnerships with local joint liability group to help the company with payment collection.

- ***Key activities:***

  MGP's business solely relies on the survey, sales and marketing, installation, quality control, service and maintenance, training, as well as payment collection.\

- ***Key resources:***

  In order to be able to operate its business, MGP should provide supporting key resources such as sales team, the installation and service technicians, quality control engineer, as well as collection team. The company also needs physical resources such as branch offices in order to be close to their end-users.

Financial aspects

- ***Revenue streams:***

  MGP's revenue comes solely from the service fee. MGP does not use any payment technologies such as mobile money. The company collects revenue collectively in cash through a weekly collection done by the collection team and JLG. The JLG helps MGP to reduce its operational costs because MGP's collection team do not have to go door-to-door to collect the revenue. With this revenue model, MGP's payback period is from 2.5 up to 3.5 years per installation.

- ***Cost structures:***

  MGP explains that most costs for the system's components. The operation costs are covered by the companies' revenue as the company expected to cover all overhead with the revenue within 12 months. The company does not spend much on marketing activities.

9.4.6 Mobisol

9.4.6.1 Mobisol's barriers

In this section, we will look deeper into the significance of each of the barriers, which obtained from the literature earlier, in the context of Mobisol's business. Mobisol describes on each of the barriers and how the company overcomes those barriers as the following:

Infrastructure

Mobisol looks at the issues related to the infrastructure as insignificant barriers towards its business. Mobisol explains that the communication infrastructure is good resulting good connectivity. However, the

road infrastructure is not always good, especially during the rainy season when the road becomes too muddy to cross. However, Mobisol does not see this as big barriers for its business since the rainy season happens not very often. Mobisol quotes, *"Rainy days only keep our teams from working effectively for about 3% of the days in the whole year, we just need to avoid to visit the village to do the marketing activities during those days, and we solve the challenge."*

Nevertheless, to cover such a huge area in a country, Mobisol relies on the regional branches and Mobishops which are dedicated shops owned by Mobisol which are located close to the villages. In this shops, there is a salesperson who is fully-employed by Mobisol to keep the shops running. In Mobishops, there are also local sales agents and technicians who are employed based on the commission to be sent out to the villages to reach the targeted users. In this way, Mobisol brings the technology very close to the end users regardless of the infrastructure in the country.

Investment

Mobisol sees issues related to the investment as moderately significant. Mobisol describes, in the early phase of the business, the funding's source of Mobisol's business mostly came from the grants. Mobisol even received some funding from the European Union in 2014. Currently, the main source of funding comes from equity and debt financing. Mobisol quotes, *"It was not that hard to secure grants, but to secure debt funding is another story. However, we managed to convince debt investors by showing the success story of our business. Right now, we are operating based on loans from larger banks."*

Financial

Mobisol considers the financial issues of the end-users as moderately significant barriers towards its business. The main targeted users of Mobisol's systems are mostly the mid and upper tier of the BOP. This group of customers is able to provide a living for the family, yet they still do not have access to credits, loans, or any access to the formal banks. It is because the whole banking sector sees this group of customers as very high risk. Thus, these targeted users could not afford to buy Mobisol systems in cash.

To overcome these financial barriers to the end users, Mobisol provides a three years installment scheme through the flexible Pay-As-You-Go payment system. The payment is made through a mobile phone whenever the users want to pay. After three years, the customers fully own the systems. In this way, Mobisol has provided a solution for the end-users to be able to afford Mobisol's systems.

Human resources

Mobisol deems issues related to the availability of human resources as moderately significant. Mobisol uses two types of employment, that is full-time employment and commission-based employment. Mobisol employs local technicians and sales agents based on the commission to help the company's operations in the rural areas. Mobisol describes that it is not very hard to find the right people to work as technicians and sales agents. Anyone who meets the requirements to be a technician or sales agent will be trained in Mobisol Akademie. Only people who pass the evaluation from the academy will be offered positions in Mobisol afterward.

However, to find people for the management position is another story. Mostly, talented people in East Africa expect a quite high remuneration. It is worsened by the fact that the pool of these talented people is not big, and Mobisol is one of many who wishes to hire them. Thus, Mobisol needs to compete with other companies or institutions to win these talents. To overcome these challenges, Mobisol established a talent management team which focuses on building and finding the right talents for Mobisol.

Technical

Mobisol considers technical barriers as slightly significant. Mobisol quotes, *"We do not have many options and the possibility of sourcing the technology locally in East Africa, especially the high-tech*

components." Moreover, Mobisol explains that there is no standardization from the government for Solar products which are sold in the country.

To overcome these issues, Mobisol collaborates with partnering companies which have the ability to manufacture the components abroad instead of making the products locally in East Africa. For the standardization issue, Mobisol relies on Lighting Global certification, which is the most acknowledged certification in the industry, to certify its products. It is important to have this industrial certification since it helps Mobisol to import and sell its products in the country where Mobisol operates.

Market demand

Mobisol looks at the issues related to market demand as slightly significant. Mobisol explains that the targeted users are quite familiar with the solar technology, especially in Kenya, since there are already some small companies operate in the country. Mobisol quotes, *"In Kenya, the idea of solar technology is quite well-known. Nevertheless, in the very remote areas, this idea could be still quite new."* Mobisol adds that, in general, the targeted customers are very interested in Mobisol systems. However, they need some time to come into the decision to buy the product since it is a relatively expensive product for them. It could take up to six months to translate the customers' interest into sales.

To convince the customers to buy the products, Mobisol tries to reach the targeted users in many ways. Mobisol has sales agents who approach the targeted users in more personal ways which are telesales and local sales agents. Telesales is responsible for offering the products through phones, while local sales agents are accountable for going door-to-door to educate the targeted users and promote the products. These local sales agents are people from the village, so they know the neighborhood and are very well-connected with the community in the villages. Thus, these local sales agents could help Mobisol to approach the community through the people from inside the community. Mobisol also employs a marketing team which conducts products activations and roadshows. The marketing team is responsible for going to the villages to promote the products to the rural communities by having products presentation and demonstration in the villages.

Social, Behavioral, Cultural

Mobisol considers social, behavioral, and cultural barriers as slightly significant towards its business. Mobisol explains, *"There are some copycats, some uncertified and low-quality products in the market. These products could distort the market because people are more and more dissatisfied with these products."* However, Mobisol sees that this issue does not happen quite often. Mobisol believes by having local people who know the local cultures, values, and rules, promoting Mobisol's product as local sales agents, Mobisol could gain trust from the targeted users. It is because the products are well-promoted by the people within the community. Mobisol adds*, "While promoting our systems, we need to educate the targeted users and explain to them that we are different from other companies because we provide excellent quality products at affordable payments scheme, and warranty for three years. It means that the customers do not have to worry about the systems in the next three years."*

Governmental/Institutional

Mobisol sees the issues related to the government and other institutions as moderately significant towards its business. Currently, Mobisol is benefitting from the current policies in the form of import duties' exemption for solar technologies. However, the supporting policies change quite often, which could influence Mobisol's business since the majority of the components are imported from other countries, such as from China and Germany. Thus, it is important to close contacts with the governments to get any information related to any changes in the policies. To have access to this information, Mobisol actively participates in the Global Off-Grid Lighting Association (GOGLA) which is an industry association, to exchange some information

regarding the policies' issues with other companies. This association could also speak to the government on behalf of the industry to get the government in favor of companies' side, such as Mobisol.

Network/Partnerships

Mobisol deems the problems related to the networks and partnerships as slightly significant. Mobisol describes that huge supports for rural electrification come a lot from the industrial sector. However, there is still a lack of collaboration with government. Thus, it is important to actively participate in the association to push the government to collaborate with the industries which focus on the rural electrification.

Environmental

Mobisol sees the issues related to the environment as insignificant. At the moment, Mobisol does not have a lot of broken systems in the market. Thus, Mobisol collect all the faulty and broken components or systems back in the office and have them prepared for the recycling process. Since the broken components are not much, Mobisol still works in the planning of recycling process. Mobisol explains that all the systems are in low voltage. Moreover, the battery is sealed, and it could not be opened by anyone, especially the users. Nevertheless, in the future, Mobisol plans to have a recycling company as a partner to do the recycling process on behalf of Mobisol.

