CHALMERS

Commercialisation of Oasis

-Targeting Customer Segments for a Thermal Solar Energy System

Bachelor's Thesis in Industrial Engineering and Management

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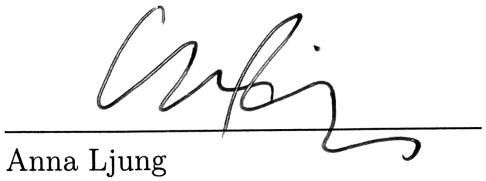

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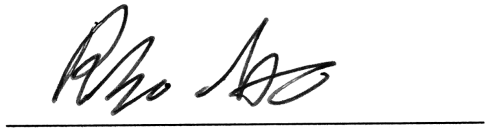

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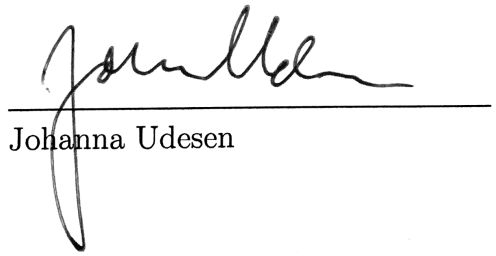

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Abstract

This study was performed in order to aid the commercialisation of a thermal solar energy system by United Sun Systems International Ltd. The purpose was to study how the company could direct their focus when targeting potential customer segments, and how to develop value propositions for each segment respectively. The thesis therefore includes a literature review, resulting in knowledge about the Customer Development Process, the Business Model Canvas, the Mom Test and different solar energy technologies. Hawaii, Chile and California were identified as potential markets through initial online research. The customer segments were later defined as urban, on grid areas in Hawaii and California, and off grid mining industries in Chile. Through iterative work in conducting interviews these segments were evaluated and value propositions were then developed based on the information generated from the interviews.

The study concludes that California and Chile contains potential customer segments which calls for further research. Hawaii posed several challenges such as technology lock-in and high air humidity, and is therefore not recommended for further research. In addition alternative markets are also suggested for continued work based on information acquired through research and interviews.

Keywords: commercialisation, renewable energy, concentrated solar power, customer segmentation, value proposition, hypotheses.

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Vocabulary

The vocabulary presents concepts and abbreviations used in this thesis and is structured in alphabetical order.

Business Model: Is a model that shows how a business operates in order to create, deliver and capture value.

BMC: Business Model Canvas, a template helping companies to build business models. The canvas consists of nine building blocks, each representing a suggested part of a business model.

CSP: Concentrated Solar Power is a solar energy technology where the heat from the sun is concentrated on receivers. The heat can then be used to produce electricity.

Direct Normal Irradiation: The component of solar irradiation that is hitting a surface that always is perpendicular to the sun.

Diffuse Horizontal Irradiation: The irradiation that has been scattered by different obstacles in the atmosphere before it hits the Earth's surface.

Global Horizontal Irradiation: The sum of all solar irradiation that is collected on a plane that is horizontal to the surface of the Earth.

Iteration: A process that confirms, modifies or rejects a stated hypothesis. In this study iterations are made by interaction with actors on potential markets.

LCOE: The Levelized Cost of Energy is the ratio between a certain technology's

cost during its entire lifetime and the amount of electricity generated during this time.

Letter of Credit: A letter that a bank sends to a potential seller, guaranteeing that the payment from the buyer will be made on time with the correct sum.

Market pull: When a product is being developed through the demand of the market.

Oasis: Oasis is USSI's concentrated solar power system consisting of a parabolic dish, a thermal battery and a Stirling engine.

Off Grid Actors: Actors that are not connected to electrical grids.

On Grid Actors: Actors that are connected to electrical grid.

Operational Lifetime: The time span of which a technology is operative and delivers energy.

PV: Photovoltaics is a solar energy technology based on collisions between photons from the sun and solar panels, containing small PV-cells. Unlike CSP PV utilizes the sunlight and not the heat.

PV Effect: The way PV panels utilizes photons to produce electricity.

Sensible Thermal Energy Storage: A technology that uses the heating or cooling of a particular storage medium to store thermal heat from the sun.

Solar irradiation: The energy from the sunlight coming from all of the sun and is being measured down on Earth.

Solar radiation: A term describing the electromagnetic radiation that the sun emits.

Thermal Storage Based on Phase Changes in Materials: A technology that uses the phase changes of different materials in order to store thermal heat from the sun as latent heat.

The Customer Development Process: A four step model for how to create, test and validate a business model and further on expand the company. The four steps are customer discovery, customer validation, customer creation and company building.

The Mom Test: A framework used to get in contact with and interview potential customers. The aim is to receive truthful insights by asking open questions.

The Product Development Model: A product focused model that shows an approach for developing, testing and launching products.

Renewables: Different types of renewable energy sources.

Technological lock-in: When a technology dominates the market although there is another superior technology available.

Thermal energy Storage Based on Chemical Reactions: A technology that uses different chemical reactions and chemical reactants in order to store thermal heat.

Technology push: The act of a product being developed internally and pushed onto the market.

Thermal Energy Storage: A broad term for a set of different technologies, that are able to store thermal energy and use it at another point in time in order to better match the supply and demand of energy.

Utility-scale: When power is mass produced and distributed to customers through the grid.

US Department of Energy: An American authority, primarily responsible of tackling issues related to the environment and energy sources.

1
Introduction

Randall (2016) at Bloomberg New Energy Finance states that the energy from coal, oil and gas will begin their terminal decline in less than a decade. The world can no longer be dependent on these for supplying its energy needs. Randall (2016) also predicts that the dominant energy source will be solar. If this prediction turns out to be correct the global energy market will already now have to adjust to these circumstances. About Money (2016) states that solar energy sprung onto the market in the 1970s and since then it has according to Global market (2016) expanded into a USD 65 billion industry world wide. Sørensen (2015) claims that there recently has been a decline in prices for solar energy systems, such as solar panels for consumers and solar thermal systems with different applications. According to Sørensen (2015), solar panels have seen a great increase in amount of capacity installed and solar thermal systems have become prevalent in different fields such as provision of hot water. Further on Sørensen (2015) says that with these developments in solar energy, the issues that may hinder solar energy from becoming a common part of today's energy sources have become a subject that is relevant to discuss.

Ultimately, today's technologies are experiencing a major flaw in distributing solar energy during the dark hours of the day due to limited storage possibilities. As solar power is a direct power source, it has been a challenge delivering energy during peak demand that occurs during evening. This is for instance a serious issue in California, where there is a distinct overproduction of solar energy during the day, and a lack of energy during peak demand in the evening (NREL, 2015). This challenge is commonly referred to as the Duck Curve which is shown in figure 1.1.

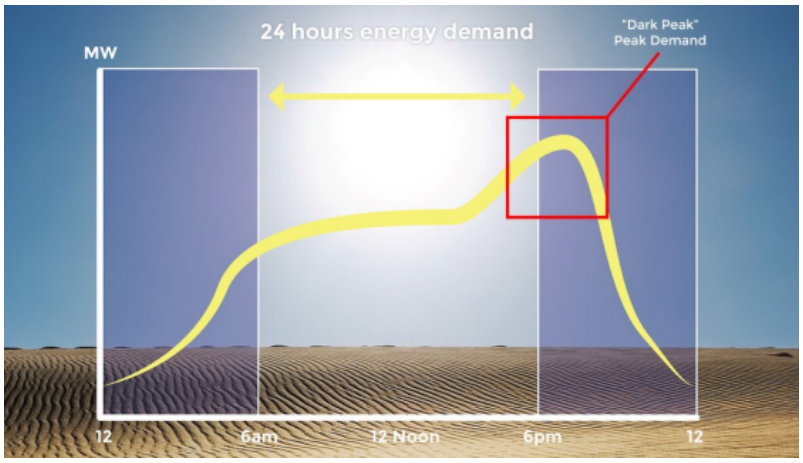

Figure 1.1: The Duck Curve. The peak energy demand appears around 6 pm in the evening. (United Sun Systems International, 2017a)

One solution to the Duck Curve is big scale storage, a solution that in itself leads to new challenges. The life span of the batteries used in solar cell technology is on average five years due to its rapid decrease in performance (Saft, 2014). As well as being dependent on noble metals recycling these metals is energy intensive, requiring six to ten times more energy than mining (Battery University, 2016).

The challenges of the Duck Curve and thermal storage are the main reasons for the existence of this study. United Sun Systems International is a company that is operative in the field of solar energy. They have come up with a solution to the challenges of the Duck Curve and storage: the *Oasis*, a solar energy product able to store thermal heat for usage during peak hours of the day. The aim of this study is to aid in commercialising *Oasis* by providing research regarding potential customer segments and their value propositions.

1.1 United Sun Systems International Ltd

The climate change fuelled the vision behind the foundation of United Sun Systems International Ltd, hereby referred to as USSI. The company was founded in Gothenburg, Sweden in 2010 by Lars Jacobsson with the ambition to provide continuous solar energy 24/7 for a cost less than that of fossil fuels. By using a concentrated solar panel in combination with a Stirling engine, they can harness energy with twice the efficiency of solar cells while a revolutionary battery solution supplies energy all day round, all of it for a lower cost than fossil fuels and modern day solar cell technology.

Ever since their founding, USSI and their partners have in some way been engaged in creating and developing more than 80 percent of concentrated solar power projects that have involved a Stirling engine and a parabolic dish. A combination of USSI's experience within the field of solar energy and last years increase in energy prices is having USSI convinced that *Oasis* is commercially mature enough to enter the market. (United Sun Systems International, 2017b)

1.2 Purpose

The purpose of this project was to identify suitable customer segments for USSI, and develop value propositions for each segment by iteratively testing hypotheses according to the Customer Development Process. This study aimed to form a basis for the commercialisation process of *Oasis*.

1.3 Problem Statement

The transition from fossil fuels to alternative energy sources is inevitable, however the question of which energy sources and technologies that will be commercially successful still remains. The market currently provides with alternative energy sources such as nuclear, hydro, solar, wind and geothermal, each obtaining individual qualities that attracts different customers.

Solar energy is estimated to expand into the the largest renewable energy source with its wide technology range (Randall, 2016). *Oasis* offers a specific solution combining established technology with the latest research in storage and USSI are now in need of determining who their potential first customers are in order to commercialise *Oasis*.

There are many possible customers and the value propositions could be tailored for each one of them. The problem statement is summarised in two questions that have been taken into account during this study:

1. How could USSI direct their focus when targeting potential customer segments for *Oasis*?
2. What does a suitable value proposition for these customer segments include?

1.4 Scope

The time scope of this project was four months. This resulted in limited workload adapted to the current project time. Therefore, the project initially began with a broad perspective to be narrowed down quickly into more specific areas. There were several potential geographical areas that fulfilled the solar irradiation required for *Oasis* and this study focused on California, Hawaii and Chile. These markets were chosen in an attempt to cover as large a spectrum of USSI's potential customer segments as possible.

The level of solar irradiation required for *Oasis* exists in regions that due to physical distance called for using email, Skype and telephone calls when getting in contact with different actors. The interviews were conducted via Skype, email conversations or face to face. Interviews were carried out until two weeks before due date in order to have time to compile and analyse the answers.

The Lean Startup methodology is suited for iteratively developing products based on customer issues and needs. Since the company had already developed *Oasis* there was no possibility to develop or change the product iteratively during the project. In other words, this study is an example of testing out the Lean Startup methodology on a technology push product by focusing on the Customer Development Process. This involved finding suitable customer segments and developing value propositions by interacting with these customers in order to find the ideal market fit.

1.5 Structure

The thesis is divided into seven chapters. After the introduction follows a Literature Review that contains a methodology review and a technology review. The practical work during the study is presented in chapter three: Method. Chapter four presents the process in which markets are identified, hypotheses are stated and interviews conducted. The process and alternative methods are discussed in the fifth chapter: Discussion, from which a conclusion is drawn constituting chapter six. Finally the Further Research accounts for an advised path to proceed the process of commercialisation.

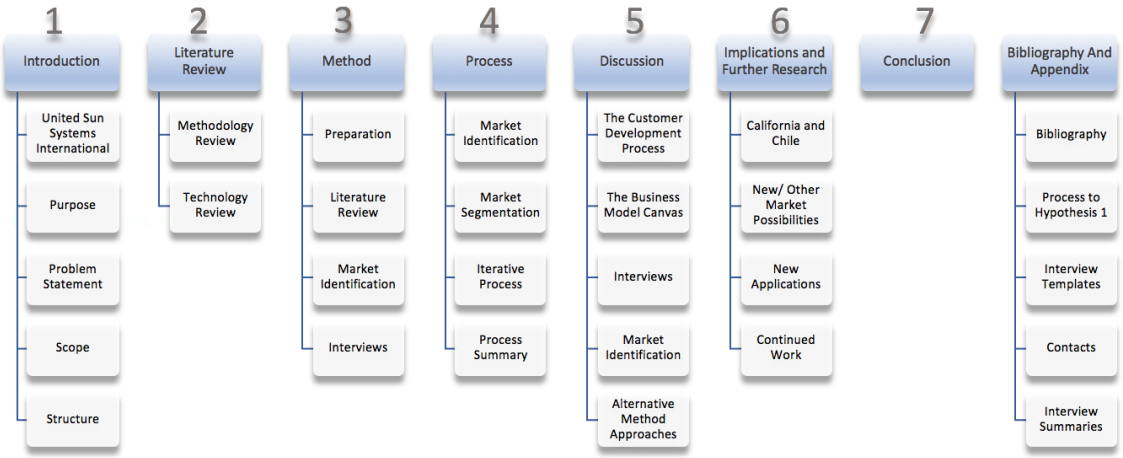

Figure 1.2: Report Structure

2
Literature Review

The Customer Development Process, the Business Model Canvas and the Mom Test forms the basis of this study, therefore a thorough initial understanding of them is required to determine if they suit the purpose of the study. The literature review consists of two main parts. The first part describes the mentioned methodologies. The second part is a technology review which describes general solar and storage technologies including USSI's technology.

2.1 Methodology Review

The methods below are common with the Lean Startup methodology that aims to work iteratively, keeping the customer in focus. The usage of these methods deepens the understanding of the customers and enable creation of value propositions for targeted customer segments.

2.1.1 The Customer Development Process

According to Blank & Dorf (2012) many startups need a structured procedure to turn hypothesis into facts, in order to develop a suitable business model. With this as a starting point Steve Blank developed the Customer Development Process and published it in *The Four Steps to the Epiphany*. Since then the methodology has been further developed by him and other entrepreneurs, for example Erik Ries, author of *The Lean Startup - How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses.*

According to Blank & Dorf (2012) the Customer Development Process is designed to solve the problems aligned with the traditional product development. Blank & Dorf (2012) describes the traditional Product Development Model as a path to disaster. They write that this is a model that emerged early in the twentieth century and is a product centric model that first spread to consumer packaged goods industry and then ended up being an important part of startup culture. Blank & Dorf (2012) further claim that the model works for well defined markets with well known competition and customers. The problem is, according to Blank & Dorf (2012) that few startups live up to these criteria, but continue to use the model. This results in investments and product development that are based upon a model that is poorly suitable for startups, which could lead to failure (Blank & Dorf, 2012).

Figure 2.1 displays the Product Development Model step by step. In the first step, Concept, visions and key ideas are transformed into a business plan. Next, the Product Development step, represents that all involved parties within the companies are working on the development process. Notably this is done isolated from each other. In the third step the product is controlled to see if it works as it is supposed to do. If it does, it is ready for step four, Launching. The Product Development Model does not take the customers into account when developing the product. The main purpose with the model is to develop the product, not working on the customer relations. The customers however can be seen as a crucial part of the development of a new product, since it is the customers who consider buying it. Leaving out the customers could result in the company investing in a failed product. (Blank & Dorf, 2012)

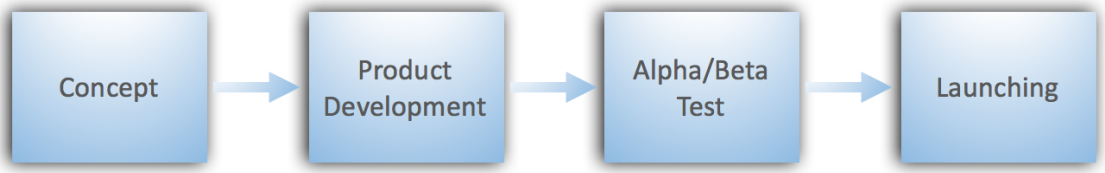

Figure 2.1: The Product Development Model (Inspired by: Blank & Dorf 2012).

Instead of using the Product Development Model, startups could gain profit by using the Customer Development Process. In short, this is a process of market discovery, customer location, assumption, validation and business growth, all that startups usually lack a process for. This process is designed to solve problems that might come up while using the Product Development Model. For instance problems in finding suitable customers, misdirected marketing, difficulties in generating sales and also handle the risk connected to launching the wrong product. (Blank & Dorf, 2012)

Figure 2.2 shows the steps of the Customer Development Process. In the Search Phase, the business model is developed, tested and validated. In the Customer Discovery step, potential customer segments are stated as hypotheses and a plan describing how to test the hypotheses is also initiated. This test plan is carried out in the second step, Customer Validation. If the hypothesis is shown to be correct the process moves forward into the Execution Phase, where focus is on growing and establishing the company. If not, the first step is repeated but with modified hypotheses based on the learnings drawn from the testing. (Blank & Dorf, 2012)

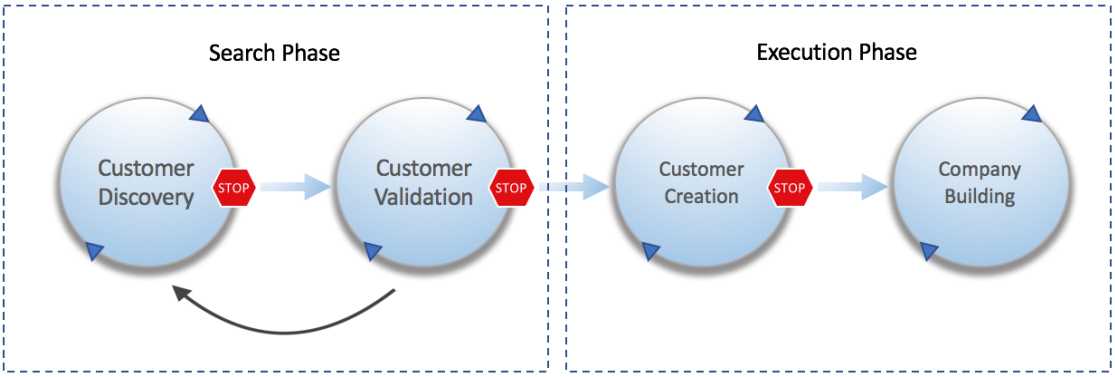

Figure 2.2: The Customer Development Process (Inspired by: Blank & Dorf, 2012).