9.4.6.2 Mobisol's business model

Value proposition

Mobisol offers clean energy through high-quality Solar Home Systems at an affordable price. Mobisol combines the three years flexible payment plan via mobile phone, reliable customer service, and innovative remote monitoring technology. Mobisol's commitments are quality, product innovation, and sustainable development

Customer interface

- ***Customer segments:***

  Mobisol sells the products directly to the end-users. *Mobisol quotes, "The fact that We are integrated almost 100% from product design, distribution, and after-sales service, we need to know our customers in much detail."* Mobisol's customer segment is the low-income people who are in the mid and upper tier of the BOP and do not have access to the grid. This group of customers usually have frequent yet fluctuating income and are able to provide a living for their family. The majority of Mobisol's targeted users are farmers who live in a family of five people (parents with three children). They live in a small house which has up to three rooms. The targeted users' income varies a lot. However, Mobisol selects its customers based on their income and monthly surplus.

  Mobisol only sells the system to the people whose monthly surplus (after regular expenses) is twice the amount of the planned monthly installment for electricity. It is important to select the right customers to lower the risks of Mobisol's business since Mobisol owns the risks of payment plan by itself.
- ***Customer relationship:***

  Mobisol develops a personal customer relationship through a dedicated customer care and customer hotline. If anything happens with the systems, the users could call the customer hotline, and the customer care team would help the users to fix the problem. If necessary, the customer care team connects the maintenance team in the regional branch with the users. The customer care also takes feedbacks from the users and does frequent after-purchase calls to ask the users whether they are satisfied with the systems and its installations.
- ***Channels:***

Mobisol sells and distributes the systems through dedicated Mobisol shops called Mobishops. These shops are located nearby the villages so that the targeted users could easily access these shops. In addition, Mobisol hires local people from the villages to be Mobisol local sales agents based on commissions. These local sales agents go to the village leader and use door-to-door approach to reach the targeted users as well as to promote Mobisol's products.

Infrastructure management

- ***Key partners:***

  Mobisol has established strategic partnerships with different institutions in order to support its business. Mobisol is a part of various associations which focus on sustainable energy and development as well as rural electrification, such as GOGLA, Power Africa, Power For All, Alliance for Rural Electrification (ARE), and UN Initiative Sustainable Energy for All.

  Other strategic partners are the international donors, investors, and financial institutions. It is important to have a strong connection with these types of strategic partners since these partners help Mobisol to grow. In early 2014, Mobisol and its partner Energy Development Corporation Ltd (EDCL) have been awarded a Grant under the 11th European Development Fund (EDF). *The grants are used to develop The Prepaid Energy Project which is a Rent to Own Solar Home Systems Projects, in cooperation with Rwandan Government. The goal of this project is to improve the quality of life* of the low-income people who live in rural areas by offering a clean and sustainable energy supply alternative, which is affordable and supports economic activity.

  To provide high-quality SHSs, Mobisol sources the SHS's components from different suppliers and manufacturers in various countries. The major parts of the systems are manufactured in China, several components are made in Germany, and the panels partly come from Kenya. Moreover, to be able to provide the three years payment scheme via mobile phone, Mobisol works together with mobile networks operator to enable payment through mobile money.

- ***Key activities:***

  Mobisol combines many activities in order to make its business model works. Mobisol integrates almost 100% its main activities. Mobisol main activities consist of several tasks which are product designs, product testing, sales and distribution, financial planning for the end users, installation, after-sales services, training, and waste collection.

- ***Key resources:***

  Based on Mobisol's key activities, Mobisol needs several key resources which are the R&D and QA team, the sales and marketing team, service team, talent management team. These key resources are valuable for Mobisol's business and operation to design, test, sell, distribute, install, the products as well as to provide the after-sales services to the targeted users.

Financial aspects

- ***Revenue streams:***

  Mobisol's revenue stream solely depends on the sales of the systems. Mobisol, together with the Mobile network operators, has enabled three years flexible payment plan via PAYG scheme using mobile money. Aside from the PAYG scheme, Mobisol offers the system at a 15% to 25% discount price if the customers buy the systems in cash.

- ***Cost structures:***

  The most important costs to be incurred while operating Mobisol's business are the cost of the hardware or the products, the service networks, and the administration staffs.

9.4.7 SELCO

9.4.7.1 SELCO's barriers

In this section, we will look deeper into the significance of each of the barriers which obtained from the literature earlier, in the context of SELCO's business. SELCO describes on each of the barriers and how the company overcomes those barriers as the following:

Infrastructure

SELCO deems the issues on the infrastructure to be moderately significant towards its business. SELCO explains, despite remote locations of its customers, the company has managed to overcome the issues by designing unique operating areas. SELCO has 49 energy service centers (ESC) which act as SELCO's basic building block of its rural operations. Each of ESCs covers an area with a radius of 80 to 100 km in which it markets, sells, installs, and provides services. Through the ESCs, SELCO could reach into the smallest and most remote communities. Furthermore, SELCO has two warehouses which are located in the North and South Karnataka. A certain portion of products is stocked in the warehouse so that if anything happens with the systems, a replacement of the products could be made quickly.

Investment

SELCO considers the issues related to the access of investment to be moderately significant. SELCO explains that over the years SELCO has worked very hard to find the right partners and investors for the company. SELCO describes, "*There are many investors who are interested in being our partner. However, we are looking for the investors who are not only profit oriented but also impact-oriented. It is difficult to find the like-minded investors, and we have to be very careful in choosing the right partners for the company."* Thus, SELCO spends much time finding the right investors instead of just waiting and receiving money from any partners coming to the company. Once SELCO finds the perfect partner, the company tries to seal a long-term partnership agreement with the investors.

Financial

SELCO deems the financial barriers as extremely significant. SELCO focuses on providing the sustainable energy solution to the underserved communities in rural and urban areas. The majority of the customers have access to the bank because of the government's policies which encourage and mandate local banks to open the access to the low-income people. However, many of them do not use the bank account properly, such as zero balance account, or no transaction at all. They also do not have access to credits and loans from the banks because of the nature of their income.

To overcome these challenges, SELCO works together with 30 financial institutions, such as MFIs, local village banks, and community partners. SELCO explains, *"Together with our partners, we develop customized financial products for our customers so that the affordability does not become barriers to purchase the system."*

Human resources

SELCO considers human resources as a very significant barrier towards its business SELCO describes, *"In general, being in Bangalore, it is rather easy to find good talents for the company. However, it is often that the expected salary is very high. Thus, most of the time, the skills are available but they might not willing to work for us."* On the other hand, SELCO adds, it is easier to find technicians who want to work for the company. SELCO works together with the training institutes to introduce its training programs to be put into their course works. SELCO emphasize, "*Our number one strength is our people. We invest heavily in human resources, so we know what kind of people we hire for the company."*

Technical

SELCO considers technical barriers as very significant. SELCO sees the technical barriers mostly come from the lack of R&D activities to work on energy efficient appliances to provide an energy solution for people

in India, especially in rural underserved communities. SELCO explains, *"There has been a lot of request from the customers to have some appliances powered by solar energy. However, many of the appliances available in the market are not energy efficient which results in bigger systems and higher prices."* SELCO explains that there has been a lack of innovation from the manufacturers to make appliances that are compatible with solar energy systems. Although this challenge has no big impacts towards SELCO's business, it has been a limitation for SELCO to serve its customers based on their needs. Thus, SELCO has worked with international R&D institutes, Universities, and technology providers to develop solutions for its customers.