2.1.2 The Business Model Canvas

The study of the Business Model Canvas, BMC, has its starting point in *Business Model Generation*, a publication by Osterwalder & Pigneur (2009). They created this model to help companies understand and build business models in order to create, deliver and capture value. They describe a business model as nine building blocks and the BMC as an illustrative overview of these building blocks.

Figure 2.3 shows how the nine building blocks are put together to the BMC, first to follow is a description of the right hand blocks. The Customer Relationships and Customer Segments blocks contain the different actors the company want to reach. The Value Propositions block describes which products and/or services that are needed to satisfy a special Customer Segment. The Channels block shows how the company plan to reach the Customer Segments in order to deliver the custom-made Value Proposition. Lastly, the Revenue Streams block define the income generated from a successful business.(Osterwalder & Pigneur, 2009)

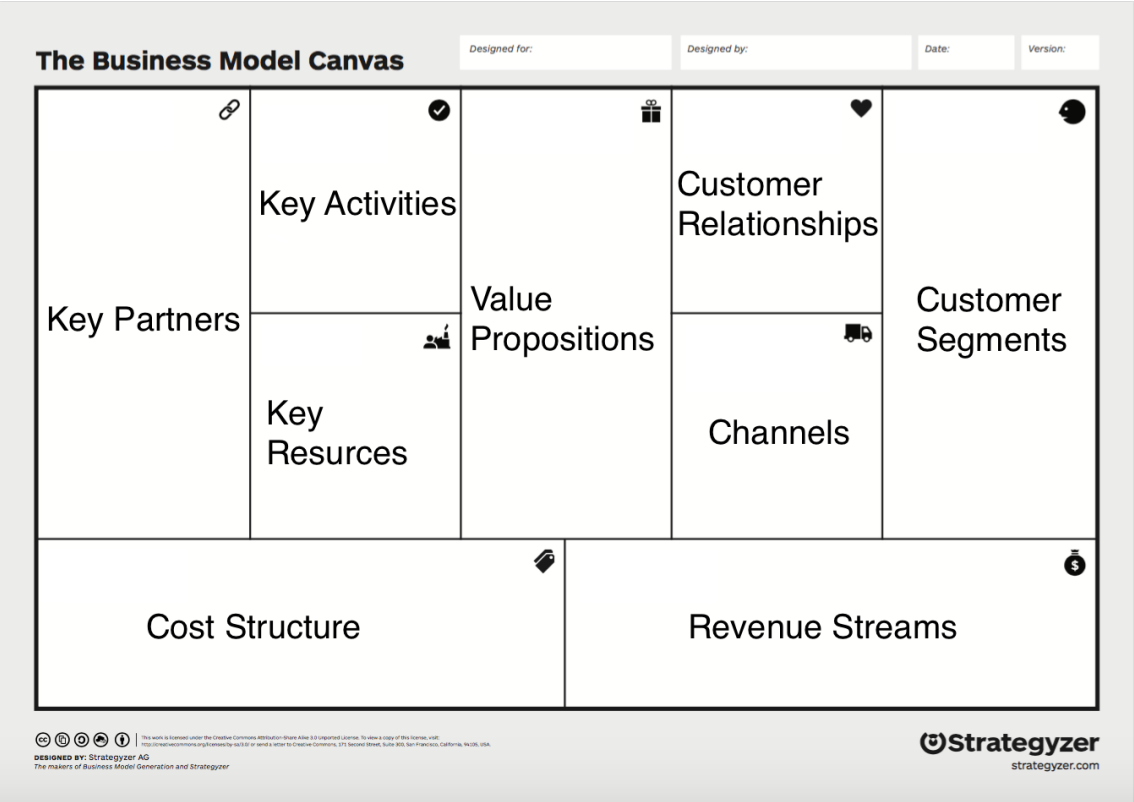

Figure 2.3: The Nine Building Blocks displayed in a BMC by Strategyzer. (Strategyzer, 2017)

The left hand blocks display all actors and assets that are needed to achieve the right hand blocks. In order to make the business model work, potential Key Resources are analysed as well as Key Activities, these blocks describe what the company requires. The Key Partners block describes the network of suppliers and partners that the company is a part of. This is often considered as a corner stone of the business model since many activities included in the business model is depending on this network. The last block, Cost Structure, contains all expenses. (Osterwalder & Pigneur, 2009)

2.1.3 The Mom Test

According to the Customer Development Process it is of importance to take care of the customers' wishes when developing a product. Therefore interviews are required. The following section presents Rob Fitzpatrick's principles about how to get out of the building and talk to customers.

The Mom Test by Rob Fitzpatrick (2013) is a practical manual on how to talk to customers. The idea is to ask the right questions and as a result learn even more and about the customers needs and do it faster than a traditional market research. Sometimes those interviews, or as Fitzpatrick (2013) rather calls them "casual meetings", give useful information. By getting out of the building in an early stage, unnecessary investments in time and resources can be avoided.

The first obstacle that Fitzpatrick (2013) mentions is the fact that people tend to lie. Once the idea is presented people or customers compliment and encourage it, even though they do not believe in it. The book walks the reader through several tips and exemplifies what kind of questions that generates truthful answers. The Mom Test is explained by the author as "not even your own mother can lie to you".

Core beliefs in The Mom Test:

1. Talk about their life instead of the idea
2. Ask about specifics in the past instead of generics or opinions about the future.
3. Talk less and listen more.

By following the Mom Test when formulating questions, great learnings can be drawn from the customers' behaviour and problems and further how the solution can be created and presented. In fact, Fitzpatrick (2013) says a bad customer conversation is not only useless but worse, "they convince you that you're on the right path. They give you a false positive that causes you to over-invest your cash, your time, and your team" (p.7). The author has himself learned by own failures and achievements and recommends to keep the meetings casual. By asking about the customers lives and problems it is easier to avoid talking about the business idea and thereby also avoiding the lies and compliments.

Finding conversations is often easier if the idea is of business-to-consumer character rather than business-to-business. Then it is easier to ask people about their everyday life in a casual way and meet them in person. It is also easier in most cases since the financial buyer and decision making part is not as complicated as within a firm. Fitzpatrick (2013) gives an example on what to include in an email or talk in order to settle a meeting. The content should include a Vision, Framing, Weakness, Pedestal and Ask. During a meeting it is important to take notes and share the learnings with the team afterwards.

2.2 Technology Review

In the process of finding customer segments, knowledge of USSI's technology system as well as alternative technologies are required in order to gain a better understanding of the solar energy market. Different markets and customer segments demand different qualities and are therefore in need of diverse value propositions. Technologies and storage opportunities are presented below for a better the understanding of available solar energy products.

2.2.1 Solar Radiation

Solar radiation is a term often known as solar resource and describes the electromagnetic radiation that the sun emits. With the help of several different technologies, energy can be produced with the help of solar radiation. The solar radiation at different geographic places varies and depends on factors such as weather and what time of the year it is. (U.S Department of Energy, 2013)

Zell (2008) defines the term irradiation as the light energy that radiates from an object onto another object per square meter per second. Zell (2008) further explains solar irradiation as the energy from the sun measured on Earth. Ammonit (2017) states that the irradiation that is always perpendicular to the sun is known as the Direct Normal Irradiation, which is the irradiation that CSP technologies utilize. Another type of irradiation is the Diffuse Horizontal Irradiation. Ammonit (2017) explains this solar irradiance as the one that was scattered by objects in the atmosphere before it hits the surface. Thus, Diffuse Horizontal Irradiation comes in equal quantities from every direction (Ammonit, 2017).

Global Horizontal Irradiation includes both the Direct Normal Irradiation *and* the Diffuse Horizontal Irradiation, see equation 2.1. It is defined as the total radiation that hits a surface horizontal to the ground and is the unit used when measuring photovoltaics, PV. (Ammonit, 2017) The Solar Zenith Angle α in equation 2.1 is the angle between the sun and a line that is perpendicular to the Earth's surface. (Cronin, 2014)

$$GHI = DHI + DNI \cdot cos(\alpha) \tag{2.1}$$

$GHI = Global\ Horizontal\ Irradiation$
$DHI = Direct\ Horizontal\ Irradiation$
$DNI = Direct\ Normal\ Irradiation$
$\alpha = the\ solar\ zenith\ angle$
(Ammonit, 2017)

2.2.2 Concentrated Solar Power

CSP is a technology where the Direct Normal Irradiation is being reflected on a mirror and consequently concentrated on an area known as a solar receiver. The receiver transfers energy from the sun to a liquid that can transfer heat. This can further be used for electricity production or distributed as heat for end-consumers. CSP plants can also have a system to store heat in order to produce electricity when sunlight is not available. (Simbolotti, 2013a)

There are four primary CSP technologies on the current market; Parabolic Dish, Solar Tower, Parabolic Trough and Fresnel Trough. There are big technological and economical differences between these technologies and the capacities of these technologies also differ which is showed in table 2.1. (IRENA secretariat, 2012)

Table 2.1: Shows the capacity range of four main CSP technologies. (IRENA secretariat, 2012)

CSP Technology	Parabolic Dish	Linear Fresnel	Solar Tower	Parabolic Trough
Capacity $[Megawatt]$	0,01 to 0,025	10 to 200	10 to 200	10 to 300

The reason that the Direct Normal Irradiation is the only type of irradiation of interest for CSP is that it can be concentrated to the very high temperatures that CSP demand for production of electricity. For CSP to be an economically justified option, a DNI of at least $2000 kWh/m^2$ *per year* is required. The larger the Direct Normal Irradiation is, the lower the cost will be if everything else is unchanged. (IRENA secretariat, 2012)

In some geographic areas with the highest Direct Normal Irradiation of $2800 kWh/m^2$ *per year*, CSP technology can potentially produce anywhere from 100 to $130 GWh/km^2$ *per year* of energy. A 20 megawatt energy plant using coal can approximately produce the same amount of electricity using a capacity factor of 75 percent. (Simbolotti, 2013a)

In order to determine the costs of an energy system, the Levelized Cost of Electricity, hereafter referred to as LCOE, is calculated. The LCOE for an energy system is defined as the ratio between the lifetime costs and its expected total power output during that lifetime. The latest measurements of LCOE for CSP technology globally in 2014 shows that the LCOE ranges anywhere from 0,20 to $0,35 USD/kWh$ (Daniel, 2015). In comparison, the global LCOE for fired coal ranges from approximately $0,04$ to $0,15$ USD/kWh, and for nuclear energy between $0,09$ to $0,150$ USD/kWh according to Salvatore (2013).

2.2.3 Solar Photovoltaics

PV is a solar energy technology based on the collision between photons from the sun and PV cells on solar panels. Every cell contains a negative and a positive charged side that generates an electric field. Once the photons collide with the cells, electrons are released creating a current that generates electricity (U.S Department of Energy, 2011). The process of producing electricity from energy photons is known as the PV effect, (NREL, 2017). The PV technology can produce electricity also on cloudier days. It will however lead to reduced amounts of generated electricity. (Simbolotti, 2013b)

Larger solar resources implies a lower cost for producing electricity, meaning their LCOE is lower in comparison to smaller solar resources. There are two separate types of PV systems and their respective LCOEs are shown below. (Daniel, 2015)

- LCOE of residential PV in smaller scale ranged from $0,14 USD/kWh$ to $0,47 USD/kWh$ in 2014 for the countries that were measured.
- LCOE for more utility scale PV ranged from $0,11 USD/kWh$ to $0,28 USD/kWh$ in 2014.

These are average, regional values (Daniel, 2015).

2.2.4 Storage Technologies

Thermal energy storage is the term for technologies that let thermal energy be stored and used later on whenever it is needed. The stored thermal energy can also be converted into electricity. There are three main thermal energy storage systems, sensible thermal energy storage, thermal storage based on phase changes in materials and thermal energy storage based on chemical reactions. (Hauer, 2013)

Sensible thermal energy storage is a technology that uses cooling or heating of a storage medium that can either be in solid or liquid state. Oftentimes, this storage medium is contained in a tank with heavy thermal insulation. The most common thermal storage is water.
Hot water tanks is a common application for sensible thermal energy storage, that is being used for storing thermal heat seasonally, combined with smaller heating systems. Energy parks using water tanks today has proven to be a cost efficient method for storage with several areas for potential improvement, such as maximising the thermal insulation and optimising the stratification of the water (storage medium). The capacity of this storage technology is $10 - 50 kWh/t$ and the cost stretches from between $0,1 - 10 Euro/kWh$. (Hauer, 2013)

In thermal energy storage systems based on phase changes in materials, energy is stored as latent heat when the material of the storage system changes phase. By using different materials and techniques, both long- and short term storage is possible. The different phase changes can be solid to liquid or solid to solid. The

capacity of this technology is $50 - 150kWh/t$ and the cost ranges from between $10 - 50Euro/kWh$. (Hauer, 2013)

Thermal energy storage based on chemical reactions uses different chemical reactions in order to store heat. A higher capacity in comparison to the previous storage technologies can be achieved with the help of these chemical reactions. In order to store and release heat when it is needed, chemical reactions such as adhesion and adsorption may be used. A certain substance is being adsorbed or adhered to another solid's surface. These types of reactions can be widely varied by using several different reactants. The capacity of this technology is $120 - 250kWh/t$ and the cost stretches between $8 - 100Euro/kWh$. (Hauer, 2013)

2.2.5 USSI's Solar Energy Technology

Oasis is a CSP technology, categorised as Parabolic Dish, that will be able to deliver energy to businesses and households during the hours without sunlight in a way that is cheaper than other energy sources such as fossil fuels. It consists of three main parts, a 12 meter in diameter parabolic dish, a battery and a Stirling engine. see figure 2.4. *Oasis* has the ability to deliver energy for 0,06 US cents per kWh. Other sources of renewable energy are more expensive which is shown in table 2.2 (2017). This is competitive with the earlier mentioned LCOE values for fired coal and nuclear energy. (United Sun Systems International, 2017a)

Table 2.2: Showes the LCOE values for three solar energy technologies, compared to *Oasis*. The value for *Oasis* is taken from (United Sun Systems International, 2017a). The other values are taken from (Daniel, 2015).

Solar energy technology	*Oasis*	Residential PV	Utility scale PV	CSP
Cost (LCOE) $[USdollars]$	0,06	0,14-0,47	0,11-0,28	0,20-0,35

Oasis has a parabolic dish in which heat from the sun is being reflected and consequently received by the solar receiver, see figure 2.4. The parabolic dish, also known as a concentrator, is completely full of mirror glass. It follows and adapts itself to the sun's position to be able to reflect the heat to a solar receiver, located on top of the thermal battery, see figure 2.4. Amongst several CSP technologies and PV, *Oasis* has the highest efficiency of over 30 percent while the other CSP technologies and the PV technology only have approximately 15 percent.(United Sun Systems International, 2017a)

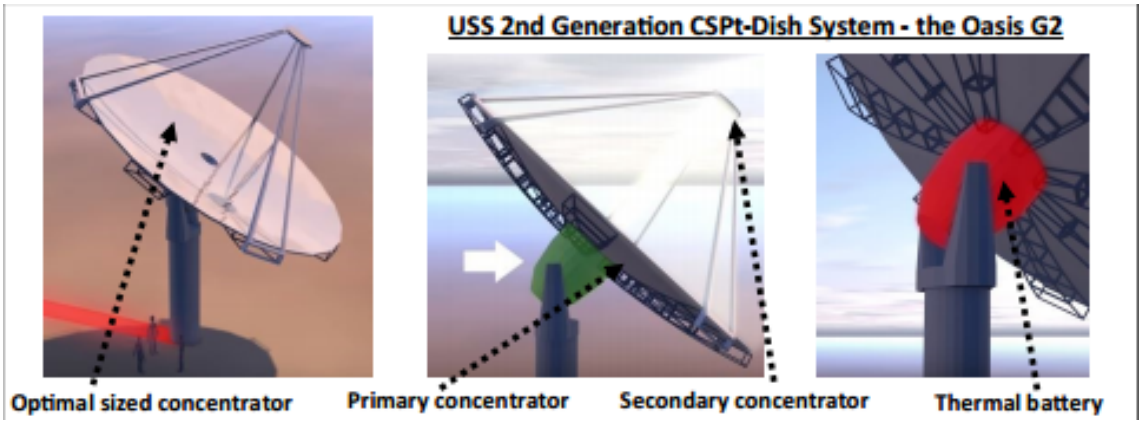

Figure 2.4: Illustration of *Oasis*. Left to right: *Oasis* size compared to a person, concentrator placement, thermal battery placement (United Sun Systems International, 2017a)

The solar receiver on top of the thermal battery receives heat coming from the sun. The heat is being stored in a storage tank in the battery. The heat can, at any point in time be released to initiate electricity production. With the help of ingoing heat pipes from the solar receiver, the storage medium is heated up to around 800 degrees Celsius. This thermal battery does not lose any heat while it is stored and the life span of the battery is at least 100 years. The battery can also be charged and discharged for an unlimited number of times. The stored heat can consequently power the Stirling engine with the help of another set of heat pipes leading from the battery to the engine. Figure 2.5 shows a schematic illustration of the thermal battery and its primary features. (United Sun Systems International, 2017a)