Market demand

SELCO sees barriers in the market demands as moderately significant towards its business. SELCO explains that the customer's awareness is not a huge factor for the company. The majority of people in India have some ideas about solar energy. However, SELCO describes that some education still needs to be provided to the community. SELCO quotes, *"We need to make them understand that we provide a long-term and viable solution for them. We need to make them compare the benefits and how much do they pay for our systems and kerosene every month. People need to see this value before they see other things, such as climate change."*

SELCO adds explains that every solution that the company provides come from the problems. SELCO adds, "*It is important for the company to focus on the problems and the needs of the people before trying to design the solutions. Otherwise, the company will experience a hard time to sell the products because people will not see any value from the products. Some people might hesitate using the products, but it is fine. We just need a good marketing strategy to support the entire things such as to create awareness and to make people have a better feeling about our products and services."*

To overcome these issues, SELCO makes sure that the company has a local presence in the community. Thus, SELCO established branch offices called Energy Service Center (ESC) which are located nearby the community. SELCO provides end-to-end services, such as marketing, demonstration, sales, installation, maintenance, and services from these branches.

Social, Behavioral, Cultural

SELCO considers social, behavioral, and cultural barriers as extremely significant towards its business. SELCO views the poor as a heterogeneous society. SELCO explains, *"The poor consists of the different level of poverty. It is impossible to look at them as one big segment. The needs of the poor could vary a lot because of different local culture, norms, occupations, and locations*." In order to solve this issue, SELCO sees the poor as the business' partners in solution design and employment. SELCO offers a solution in the form of a complete package that can be customized based on the needs of the poor. Moreover, SELCO relies heavily on the local talents. Currently, the company has 450 people, in which 300 employees are from the local areas. These local employees live from those areas and well-connected to the community. SELCO adds, "*It is a big factor when you have local staffs to understand the local culture and dynamics in the community."*

Governmental/Institutional

SELCO deems the barriers related to the governments and other institutions as very significant. However, as SELCO has been established for more than twenty years, the company has many experiences working with the government. SELCO has a dedicated team who works closely with the government on the schemes and programs that are relevant to it company's purpose and values. For instance, SELCO works with the local government in the village development program and local livelihood development programs. At the national level, SELCO actively promotes and advocates for pro-energy access policies which benefit the sector as a whole.

Network/Partnerships

SELCO considers the barriers related to networks and partnerships as very significant. SELCO works with local companies to ensure the supply of PV components that the company needs for the systems. SELCO chooses to work with different vendors to supply the components that the company needs because SELCO needs flexibility for its customization. There are a couple of criteria in selecting suppliers. SELCO explains, *"We spend much time to build a relationship with our vendors. It is a long-term relationship. It is important that our suppliers are aligned with SELCO because we are working in the market which has so many uncertainties."* SELCO describes that the suppliers should provide credit terms that are suitable for the company, could be 60 to 90 days, they also should offer customization, and they have to be close to the area of our operation.

Environmental

SELCO explains that the barriers related to the environment are moderately significant. It is because SELCO works closely with local companies to recycle old systems components, which includes batteries as well.

9.4.7.2 SELCO's business model

Value proposition

SELCO focuses on serving underserved communities in rural and urban areas with customized sustainable energy solution. SELCO offers customized products and a financial scheme based on the needs of the poor. The company also provides reliable services through warranty and doorstep services within 24 hours.

Customer interface

- ***Customer segments:***

  SELCO's customers' segment is the underserved communities and businesses in rural and urban areas. 80% of SELCO's customers are the underserved communities who earn from $100 to $200 per households per month. It means that customers live less than $2 per day. Typical SELCO's customers are farmers and industrial labors who do not have a fixed income. The money is usually seasonal and unpredictable.
- ***Customer relationship:***

  SELCO develops a customer relationship through its dedicated ESCs. The ESC is the building block of SELCO's rural operations. Each of ESC has a service territory in which it responsible for serving end-to-end service to SELCO's customers. Through these ESCs, SELCO reaches into the smallest and most remote communities. SELCO provides door-to-door service. It means anything happens to the system, the customers could directly call the ESC, and the ESC ensures prompt service at the customer's doorstep within 24 hours.
- ***Channels:***

  SELCO sells the products directly to the end-users. The sales and marketing team from the ESCs are responsible for reaching the customers even in the rural and remote areas. Moreover, SELCO has commission agents who work with incentive structures. It means that these agents receive incentives whenever they could translate the customers' needs into sales. These agents work closely with the ESCs to assist the ESCs finding new customers.

Infrastructure management

- ***Key partners:***

  In order to overcome barriers to SELCO's business and to have a sustainable and profitable business. SELCO has established strategic partnerships with different companies, institutions, organizations, donors, and even universities. SELCO established long-term partnerships with its suppliers to provide the components that the company needs to serve the customers. Moreover, SELCO has developed partnerships with university, institutions, and organizations to develop its products and technologies, such

as Massachusetts Institute of Technology (MIT), Engineers Without Borders (EWB) Engineers for Social Impact**,** S.D.M Institute of Technology**.**

SELCO works closely with rural banks, commercial banks, credit co-operative societies, NGOs, and MFIs to facilitate financing to the end-users so that they could afford the systems. SELCO's pioneering work in rural India has encouraged a lot of financial institutions to create a separate line of credit for solar systems.

SELCO collaborates with the local community-based organization (CBO) and international partnership to promote its services to the community and the world. SELCO also maintain long-term partnerships with the investors to support and expand its business in India.

SELCO also works together with a local recycling company to make sure that all the waste products from SELCO could be recycled and reused.

- ***Key activities:***

  SELCO's business solely relies on six main activities, which are R&D or product design, QC and QA, sales and marketing, installation, maintenance, and services. SELCO pays much attention to the development of its products and services. The company establishes an incubation lab to make sure that the customers do not miss out the latest technological advances in the field of SET. **This lab** develops, evaluates, tests and monitors cutting-edge technology as well as business models in partnership with underserved communities. The end-to-end services such as sales and marketing, installation, maintenance, and services are served through SELCO's ESCs. SELCO also believes in the power of local talents. Thus, SELCO provides scheduled training to improve the skills of its employees. SELCO is also responsible for the waste collection of its faulty and old products from the market in order to make sure there are no waste products which may harm the environment.

- ***Key resources:***

  Based on the SELCO's main activities, SELCO's key resources are R&D and QA team, sales and marketing team, technicians, and ESC manager. Moreover, SELCO also needs physical resources to deliver its value proposition to its targeted customer which are ESCs, warehouses, and the incubation lab. These key resources are important in SELCO's business to develop, test, sell, distribute, and promote the products as well as to provide the after-sales services to the end-users.

. **Financial aspects**

- ***Revenue streams:***

  SELCO's revenue streams solely depend on the sales of the products. Together with SELCO's financial partners, the company assures that its customers have access to the credits with local financial institutions. The credit terms range from 5% to 14%. The customers typically put 10% to 25% down payment and pay the balance over three to five years. The transaction happens between the banks and the customers. Thus, SELCO receives payment from the banks in cash. In this way, SELCO transfers the risks of its revenue to the financial institutions. This model works well as SELCO has been profitable for the last eight years.

- ***Cost structures:***

  SELCO explains that the biggest costs of the company are product and material cost, operational cost, and marketing cost.

9.5 Details of PV projects in Indonesia

9.5.1 PLN

9.5.1.1 PLN's barriers

Infrastructure

The targeted customer for SEHEN program is those who live in rural areas and have a minimum distance of 25 km away from the main grid. These criteria lead to challenges related to infrastructural issues

since the road conditions in the rural areas are considered poor. However, as PLN is the only state-owned utility company, the company is responsible for providing the electricity access to the people across Indonesia. In SEHEN program, PLN relies on the local agents for the payment collections and the maintenance of the systems. Thus, PLN stated that the infrastructural issues are moderately significant towards SEHEN business.

Investment

According to Mr. Suharto, the issues related to the investment is not significant on SEHEN program. It is because SEHEN program is completely supported by the national government through APBN.