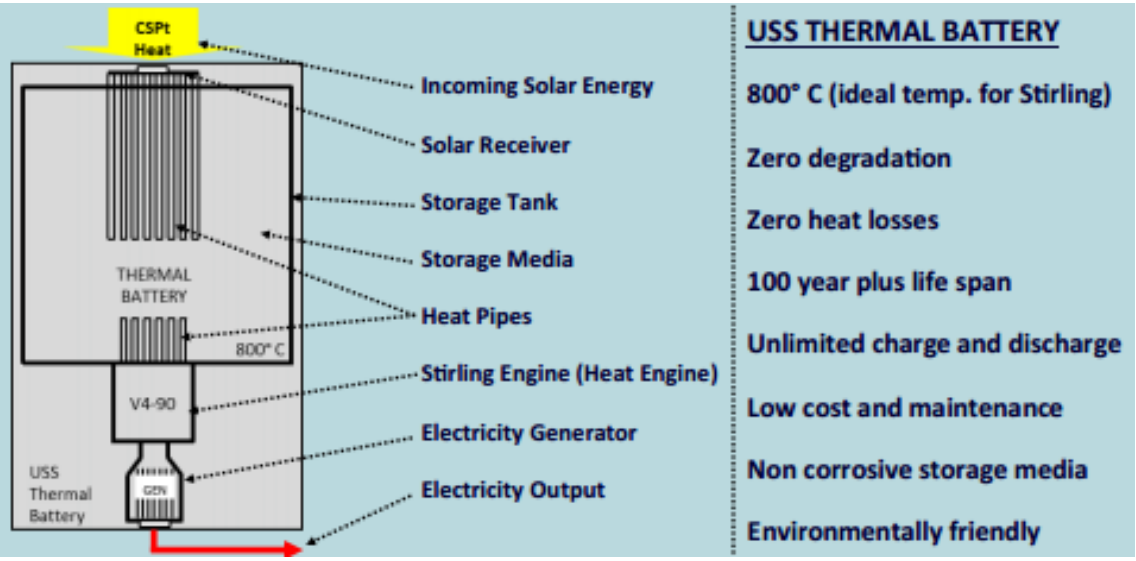

Figure 2.5: The thermal battery and how it is connected to the solar receiver and the Stirling engine. (United Sun Systems International, 2017a)

The final component of *Oasis* technology is the Stirling engine. As mentioned above, the stored heat can power the Stirling engine when required and then the engine can power an electric generator that will produce and provide electricity. Inside the Stirling engine there is a gas that will expand when the engine is being started by the heat. A power generator is connected to the Stirling engine. The Stirling engine will power the generator in order to generate electricity during dark hours of the day. (United Sun Systems International, 2017a)

3
Method

In order to give a clear overview of how the study has been conducted this section describes how the practical work during the study was approached. Market Identification and Literature Review was based on secondary data, whereas the iterative work was based on primary data from the conducted interviews.

3.1 Preparation

Because the basis of the Customer Development Process is common with the Lean Startup methodology, all members underwent the ten hour online class *How to Build a Startup* directed by Steve Blank at Udacity. *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses* by Eric Ries (2011) further provided an understanding of the methodology. A workshop in how to conduct interviews was also attended by members of the team in order to attain practical knowledge regarding future interviews.

The academic framework was put together with the directions from the examiner and Course Coordinator Erik Bohlin during his lectures. Marouane Bousfiha, doctoral student at the Chalmers Division of Entrepreneurship and Strategy, acted as the principal supervisor during the process of the study, aiding in interpreting the Customer Development Process, guiding the work and directing the composition of the thesis. The Chalmers Division of Language and Communication advised in the structure of the thesis.

Part of the preparation required by the Chalmers Administration was to review the method of a previous Bachelor's thesis. A Planning Report was also required in the beginning of the course, containing a background, purpose, problem statement and the method of the thesis.

USSI provided input through weekly conference calls with Magnus Millingen, Chief of Sales and Marketing. Lars Jacobsson, CEO, was also present during some of these meetings.

3.2 Literature Review

The literature review was conducted using recognised publications regarding lean commercialisation. The foundation of the method is the Customer Development Process, using *The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company*, by Steve Blank and Bob Dorf (2012). The process of formulating hypothesis was aided by using Business Model Canvases, based from the *Business Model Generation* by Alexander Osterwalder and Yves Pigneur (2010). The framework of the interviews are *The Mom Test: how to talk to customers and learn if your business is a good idea when everybody is lying to you* written by Rob Fitzpatrick (2013).

A technology review was performed in order to gain deeper knowledge of USSI's technology and alternatives within the solar energy market. This review covered different solar uptake techniques and their storage systems, as well as means of describing product costs, efficiency and units related to solar energy technologies.

3.3 Market Identification

The purpose of the market identification was to find potential geographical markets. It was carried out online by reading through secondary data such as articles, publications and studies. Useful overall information was collected from Solargis, IRENA and NREL.

The reviewed data concerned the amount of Direct Normal Irradiation in geographical areas was a solar map from Solargis (2016). Regulations, politics and conflicts were investigated using Landguiden in the remaining areas. The article *How Australia Perfected Solar Power and Then Went Back to Coal* published by VICE (2014) gave a hint of how tricky an energy market can be.

After this market identification, three markets were studied further to distinguish potential segments and the actors within each segment. This required extensive research including news agencies such as CSP Today. For California and Hawaii, the U.S. Energy Information Administration provided a basis of information. For California in particular the following sources were exploited: *California Energy Commission, Energy Commission Adopts 2016 Integrated Energy Policy Report Update* and Solar Energy Industries Association. The Hawaii research benefited from *State of Hawaii Energy Resources Coordinator's Annual Report 2016* and *HECO: 2015 Sustainability Report.* For Chile the following sources accounted for the research: Global Energy Network Institute, *SolarReserve eyes Chile CSP wins as surplus PV disrupts markets, Why Chile's mines run on renewable - and Australia's don't* and *REN21's Global Status Report (2016).*

3.4 Interviews

Interviews acted as the sole input when testing the hypothesis for each segment. The intention when choosing interviewees was to get in touch with different actors such as competitors, customers and independent parties being universities or field experts. These actors also had different roles within a market in terms of being an influencer, decision maker, buyer or user. Emails were sent out in order to reach out to people and set up meetings. The structure and content of the emails were in accordance with the Mom Test's email template, which contains the following five parts: Vision, Framing, Weakness, Pedestal and Ask, however the order can vary.

The number of emails sent and the successful responses are presented in table 3.1. Successful responses are here defined as responses leading to interviews or valuable email conversations. The variation in the amount of sent emails depends on the success in attaining successful responses. Since California and Chile had the lowest response rates, more emails were sent out within their respective segments. The final response rate is modelled in figure 3.1.

Table 3.1: Overview of the emails sent during the project.

Market	**Sent emails**	**Successful responses**
California	24	1
Hawaii	13	3
Chile	19	1
Domain experts	6	3

Equation 3.1 shows the formula for calculation of the response rates and the rate for each segment is presented in figure 3.1

$$Response\ rate = \frac{Successful\ responses}{Sent\ emails} \tag{3.1}$$

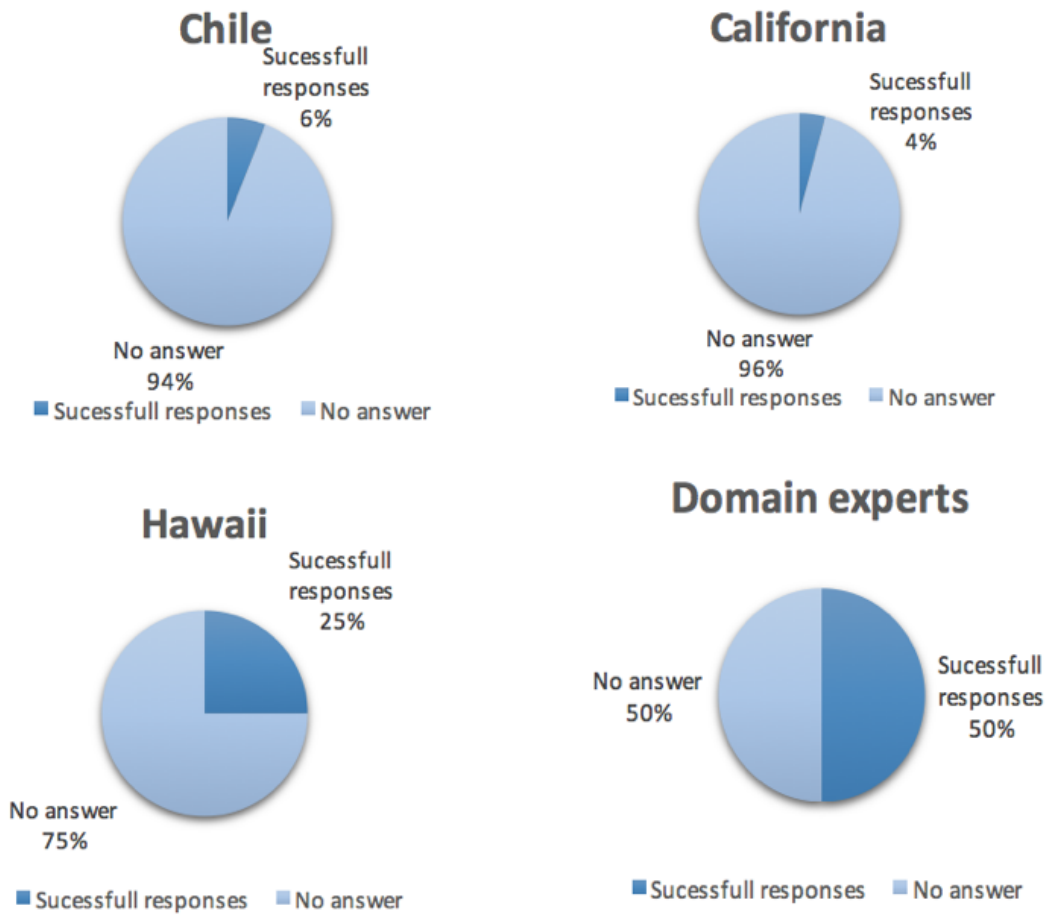

Figure 3.1: Response rate of the different segments.

Once a meeting was set up, either via Skype or in person, questions following the Mom Test criteria were prepared, see appendix B. All interactions, either through interviews or emails, that were considered successful in terms of resulting in valuable information are listed below. First is the name, role and organisation presented and then a brief motivation to why the person in question was contacted for this study. Summaries of the interviews are to be found in appendix D. The aim of the selection of interviewees were to reach as many different types of actors and people with different roles as possible, in order to cover more angles and thereby get a more holistic view.

- **Chris Hinton, Solar Portfolio Manager at Sempra Renewables**
  Chris Hinton was chosen as an interviewee due to his wide knowledge of Sempra Renewables' use of renewable energy. Hinton has full insight in how Sempra Renewables work with solar power and how they finance projects within the field of solar power. He also knows what challenges Sempra Renewables faces in the future regarding renewable energy sources.

- **Dr. R.K Pachauri, Former Chairman of the Intergovernmental Panel on Climate Change**
  Dr R.K Pachauri was chosen as an interviewee due to his extensive expertise in the field of renewable energy, especially solar energy. He was chosen in order to receive his insights and thoughts about important topics regarding solar energy, such as commercial development of solar energy in the future.

- **Kevin Davies, PhD Mechanical Engineering and Assistant Researcher at University of Hawaii at Manoa**
  Kevin Davis has several years experience in product development in renewable energy. He currently focuses on evaluating different renewable energy techniques at Hawaii. Since his research is funded by an independent university, objective information about competitive techniques and the overall energy situation could be collected.

- **Mark Mehos, Group Manager - Thermal Systems and CSP Manager at National Renewable Energy Laboratory**
  Mr. Mehos joined NREL 1986 and is involved in the development of several new grid-integration studies investigating the interaction of CSP systems with thermal energy storage within the western U.S. He and his team have figured out how CSP with storage should be valued by the market, for this reason Mehos was considered a meaningful interviewee.

- **Tomas Kåberger, Professor in Energy and Environment at Chalmers University of Technology**
  Tomas Kåberger was chosen as an interviewee due to his extensive research and expertise of renewable energy. His research contained technological development of energy sources and market terms. He was chosen in order to receive thoughts and insights about solar energy and market terms.

- **Veronica Rocha, Renewable Energy program Manager at Hawaii State Energy Office**
  Almost all generated electricity on Hawaii is regulated by the state. In order to procure new energy projects, they first have to be accepted by the state. Therefore it was of great importance to gain input from the State. The interviewee, Rocha, has prior to this position worked as sales manager for a CSP company.

- **Beth Tokioka, Communication Manager at KIUC**
  Kauai Island Utility Cooperative, KIUC, is one of the biggest electricity providers on Hawaii, regulated by the Hawaiian State. They operate on the island Kauai and were believed to be a potential customer.

- **Victor G. Fainberg, Intermediator and Consultant at St Louis & Co**
  Fainberg's contact info was given by USSI. Fainberg had contacted them some time ago interested in their CSP Parabolic Dish and is a potential buyer of the product.

The BMC was used in order to ease the Customer Development Process. The focus was however on two of the building blocks; Customer Segments and Value Propositions. These building blocks were readjusted due to customer information during the project and therefore they were in center of attention. Figure 3.2 shows the building blocks that the project will focus on. The remaining seven building blocks were stated in the first hypothesis and only modified once according to inputs from USSI. That is, these seven building blocks remained the same throughout the interviews.

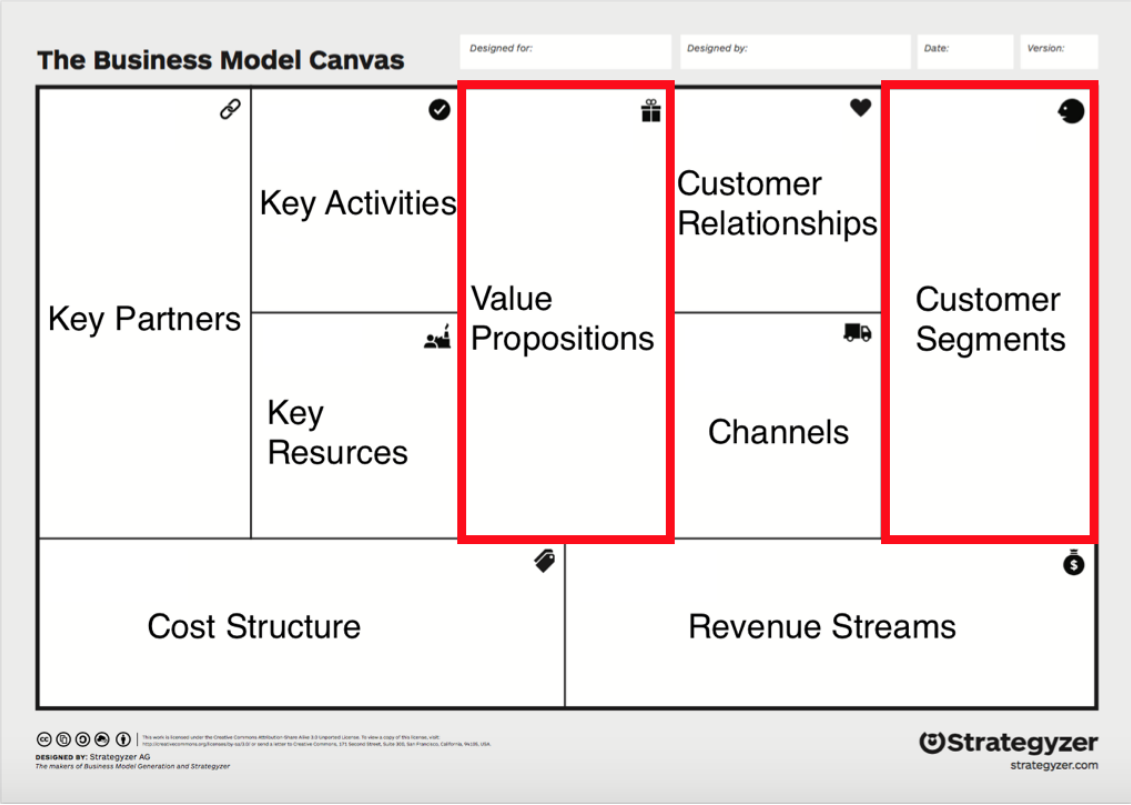

Figure 3.2: Illustration of which parts of the Business Model Canvas the project targeted (Strategyzer, 2017).

4

Process

By applying the methods stated in the previous chapter, the following section accounts for the generated output. The initial market identification along with preferences from USSI motivated the first hypothesis that the iterative study originated from. Iterations were motivated by the analyses of the interviews conducted throughout the study. All changes of hypotheses were tracked through Business Model Canvases. Figure 4.1 illustrates the steps forming the process.

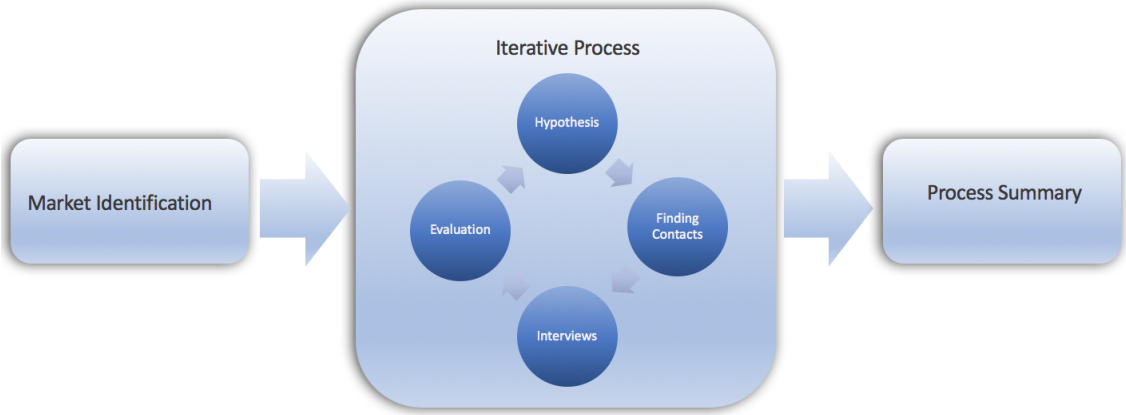

Figure 4.1: The different steps of the process.

4.1 Market Identification

Choosing potential markets was first and foremost limited by the Direct Normal Irradiation, see figure 4.2. Direct Normal Irradiation is the only type of sun irradiation that can be absorbed by CSP, as supposed to PV which also takes advantage of Diffuse Horizontal Irradiation (Solargis, 2017). *Oasis* needs a Direct Normal Irradiation of at least 2000kW h/m^2 per year to provide energy at a competitive price (United Sun Systems, 2017). This immediately excluded larger parts of northern Europe as well as North and East America and Russia, which are represented as darker areas in figure 4.2.