Financial

Mr. Suharto deems the financial issues of the end-users are moderately significant towards SEHEN program. Mr. Suharto also added, "*SEHEN program is eligible for everyone who wants to install an SHS on the top of their roof regardless of their income, as long as they could make the initial deposit which amounts about IDR 500,000 (EUR 35.5) to the banks."* This decision was made because PLN believed that the majority of people who live in rural areas are not poor. They have a lot of assets, such as livestock and agricultural products, which could be sold to fulfill their daily needs, which include the electricity services. However, this decision could be a mistake made by PLN in SEHEN program. As a result, a lot of SEHEN systems need to be taken out because of there is no continuous subscription fee being made in the bank.

Human resources

At the beginning of SEHEN program, all the subscription fee must be made by the villagers by themselves. The payment could be done by putting a deposit in their bank account. However, this scheme fails to be implemented for a long-term since many people are no longer pay for the systems. Thus, PLN needs to collect the payment actively by coming to the village. Mr. Suharto explained that this condition leads to several challenges in the availability of human resources because of the number of people who sit in PLN branch offices are limited. He considers this issue as slightly significant. Currently, PLN relies on its agents and the third party to do the payment collection in the villages.

Technical

Mr. Suharto considers the issues related to the technical aspects are not significant for SEHEN program. It is because all the technology providers have to pass through bidding and tendering process at the provincial level. Thus, all the technologies used in SEHEN program should have met the requirements given by PLN at the provincial level in order to win the projects.

Market demand

Mr. Suharto claims that the issues related to market demand are slightly significant for SEHEN program. In general, all the people in the villages are excited about the technology and SEHEN program. However, most of them found that the subscription fee is a bit too high. Thus, they need some time to think about whether they could afford the systems or not. However, in general , after one or two months, many of the villagers decided to apply for the program, especially when there is one of the households in the village started using the system. Mr. Suharto added, "*It is important to make the villagers understand that this electricity service is quite affordable. The payment of the system also could be made very flexible. The villagers could make the deposit on the bank whenever they have money. In that way, this program looks more attractive to the villagers who do not have a stable income each month."*

Social, Behavioral, Cultural

On the Social, Behavioral, Cultural issues, PLN considers them as very significant issues towards SEHEN business. Mr. Suharto explained, "*People in the village do not get used to going to the bank to deposit their*

money. Furthermore, they do not get used to credit or subscription schemes. These cultural and behavioral issues make the villagers are too lazy to pay for the systems to the bank." Thus, PLN will take out the systems for those who fail to continue their subscription fee after three consecutive months.

Governmental/Institutional

Mr. Suharto considers the challenges from governmental/institutional a slightly significant. It is because there are a lot of donor-driven government programs which give the SHS for free or the electricity services with small subscription fees determined by the community themselves. However, Mr. Suharto sees this program as a minor issue since the government programs often have limited number of SHS or capacity of centralized PV power plants. This condition still leaves SEHEN program to be considered by the villagers as one option to have electricity access.

Network/Partnership

Mr. Suharto deems the issues related to network/partnerships are not significant for SEHEN program. It is because PLN is the only player in the market and SEHEN program is a national program supported by the national government. Mr. Suharto added, "*We just offer the systems to those who are in need. If the villagers want the systems, they could pay the deposit in the bank. On the other hand, if they want to wait for the government programs, it is all up to them. We cannot insist them to buy our system*."

Environmental

Mr. Suharto considers the environmental issues as moderately significant for SEHEN program. It is because PLN has not set a rigid plan for the systems that need to be recycled. Currently, all the systems, which are in good and poor conditions, are saved in PLN Sumba's warehouse. These systems are considered as the national assets which could be used or refurbished later if needed.

9.5.1.2 PLN's business model

Value proposition

PLN focuses on providing an affordable electricity access to those who do not have access to the grid by using easy to use off-grid PV systems or SEHEN systems. The SEHEN systems were obtained through national bidding program held by the provincial government. These PV contractors or companies who win the bidding process could take over the projects by providing everything needed to construct SEHEN systems. In the case of Sumba Island, SEHEN system used is provided by Sundaya, an Indonesian company which manufactures various types of solar technologies. For SEHEN program, the technology used is Sundaya Utilium 4 light kit which consists of 10 Wp PV panel, four modular light kit integrated with a lithium-ion battery. Despite the fact that the system has four modular LED lamps, PLN hands out only three light to the customers while one lamp is kept back for the backups or replacements (Ritter, 2011).

Customer interface

- ***Customer segments:***

  The targeted customers for SEHEN program are the villagers who do not have access to the grid. The targeted market for the program is the people who live in remote and isolated areas which have a minimum distance of 25 km from the main grid. PLN stated that there are no targeted customers based on their income as long as these customers could pay the initial deposit then they are eligible for SEHEN program
- ***Customer relationship:***

  PLN develops its customer relationship through general PLN customer service. There is no customer service which is dedicated to SEHEN program. It is a customer service which responds any inquiries and complaints from all PLN customers who are mostly grid-connected customers. The customers could also

come to the nearest PLN branch offices from their location to submit their complaints related to SEHEN systems, which include the services and repairing of the systems. PLN also developed local agents in the village. These agents could collect the faulty systems or any broken parts to be repaired to the nearest PLN branch office with a small fee from SEHEN's customers. These agents, who operate based on the commissions, are also responsible for collecting the payment of the systems.

- ***Channels:***

  PLN relies on its branch offices to distribute and sell SEHEN systems. As the customers make the first deposit in the local bank partner, they could pick up the SEHEN systems from the nearest PLN branch office by showing their proof of its first deposit in the partnering bank.

Infrastructure management

- ***Key partners:***

  In order to run SEHEN program, PLN needs to establish partnerships with several key stakeholders. Firstly, PLN cooperates with the local government to ease its marketing activity in the villages through the village bodies and village leader.Secondly, in order to provide flexible payment, PLN collaborates with local banks such as NTT bank and BNI bank to provide saving accounts which are free of administration fee for SEHEN's potential customers. Also, PLN cooperates with SUNDAYA, the PV company which won the bidding process for SEHEN program, to provide very energy efficient and easy to use systems.
- ***Key activities:***

  As the only one electricity company in Indonesia, the main activity of PLN is to provide electricity access to the people. Just like PLN's grid-connected business, PLN's main activities in SEHEN program consists of three areas which are sales, distribution, and services. In addition, a bidding and marketing activities are needed specifically for SEHEN program because it is a new program from PLN with different technology and different payment schemes. Thus, a marketing activity which consists of socialization, education, and demonstration is needed to introduce SEHEN program to the targeted customers.
- ***Key resources:***

  The most important key resources are PLN branch offices and PLN employees. The branch offices are important since these are the end or closest point for PLN to reach and serve the targeted customers. PLN branch officers are responsible for selling, distributing, and promoting the products as well as to provide the after-sales services to the users. PLN employees are also important because they are the ones who operate SEHEN business.

Financial aspects

- ***Revenue streams:***

  Just like the grid-connected program, PLN's revenue streams for SEHEN program solely depend on the sales of the electricity services. The revenue is received through the first deposit made in the partnering banks and fixed monthly subscription for the electricity services provided by SEHEN systems. The customers who are interested in installing SEHEN system in their house need to make the first deposit with the amount of IDR 500,000 (EUR 35.5) in the partnering banks. This deposit will be automatically deducted by PLN for the monthly subscription which cost about IDR 35,000 (EUR 2.5). Thus, this initial deposit could last for more than a year. Using this scheme, the customers do not have to pay as long as there is money in their bank account. When the deposit has depleted, the customers could top up their credits by placing some money in their bank account whenever they go to the bank or whenever they have money. Thus, it provides a huge flexibility for the customers in terms of the payment. If there is a failure for the deduction of the monthly fee after three months, PLN will take SEHEN systems back. Nowadays, PLN also collect the payment manually through local agents who operate based on the commission. These agents collect the payment from SEHEN customers and make the deposit directly to the PLN counter.