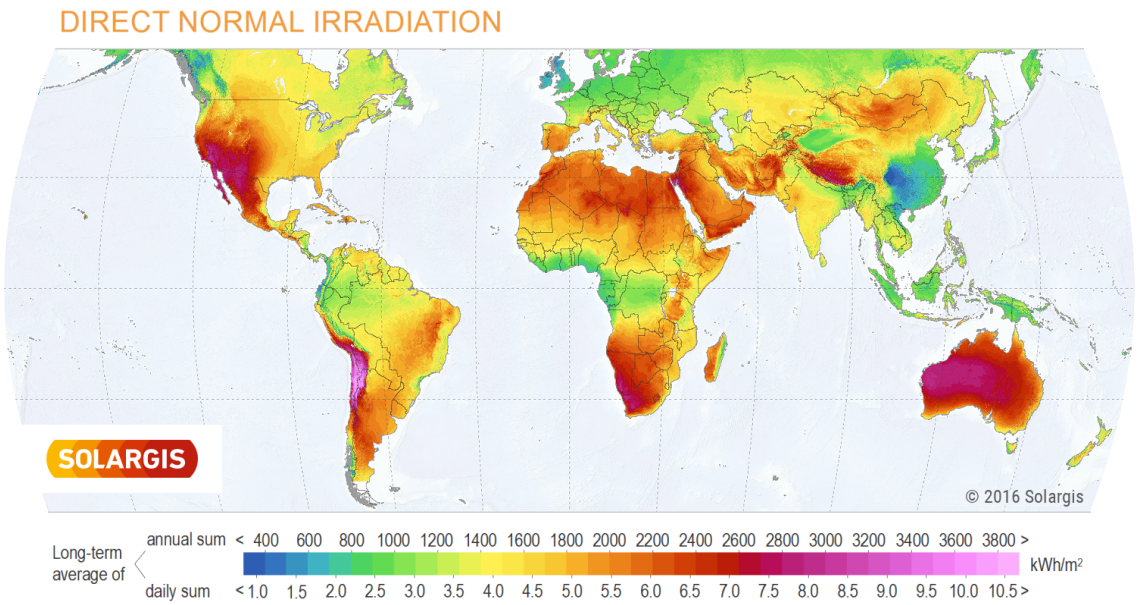

Figure 4.2: Direct Normal Irradiation, (DNI Solar Map © 2016 Solargis).

The following restriction was political instabilities that prevents actors from entering a market. By operating in a market, businesses would most likely have to invest in facilities, labour, land and assets, which could all be affected adversely due to lack of political stability. Political stability is therefore important and a necessity to attract businesses. Instabilities such as conflicts, wars and economic crisis can make companies turn away and would therefore cause difficulties when trying to establish on a market. This restriction excluded areas and countries in the Middle-East and parts of Africa such as South Sudan, Somalia and Western Sahara, but also areas in Asia including Afghanistan, the Philippines, Nepal and more (Landguiden, 2017).

The energy market is well established, and as Granstrand claims in Industrial Innovation Economics and Intellectual Property (p.132, 2016) these kinds of mature markets usually compete based on price. Therefore, the market entrance for a new technology is easier if the general price level is high. Regions with high electricity prices due to high dependency of imported energy could have great incentives for wanting to make a shift towards renewable energy and invest in *Oasis*. Some regions with this potential could be far offshore islands such as the archipelago of Hawaii and the Canary Islands, or off-grid industries like mines.

Further on, as one *Oasis* system delivers 33kWh this technology requires a relatively large energy demand (United sun systems, 2017). This excluded rural areas in large parts of Africa that only required a small amount of energy supply for activities such as lighting, charging cellphones and cooking (Lightning Global, 2016). Moreover, state regulations and subsidies are crucial in affecting the market and how willing potential customers are to invest in renewable energy. For example, Australia's regulation concerning the need for distributing contracts before production is preventing large scale solar energy facilities from entering the market. Instead,

according to Ball at the Australian Department of the Environment and Energy (2016), Australia's solar energy production mainly derives from private rooftop solar.

National Renewable Energy Laboratory has listed all CSP projects in the world. This information showed which kind of stakeholders that were currently investing in CSP and where the competition was. In this early stage for USSI, competition could be either unwanted or actually useful to trigger the development of the market. In order to determine this, the aim was to identify customer segments with different levels of competition. How much an actor had invested in PV was an indicator of whom was interested in solar power in general, but recent purchases in PV would make it an unlikely investor right now. Further on, *Oasis* competes against more than just other solar energy technologies. It might enter a market with known energy demands that is presently covered by an energy supplier that distributes another source of energy.

This identification excluded multiple areas through regulations, political instabilities and competition, but also provided several options for a Customer Development Process. By getting advice from USSI, who possessed knowledge and competence in this area, a final exclusion could be made. USSI recommended markets that have potential for media coverage, but also potential for commercialisation and therefore economic growth. By incorporating this advice the final three markets that were analysed are presented below.

4.2 California Segmentation

California is a prominent force within renewable energy and especially solar energy sources. According to GreenTechMedia (2016) California has got more solar power than any other state in the U.S., see figure 4.3.

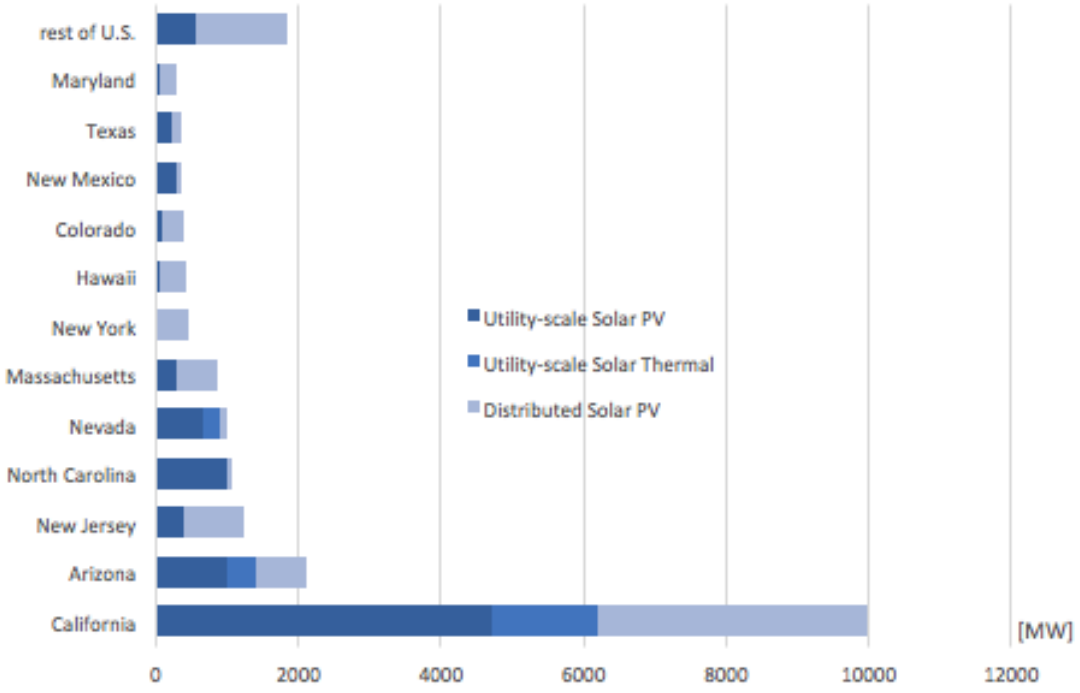

Figure 4.3: Solar electricity generating capacity, monthly, end of November 2015, inspired by: U.S Energy Information Administration, (2015).

Comstock (2016) from the US Energy Information Administration, EIA, states that California has got the most capacity in the country in terms of solar PV and solar thermal. In fact it has got more capacity than the rest of the country combined, with a total of 73 percent of the country's solar thermal. While many states has got solar PV there are only three states, California, Arizona and Nevada that have enough land in arid areas which utility-scale solar thermal systems often require. California is therefore a market where solar energy is well developed and integrated within the state. Not only do they posses great knowledge in this area but there seem to be opportunities to innovation and change in this market. In this project California is analysed on grid, both small and large scale customers.

There are many solar facilities in California and several major thermal solar projects whereas the following three are the biggest.

- Genesis Solar Energy Project – this is a CSP power station located in the Mojave Desert that uses parabolic trough whereas solar energy is focused on a focal point using parabolas.

- Mojave Solar Project – this is also a CSP based solar plant located in the Mojave Desert using parabolic trough.

- Ivanpah Solar Electric Generating System – the largest CSP power station in the world located at the base of Clark Mountain in Mojave Desert, California. Ivanpah consists of three solar powers towers and uses the technology from BrightSource and the biggest investor in this project is NRG Energy.

Apart from these facilities, California is a very competitive market with many actors. Some of the biggest actors are among all, BrightSource, Southern California Edison, NRG Energy and SolarCity. These companies are all involved in the solar energy market.

According to the California Energy Commission (2017) 11.9 percent of California's energy production came from renewable sources in 2009, and they aim to increase their renewable energy production to 33 percent by 2020 using mainly solar power. The state of California had also 2016 updated their Renewable Portfolio Standard. Their Governor Edmund G.Brown, Jr had signed into a legislation that requires retail sellers and publicly owned utilities to acquire at least 50 percent of their electricity from renewable energy sources by the year 2030.(Brown, 2017)

Brown (2017) also states that the legislations have showed great results in the environmental performance of electricity. The increase of renewable energy sources have decreased coal-based sources. Electricity generated from coal has dropped down from around 11 percent in 2011 to 6 percent in 2015 while renewable energy sources more than tripled since 2011. (California Energy Commission, 2017)

4.3 Hawaii Segmentation

The Hawaiian population receive electricity through a well functional grid and the Public Utilities Commission (2017), PUC, of Hawaii is currently investing to make the grid even better. Therefore, the Hawaiian market is mainly categorised as a grid segment.