- ***Cost structures:***

  PLN key resources rely heavily on its own people. Thus, the biggest cost need to be incurred for SEHEN program is the operational cost. Then, it is followed by distribution cost and the cost of the products

9.5.2 HIVOS

9.5.2.1 Hivos' barriers

Infrastructure

According to Hivos' implementer team in Sumba Island, the barriers related to infrastructure is moderately significant. Although the locations of the projects spread across Sumba, currently the entire Hivos' team in Sumba could still handle it. According to Mr. Rudi, the team division, as well as the right scheduling, are important in order to maximize the human resources to achieve the expected target, especially in TERANG program. Mr. Rudi explained that there are two teams which deploy to different locations each day to maximize the time. One team usually consists of one field implementer and one community engagement officer.

Investment

Hivos describes the challenges related to the investment as very significant. Mrs. Maya describes, *"Although there are lots of funding available, not all of them are suitable for Hivos' needs. Thus, we need to open up our eyes and ears to see if there is funding available and suitable for us and what are the requirements to secure the funding."* This condition makes the availability of Hivos's funding quite fluctuate since the donors could come and go. However, it is important for Hivos to keep securing certain funding since Hivos is responsible for the success and the sustainability of its current projects and missions. Mrs. Maya describes that her role as the stakeholder engagement officer is essential for Hivos because she needs to invite new stakeholders who are interested in Hivos' current programs and make sure that these stakeholders could make contributions based on its role. Thus, an event called Sumba Investment Forum was held earlier this year to invite new potential investors or donors who could contribute to the sustainability of SII program.

The responsibility of securing funding for SII program happen to be at the regional and global level. Each of Program Development Manager at South East Asian level is responsible for overseeing the program as well as making sure the funding security and the sustainability of the programs. There is a staff meeting and a management meeting every month to discuss all the issues related to operations which include funding issues. Although Hivos' Indonesian team is expected to focus on the implementation of the program, it is important for the entire Hivos' team to be actively searching for the source of funding available in the market since no one knows when current donors will stop their grants.

Financial

Hivos describes the financial challenges in the end-users as slightly significant towards its program. It is true that majority of the users of Hivos' lamps are people who are at the BOP and have fluctuating income. However, some of them, although they do not have a monthly income, they have some assets in the form of live stocks such as chickens, goats, and pigs, as well as agricultural products and handicrafts. These types of people could easily sell their assets to fulfill their daily needs.

As stated in the previous section, Hivos always does location surveys and community engagement before installing the systems. Hivos considers the income per month per households, the number of family living in one house, the occupation, and their assets to see the "ability to pay" of the villagers. However, the ability to pay of the villagers is not considered as a major issue since the main targeted for Hivos project is the school. Mr. Rudi explained that the selection of lamp users is made through the school since they know the students as well as the family very well. To make sure that the school could select the villagers who are able to pay for the systems, Hivos equips the school with several pieces of training such as project management,

financial and budgeting, as well as technical aspects of the systems. In this way, Hivos makes the school acts as a responsible actor or a guarantor for the villagers who purchase Hivos lamps and use the charging services.

Human resources

Hivos considers the issues related to human resources are moderately significant. Mrs. Maya explains that it is rather difficult to find people who want to work in Sumba Island and has enough knowledge as well as the capability to deliver the target which was set in the first place. She adds, "*Actually, it is more difficult to find those who are capable of delivering the results since currently there are more than 60 NGOs operate in East Nusa Tenggara, and 40 of them are international NGOs. Besides, the recruitment, which stated the location would be on Sumba Island, is always opened for everyone regardless of their race, ethnical, and sexual orientation (LGBTQ), who is interested in applying for the position*." In order to make sure that Hivos will get a good candidate for its team, there will be a person who is in charge of SII program and a person from the Human Resources Department who interviewed the candidates in the recruitment process. Several pieces of training and introduction programs are also set for the new hires in Hivos. A performance evaluation will also be conducted every six months between the staff and its line manager to assess the staffs' major obstacles and needs in order to achieve their goals.

On the implementation's team, Mr. Rudi and Mr. Munawir explained that currently there are eight people who are responsible for the project's implementation on Sumba Island. The team is expected to cover all the projects across Sumba Island. However, to reduce the workload of Hivos team, the responsibility of technical aspects, such as installation, is given to RESCO and Winrock International. Hivos also hire enumerator team which consists of eight people who are responsible for collecting the sample data through interviews on the locations chosen by Hivos.

Another challenge is that as the international NGO, Hivos could not directly implement the projects by itself. Hivos needs to collaborate with the local NGOs for the implementation on the field, especially for the social engagement process. However, there is a challenge to the capability and the capacity of local NGOs in Sumba Island. Also, often these local NGOs have another project which leads to a lack of focus on SII program. To tackle this issue, Hivos put the local NGOs in the SK EBTKE 64K/73/DJE/2014 on the Establishment of the Steering Committee, the Organizing Committee and the Working Groups on SII program. By including the local NGOs in this letter, it is expected that these local NGOs put some serious efforts and focus on the SII program. In addition, Hivos also conducts several pieces of training and coaching programs to improve the capability of these local NGOs and makes sure that there are knowledge and capability transfer to the local human resources.

Technical

Hivos deems the issues related to the technical aspects as moderately significant. From the interview done with Hivos officers both in Jakarta and Sumba office, it could be concluded that there are three different technical issues which currently faced by Hivos. Firstly, the issues related to importation of the technologies. Mr. Dedy Haning is the one who is responsible for the importation and the shipping of the technologies from abroad until they are received in Sumba office. To reduce the complexity of the importation and shipping process, Hivos uses a forwarder service company which is responsible for delivering the products to Hivos' office in Sumba Island. Unfortunately, a lack of experience in importation prices and using forwarder service, Hivos' current provider service is not equipped with Angka Pengenal Importir (API) or an importer identification number. Inability to provide API number leads to implication on tax exemptions because the tax and VAT exemptions are only eligible for those importers who are registered with API number. Mr. Dedy Haning explained that Hivos might reimburse the tax and VAT exemptions later on after all the customs and shipping process are completed.

Secondly, the technical aspects which also influence the implementation of TERANG project are that the issues related to the institutional management. Mrs. Maya explained that a lot of commitments and

agreements which were made up front between Hivos and other stakeholders are not fulfilled as agreed. Many of this failure is caused by the internal conflicts in the institutions or organizations that Hivos work with. Thus, in TERANG project, Hivos makes sure that the community engagement is done correctly. A minimum of 70% of solid agreements from the villagers or institutions is obtained before the implementation of the project. In fact, several TERANG program's locations need to be moved because of unsupportive villagers or school committees.

Lastly, as described before, the data collection on the survey was done through interviews by the third party which is the enumerator team. Although the questionnaires were made by one of Hivos officers, Mr. Firman, independent interviews need to be done by the enumerator team (four people each team) for 25 data sample per school per day. This method of data collection could lead to bias and unexpected results since there are eight people working on different interviews. Furthermore, these enumerator teams work on the achievements per day. It means that the interview results could be influenced by the daily performance of the enumerator officers. Thus, further evaluation and analysis are done by Mr. Firman to make sure all the interview results have met the standards of the questionnaires.

Market demand

Hivos considers the challenges of the market demand as slightly significant for their project. It is due to the fact that Hivos offers electricity, a service that the villagers have been waiting for a long time. Mr. Munawir stated that the villagers always excited to have a new technology and to receive electricity for their houses although there were still few cases when the villagers do not consider the electricity is an important part of their life. This condition usually happens on the very poor villagers in the rural areas.

Hivos explained that the projects pose challenges from the government programs. It is because all of the government programs are donor driven. It is worsened by the lack of community engagement and capacity building to maintain and operate the systems. Although the government has managed to form a village committee to operate and maintain the systems, this committee often does not work as it is expected. Many villagers who use the service do not pay for the agreed monthly subscription fee. These conditions lead to several challenges for Hivos to be able to introduce TERANG Project which the villagers are expected to pay for the lamps and the charging fees.

Hivos believes that a strong community engagement followed by a clear business model as well as good technologies will make TERANG program more sustainable in the future compared to the government programs. From the interview in Kataka village, all of the correspondents gave positive response towards PV school project and Hivos lamp. The villagers are more satisfied with Hivos lamp compared to the existing SHS from PNPM or ADD program because Hivos lamp could provide a better lighting at night. The villagers also approve that the lamp and the charging fee is affordable for them which could be concluded that current business model might work to sustain TERANG program.

Social, Behavioral, Cultural

In general, the majority of people who live in rural areas and do not have access to the electricity are excited to receive electricity access. Thus, it could be concluded there is a demand for electricity in the rural areas. However, Hivos explained that there are still several challenges especially on Social, Behavioral, and Cultural issues which could be considered as slightly significant. Hivos described that some of the people do not see electricity as an important part of their life. They also do not get used to paying in credits or subscription scheme because of the fluctuating income. Some of the villagers could have a diesel corn mills which value up to IDR 8,500,000 (EUR 602) or a motorbike which could cost about IDR 15,000,000 (EUR 1063). They see a corn mills machine and a motorbike as essential devices to support and sustain their life. Thus, they are willing to sell their livestock and gather some money to pay for the devices even in cash. However, they could say that they do not have money for electricity. It is because they have been living without electricity for a long time. Some of them even live without electricity for more than thirty years.

In order to manage these challenges, Hivos believes that education and socialization about TERANG program and the importance of electricity for life are essential for the success of this program. Mrs. Maya explained, "*In general, People in rural Sumba do not need electricity to sustain their daily life because they never have electricity for a long time. Thus, Sumba people has four stages of questions related to electricity that we need to address, which are: (1) why should they pay for the electricity services? (2) why should they have to maintain and take care of the system? (3) why should they live in a group and obey the rules agreed by the community? (4) why should they create productive economic activities with the emerge of electricity?"* Hivos believes by giving the right answers to all those questions, Hivos could make the villagers realize that the electricity is an important part of their life

In addition, Hivos emphasizes that the lamp and the charging fees from TERANG program are affordable for all the villagers. It is good for the health, and it could provide better lighting than kerosene lamps. Hivos taps into school projects and prioritizes the students to have the lamps so that the people could see the difference of life with electricity. All of the interview correspondents in Kataka village approved that their children could study longer and better at night because of Hivos lamps. One of the students even won a student regional competition and got better grades at school. In this way, the view of the people on electricity is expected to change gradually that electricity is an essential part of their life.

Governmental/Institutional

Hivos deems the issues related to governmental and institutional are extremely significant towards current Hivos' programs. Hivos described there are three big challenges which influence the sustainability of its current project. These challenges are the lack of supporting regulation, the change of regulations, and the rolling or change of positions in the governmental bodies or departments.

In 2016, the MEMR has established a new regulation which is The Ministerial Decree of Energy and Mineral Resources of The Republic of Indonesia No. 38/2016 about Acceleration of the electrification ratio in underdeveloped, isolated, frontier villages and small-populated islands through the implementation of small-scale electricity power supply enterprises. Through this new regulation, Regional-Owned Enterprises or Badan Usaha Milik Daerah (BUMD), Private and Cooperatives could actively provide electricity access in the areas where PLN does not exist. However, the implementation of this regulation is not that simple. The regional government should propose which areas that are eligible for this regulation to PLN as well as to the national government, in this case, is the MEMR. Once PLN and the national government approved, the bidding process could be conducted for the proposed area. Those who win the bidding process could build private power plants and act as the electricity provider in the area replacing the role of PLN. However, currently, there are not many regional governments who are willing to perform this procedure because of several reasons such as a lack of capability to do the feasibility studies and make the proposal. Thus, it could be concluded that the implementation of current policies and regulations in Indonesia is still lacking, especially for off-grid installation and those who are in favor of the private sectors.

Another challenge which influences current Hivos' programs is that there is a change of regulations. Often, in Indonesia, the regulations change followed by the change of the ministerial or other governmental positions. In 2014, The GOI established Laws of The Republic Indonesia No. 23/2014 about Local Government. Then, it is followed by the Government Regulation of The Republic of Indonesia No. 18/2016 about Regional Officials as the derivative of the National Law No. 23/2014. These new regulations have led to implications on SII program in general due to the removal of DISTAMBEN, as one of the focal point department in SII program. Moreover, these regulations also led to a massive turnover change in the local and regional government departments. Thus, a lot of new people take over SII program in the local and regional level. This condition creates implication on the implementation of SII program since the new people are not aware and well-trained for SII program because there is no a smooth transition between the former and new governme nt officials. Thus, several pieces of training, meetings, and introduction programs need to be started all over again from the beginning.

Hivos stated that it is one of the risks for working with the governments. Thus, Hivos needs to repeat all the training and makes sure the new officials are aware of SII program and could contribute to this program accordingly. Moreover, Hivos keep lobbying and pushing the provincial government to establish a new unit at the regional level to replace DISTAMBEN called Unit Pelaksana Teknis Daerah (UPTD) or the technical implementation unit area. However, until April 2017 when the coordination meeting was held in Tambolaka, West Sumba, the provincial government has not formed UPTD yet. Thus, currently, Badan Perencanaan Pembangunan Daerah (Bappeda) or Development Planning Agency at Sub-National Level is replacing DISTAMBEN as the focal point of SII program temporarily until UPTD is ready.

Network/Partnerships

Hivos deems the issues related to the networking or partnerships are slightly significant. In general, all the stakeholders are very supportive towards SII programs. However, there is still a lack of coordination between the key stakeholders which could be seen from the overlapping PV projects in one village. For instance, in Kataka village, there is PNPM, ADD, and MVVDRT programs ran in one village. In Kadahang village, one of the locations for PV school project in TERANG program, PLN also plans to extend the grid to the village in the next one or two years. Mr. Munawir added that this condition might be caused by a lack of data synchronization and RETs mapping between Hivos and the local government.

This types of issues often discussed during formal meetings which consist of Stakeholders Coordination Meetings which are held twice a year, a Plenary Meeting, a Steering Committee Meeting and a Working Groups Meeting which are held at least once a year as well as during informal sessions. However, there is nothing that Hivos could do about PLN expansion plan because it is a national program. Thus, Hivos will still implement PV school projects in the location where PLN plans to extend the grid while waiting for the grid comes to the village.

Environmental

Hivos considers the environmental issues are not significant for right now because the programs are still in the early phase and all the technologies used are good quality products. Currently, Hivos has established a partnership with TESLA as the battery provider and recycle partner and SUNDAYA to recycle the lamps and charging station if it is needed. However, there is still no rigid and detail procedures on how the old products will be recycled in the future.

9.5.2.2 Hivos' business model

Value proposition

Hivos, together with other stakeholders in TERANG program, aims to provide affordable electricity access for people who live far away from the main grid. PV School program was chosen because Hivos wants to emphasize the importance of education for the children.

Customer interface

- ***Customer segments:***

  PV school's business model will reach out to two different users who are the school itself and the villagers whose the children go to the school. The locations of the project were selected with the help of Winrock International. There were forty locations which were suggested by Winrock International at the first place. Then, further analysis and surveys were done by Hivos which led to only twenty-five locations for PV school's project in TERANG Program. There were at least twenty-five correspondents or villagers per school who were interviewed before the location was chosen for PV school's project.

  From the interview which was done with Mr. Rudi Nadapdap, a field project manager for SII program, the selection was made based on several criteria. Firstly, the distance of the school and the village from the main grid connection (minimum distance of 10 km away). Secondly, it is the ability of the school to pay for

the system, the ability to pay of the villagers for the lamp and charging fees. Lastly, it is the ability of the school to maintain and responsible for the systems, and several other criteria's.

In Kataka village, before PV systems have been installed, the school used a diesel generator to provide electricity needs for the school's operation as well as the teachers' dormitory. According to Kataka's school headmaster, the school used to need 30 liters of diesel per week which could be translated into IDR 300,000 or EUR 21.3 per week. However, this huge amount of diesel only fulfilled three hours of electricity per day. Thus, the school or the teachers' dormitory need to use the electricity wisely.

PV systems in Kataka's school has brought differences in terms of electricity access. The one kWp PV systems currently could provide electricity during the day for the school operational and during the night for the dormitory. The villagers who're the children study at the school also could buy a special lamp which can be charged in the charging station in the school with a small fee. The targeted users are at least there are 250 students per school who can own the lamp. Currently, there are 70 students who own the lamp because of the limited lamp stocks from Hivos. All of the interview correspondents give positive response towards Hivos lamp because of the small fee and better quality of light compared to their current SHSs or kerosene lamp.

- ***Customer relationship:***

  Hivos develops its customer relationship through Renewable Energy Service Company (RESCO) and the school operator. Currently, RESCO is in the early stage of the development. RESCO is a startup company initiated by Hivos to provide energy services especially RET related in Sumba Island. While the company is not official yet, RESCO has employed six technicians and partnering with Hivos as its technical assistance in TERANG Program. In the future, RESCO is expected to be able to act as partners for the villagers or local governments which could provide basic support for off-grid sustainability and perform as a service utility partner. RESCO aims to fill in the gap of operation and maintenance (O&M), after sales services, and collection issues.

  In Kataka PV school project, RESCO is responsible for the O&M for the entire PV systems and the lamps with the help from school operator. Hivos, together with RESCO's technicians will provide training to the school operator. If anything happens with the systems, the operator could call RESCO's technicians and describe the systems' or lamp's failures. If it is a minor repair, then RESCO technician could guide the operator to fix the systems by himself. However, if the systems need major repair, RESCO technicians could come to the village and fix the systems on the ground. Furthermore, RESCO's technicians are obligated to visit the project's sites at least once a month to do monitoring and evaluation.

- ***Channels:***

  As TERANG Program is not eligible for all locations, the systems and the lamps could not be found in the market. PV systems will only be installed by RESCO in the locations which have already selected by Winrock International and Hivos. The lamps are also not available for all the villagers. The lamps are only available for the villagers who are the children go to school which has PV school's project. Those who are eligible to own the lamps could easily purchase them in the school through school operator or the teachers.

Infrastructure management

- ***Key partners:***

  TERANG program is a multiple stakeholders program. In order to make sure the success and the sustainability of PV school's project in TERANG program, Hivos has established essential partnerships with key stakeholders such as MCA-I, Winrock International, RESCO, Sundaya, GFP, local School, enumerator village body, Local government, Ministry of Education and Culture (MoEC), forwarder.

  TERANG program is a partnership program between Hivos and MCA-I. It means that MCA-I will provide a certain amount of grants if Hivos could also provide the same amount of them. Based on the current

MOU, MCA-I provides USD 4.7 million for TERANG program and so does Hivos which collect the grants from different donors.

As the lead consortium of TERANG program, Hivos relies on Winrock International and RESCO for the technical assistance especially for the choice of the technology (Winrock International) as well as the installation, O&M, and after-sales services (RESCO). For the technology, Winrock International suggested several brands and manufacturers which have good quality for the PV systems and the charging stations. Then, the decision was made through a bidding process. The final bidding process resulted that the PV systems technologies were imported from different manufacturers in Germany, The United States of America (USA), and The Netherlands. Sundaya, a local company, has won the bidding for the charging station.

Hivos, together with the GFP as the gender specialist, is responsible for the community engagement and training for the villagers and the school operators. A collaboration between TERANG Program's implementor and the school, village bodies, local government as well as the MoEC is also important from the early start to the end of PV school's project.

To reduce the workload, HIVOS established a partnership with a forwarder company to take care of all the imports and shipping issues. In this way, HIVOS could just order the products and wait the products until its arrival in Sumba office.

- ***Key activities:***

  Hivos, as the leader of the project, will be responsible for all the key activities done by other stakeholders such as Winrock International, RESCO, and GFP. For the overall PV school's project, Hivos only focuses on its main activities which are survey and socialization, training, monitoring & evaluation.

- ***Key resources:***

  The most important key resources for PV school's project are Hivos officers, School operator, and RESCO team. These people are the focal points which connect the users and the technology providers

Financial aspects

- ***Revenue streams:***

  The revenue stream on PV school's project is divided into two areas which are the revenue which comes from the school's monthly subscription for PV systems and the sales of the lamps as well as the charging fees from the lamps' users. For the entire PV systems, the school needs to pay about IDR 300,000 to IDR 400,000 (EUR 23.3 – 28.4) per month. This payment is made with Bantuan Operational Sekolah (BOS) program or the Indonesian school operational assistance program allocated from APBN. According to Mr. Rudi Nadapdap, the payback of the systems is approximately 3,5 to 4 years period. After the payback period, the school is expected to pay the service fee only. However, the business model after the payback period is not fixed yet.

  The other revenue of this project comes from the sales of the lamp and the charging fee. The lamp costs about IDR 50,000 (EUR 3.5) which could be paid in cash or twice in a month. Those who want to pay the lamp twice need to pay IDR 27,000 (EUR 1.9) per payment which will cost IDR 4,000 (EUR 0.30) more. The lamp is equipped with a warranty up to 2000 charging times or approximately two years period. After two years, the users could pay another IDR 50,000 (EUR 3.5) for the 'warranty fee' or simply buy a new lamp. The charging fee is IDR 1500 (EUR 0.10). The charging time is about four hours, and it could last from two to five days depending on the usage and the intensity used on the lamp. The payment of the lamps and the charging fee are collected by school operators or teachers who will be given to RESCO team.

- ***Cost structures:***

  The biggest cost needs to be incurred for PV school's project is the operational cost, which indudes the surveys, the socialization, and the training process. The distribution cost and the cost of the products also play an important role in making a success of PV schools' project.

9.5.3 Government's programs

9.5.3.1 Government's programs barriers

Infrastructure

Mr. Daniel explained that the issues related to the infrastructure are slightly significant for DSITAMBEN projects. It is because of dispersed population distribution as well as poor road conditions in the rural areas. This condition leads to challenges for DISTAMBEN team to reach the locations. Mr. Daniel argued that his department has asked and pushed the department from MVDDRT at the regional level to solve this problem since it is an area where this department works on. However, similar to DISTAMBEN, the department from MVDDRT have its priority and its limited budget to manage the projects they want to execute every year.

Investment

Mr. Daniel describes that the issues related to the investment are moderately significant. The funding for DISTAMBEN projects came from APBN and DAK. The amount of APBN and DAK which could be secured to increase the electrification ratio through PV technologies were limited. Moreover, the use of the funding from APBN and DAK is limited to the planning and the implementation of the project. Currently, the funding is not eligible for revitalization and maintenance of the previous projects since the ownership of the system has been transferred from the government to the individuals or the communities. Thus, DISTAMBEN has to decide the quota of the systems which could be given to the community, the locations which need to be addressed first, and the projects which give the highest impacts to the community.

Financial

Mr. Daniel deems that there are no financial issues on the end-users. It is due to the fact that the government gives the SHS or build centralized PV power plants for free. The end-users just need to pay a small amount of subscription fee which was set in the beginning by the communities themselves as an operation and maintenance fee. This fee could range from IDR 5,000 to 10,000 (EUR 0.35 to 0.70) per month per household.

Human resources

DISTMABEN in East Sumba used to have a team which consists of twenty people. Unfortunately, amongst those people, there was no person who has a technical background, especially on PV technology or other RETs. All the people in DISTAMBEN has a background in social. Thus, Mr. Daniel considers the capability and the capacity of his team to handle technical issues on the field could be moderately significant challenging. Mr. Daniel explained that there was training from MEMR which was held once a year for one week period. However, not all of his team could go to the training. Most of the training always have a certain quota which needs to be followed by the regional government. Thus, Mr. Daniel's team relied heavily on the learning by doing as well as several joint pieces of training with other NGOs in Sumba, which one of those NGOs is Hivos.

Technical

Mr. Daniels deems the issues related to technical aspects are not significant. It is because all the technologies for the projects have gone through the bidding and tendering process at the regional level. Thus, all the technologies for the projects should have met the expectation and specifications of DISTAMBEN at the first place.

Market demand

In general, there are no issues related to the market demand. It is due to the fact that the systems or the electricity services are given for free. Thus, the villagers, who currently do not have access to the electricity, always excited to receive some help from the government.

Social, Behavioral, Cultural

Mr. Daniel sees the issue related to Social, Behavioral, and Cultural as a very significant challenge. From the field study and interview with some of the villagers who received the government program, it could be seen that most of the government programs, which include DISTAMBEN project, on PV electrification in rural areas are not sustainable. It is because there is a lack of knowledge, capacity, and capability of the villagers to maintain and operate the PV systems. Although Mr. Daniel claimed that DISTAMBEN had conducted training for the villagers, there is not much knowledge from the training left which can be seen in the community. Mr. Daniel also added that the villagers are not responsible for the systems which were given to them for free, or there was a lack of ownership of the systems.

Governmental/Institutional

From DISTAMBEN point of view, the change of the regulation has affected DISTAMBEN's team significantly. Mr. Daniel explains that the issues on the change of regulations were extremely significant. It is because the new regulations have deactivated or removed DISTAMBEN in the regional government. It means that Mr. Daniel and the team can no longer actively participate in SII program or initiate any PV projects to increase Sumba's electrification ration through RETs.

Network/Partnerships

According to Mr. Daniel, the challenges on the network or partnerships are slightly significant. He described that although the projects carried by DISTAMBEN, coordination, and collaboration with other departments in the regional and local government were needed. Unfortunately, the coordination amongst the departments at the regional level is quite lacking. This condition leads to overlapping similar projects from different departments on the same locations.

Environmental

On the environmental issues, Mr. Daniel explained that it is not significant for DISTAMBEN since the ownership of the systems and the responsibility to maintain and recycle the systems were transferred to the villagers. DISTAMBEN could no longer interfere because the department does not own the asset. Other departments will act the same as the regulations do not allow them to do a further intervention. Besides, the funding is not eligible for revitalizations projects and recycling process at the moment.

9.6 A guideline: framework's usage

The framework which is developed in this study could be divided into four steps indicated by the arrows above the picture. The explanation of the framework is explained as follows:

1. The first step is the definition of two elements of business model which are customer segmentation and value proposition.
2. The second step is determining the level of barriers which might influence business performance of PV companies. The level of barriers is indicated with the color. Red means that a certain barrier is extremely significant towards the company business. Orange explains that the barriers are very significant towards the company's business. Yellow and Green represent barriers that are moderately and slightly significant towards the company's business. Lastly, Blue represents that the barriers are insignificant towards the company's business. The description of the barriers is shown in Table 2.8. In this step, several influencing factors which determine the choice of business model's elements are also shown.
3. The third step shows the guideline in determining elements of business model.
4. The last step shows that the choice of elements of business model will influence the cost required to operate the business

9.7 Details of expert interviews

The validation of the framework was done in two ways. Firstly, it was through cross cases analysis. Secondly, the validation was obtained through expert interviews. From the expert interview, we discovered that all the interviewees, who are the practitioners from PV industry, agree that they faced barriers as mentioned in the framework. The explanation of each of the barriers is given below:

Infrastructure

Mr. Hamzah describes that PT. SUN also face barriers in infrastructure as moderately significant. It means that there is adequate infrastructure to the location of the projects. However, the condition of the existing infrastructure is not good for the company to reach its users considering the costs that needs to be prepared. Thus, the company hire a third party to handle the shipping and the sales of the products. Mr. Hamzah explains that it is very important to have partners to solve the issues. He adds, without a forwarding or distributing partner, the company would need a bigger investment to operate the business. Mr. Hamzah also concurred that the higher level of barriers in infrastructural aspects, the higher involvement of third parties needed to solve the issues.

Financial

Mr. Hamzah explains that PT. SUN experiences slightly significant financial issues from its end users. He describes that the revenue collection is done direct and indirectly based on the amount of investment needed for the project. The higher the investment needed for the project, the more PT.SUN collects its revenue indirectly through its partners such as regional or local banks. Mr. Hamzah explains that it is important to have a third party as a backup so that the company does not have to cover all the financial risks by itself. Mr. Hamzah also concurred that it is better to transfer the financial risk to the third party when the level of financial barriers is higher.

Market demand

Mr. Hamzah deems the level of market demand's barriers as very significant towards PT. SUN business. Currently, PT. SUN promotes its products as well as the use of PV for electricity generation in general based on the location of the projects. Firstly, if the location of the targeted projects is within the operational range of the company, the company does its own marketing activities to promote its products. On the other hand, while the location of the targeted projects is out of the operational range of the company, PT. SUN promotes its products through regional and local government. The company also establishes partnerships with local entrepreneurs to promote and sell the products. In this way, the company would only need one person to handle one area which is out of the company's operational range. From the interview, Mr. Hamzah also agreed that the higher level of barriers in market demand, the higher involvement of third party and the more resources needed to overcome this issue.

Social, Behavioral, Cultural

Mr. Hamzah describes the level of barriers on Social, Behavioral, Cultural aspect as sightly significant. Mr. Hamzah explains that it is because the company makes sure that all the products sold in the market are A-grade. It means that the company only sells good-quality products. Mr. Hamzah adds that the company relies heavily on its partners for the company's operational activities, such as distribution, marketing, sales, installation, maintenance, and services. The company has a call center in Jakarta. When there is something happen to the system which is located outside the company's operational range, the users could call to this call center. Then, the company's engineer in Jakarta would cooperate with PT. SUN's local partners to have the systems checked. When a small repair is needed, the local partner will fix the systems immediately. In this way, the company needs less investment to operate its

business. From the interview, Mr. Hamzah also concurred that the lower level of barriers in Social, Behavioral, Cultural aspects, the less operational activities done by the company itself.

Environmental

Mr. Hamzah describes the level of environmental barriers as slightly significant. Currently, the company is only responsible for the waste collection. While the recycling process is currently still the users' responsibility.

Technical

Mr. Hamzah explains that each of PV companies might have different technical problems. Thus, solutions tailored based on the specific barriers would be needed.

Investment

Mr. Hamzah deems the investment barriers for PT. SUN insignificant. Currently, the company receives enough investment from both the internal group and external investors. He adds that it is still impossible to secure loans from the bank since this types of business is seen as high risks business. Thus, the only way to solve the investment issues is to find the right investors and donors as well as to secure some grants.

Human resources

Mr. Hamzah explains that currently the company has enough good-quality talents for every positions in the company. Thus, he deems the barriers on human resources as insignificant. However, to make sure that all the talents get enough knowledge, the company provides continuous training for its employees. From this interview, Mr. Hamzah also agreed on the solution provided by the framework which is the only way to solve issues in human resources is to provide trainings and increase the employment pool.

Government/institutional

Mr. Hamzah deems the barriers on the government/institutional aspects as moderately significant. It is because he sees the government of Indonesia has several policies which support RET. However, the implementation of the policy is still lacking. Mr. Hamzah explains that teh only way to get the supports from the government is to do lobbying activities through formal forums and personal approach to related departments which support RETs.

Network/partnerships

Mr. Hamzah describes the barriers on network/partnerships as moderately significant. It is because to find the right partners is quite a challenge. PT. SUN has some criteria to select its partners. Mr. Hamzah adds that the Return of Investment (ROI) of both parties have to be feasible. Also, Mr. Hamzah explains that it is important to have scheduled coordination meetings in order to avoid dispute

Mr. Hamzah and Mr. Bart Fugers explain that the list of barriers on the framework is already cover all the barriers they might face on the field. On the framework, both of the interviewees think that the framework is too complicated. They added that it could not be easily understood from the first look. They both agreed that it is important to make the framework simple because it needs to be used by someone. Mr. Bart fugers suggested to have empty spots to fill in by the people who use the framework. In this way, the framework would be more practical.