According to EIA Hawaii has the highest electricity prices in the country. For residential use the price for 1kWh is 28,8 cent which is 125 percent more than the US average and for industrial use the Hawaiian companies have to pay 230 percent more. In 2014, 90 percent of the energy consumed was imported, mainly petroleum being shipped to the islands. (EIA, 2017)

However, there is an increasing trend for investing in renewable energy. Figure 4.4 below shows the amount of renewable energy the Hawaii PUC regulated companies have produced yearly from 2009 to 2015.

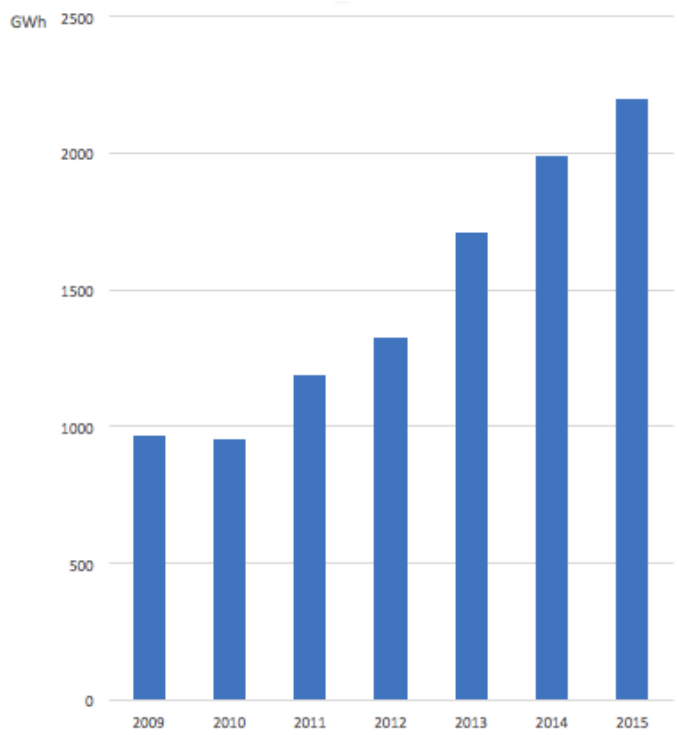

Figure 4.4: Renewable Energy Capacity for the HECO companies, 2009-2015 inspired by: Hawaii Public Utilities Commission (2016).

The Hawaiian islands have year-round tropical sunlight, steady wind and even volcano activity, the potential for producing renewable energy is great. The 2016 Energy Resources Coordinator's Annual Report claims that there is currently 65 clean energy project on the islands.

Hawaii generates more solar electricity per capita than any other state in the US (EIA, 2016b) mainly due to declining prices in PV solar which results in a great installed based of rooftop PV. However, the 2016 Energy Resources Coordinator's Annual Report states that rooftop solar power are approaching the limit of how much the grid can absorb and therefore a solar battery solution is requested.

Some actors on the markets offer battery solutions to households, for example SonnenBatteri and Tesla Energy. Direct sell to households is not an option for USSI, but just recently Tesla Energy had a pilot project with SolarCity, sprung from U.S Department of Energy, which connected their power packs to a micro grid enabling storage of solar energy (Lambert, 2016).

The Hawaiian government aims to produce 100 percent of its energy demand renewably by 2045. This goal was developed in 2008 as the Hawaiian state partnered up with the US Department of Energy in the Hawaii Clean Energy Initiative in order to get more clean energy projects running. The government stated in one of its energy policy directives:

> Our isolated, islanded grids, high energy costs, and connections to the Asia Pacific region make Hawaii an ideal test bed for new energy solutions. (Hawaii State Energy Office, 2016).

Almost the entire population gets electricity distributed through "the HECO" companies. The HECO companies are Hawaii Electric Light Company, Hawaii Electric Company, Maui Electric Company and Kauai Island Utility Cooperation. These four energy utility companies are all regulated by the PUC and are engaged in the production, purchase, transmission and distribution of the Hawaiian energy. They are submitted to follow the PUC energy plan and are currently requesting new proposals from renewable energy projects. (Hawaiian Electric Company Inc, 2017)

4.4 Chile Segmentation

Northern Chile has one of the highest degree of Direct Normal Irradiation in South America thanks to high altitudes (New Energy Update, 2016). The country is highly dependent on imported fossil fuels, 70 percent of their energy needs are imported, but they do have existing renewable energy sources today and have a huge potential in terms of solar (Energy Post, 2014). Figure 4.5 shows the increase in private investments in Solar Energy the past decade.

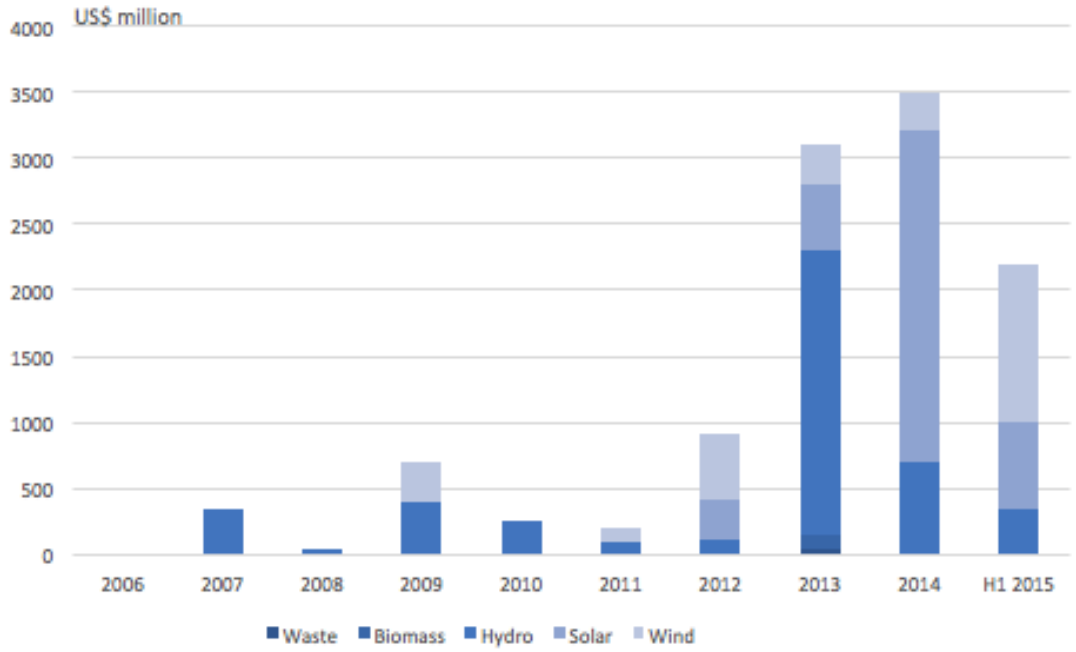

Figure 4.5: Total Investment in Renewable Energy in Chile, 2006-H1 2015. Inspired by: The World Bank Group, (2016).

The southern parts of Chile are equipped with large hydroelectric plants, while the much dryer regions up north is dominated by wind, geothermal and solar power. There are solar panel parks functioning in the Atacama region today, and CSP plants are being finished during 2018 and 2019. (NREL, 2015)

The northern region is dense in mines lying off grid and are therefore dependent on oil and coal when extracting minerals, which is an energy demanding process. According to Jamasmie (2014) the need for more and cheaper energy is crucial for Chile in order to continue its mining to competitive prices. By 2025 the electricity demand for mining in Chile is estimated to double.

According to REN21's Global Status Report (2016), Chile is one of the leading countries world wide in terms of invested dollars in renewables, surpassing their long term targets. Although the solar market for the Chilean Mining Industry is under development, there are a few actors with existing plants. One of these is the Los Pelambres Mine owned by Antofagasta Minerals, who installed a 69.5MW solar panel park by SunEdison (Clean Techninca, 2014). CSP plants are underway, such as the Atacama-1 plant by Abengoa Solar located in the Antofagasta region (NREL, 2015).

The Chilean Ministry of Energy provides a legal framework while the generation, transmission and distribution of energy is developed by private actors. In 2013, the country set the target that 20 percent of their generated energy derives from renewable sources by year 2025 (IRENA, 2015). Their main supportive regulation for renewable energy is the five percent quota obligation set in 2008.

4.5 First Hypothesis and Business Model

In the very beginning of the study a first hypothesis was stated based on previous knowledge about geographical possibilities, regulations and environmental aspects in combination with a brief meeting with Lars Jacobsson (CEO, USSI), and Mats Lundqvist from Chalmers School of Entrepreneurship.

Hypothesis 1: Suggested customer segments were mines and small telecom companies, since they are off grid and in need of their own energy production. India and Pakistan were also discussed as off grid markets since they are countries with unreliable electricity grids. On grid manufacturing industries and energy companies, both in the private and the public sector, were of interest. These segments came up to discussion since USSI requests large scale production in order to be cost competitive on grid. Cleanergy, a competitor to USSI who has the similar technology but without the storage solution, was considered as a potential customer in terms of only buying the storage solution from USSI.

The believed value propositions for the proposed customer segments above consisted of either an *Oasis* system, just the storage solution, or leasing out a share in a big solar park. Warranties and maintenance service could be added with any proposition, which both have positive effects in getting and keeping the customers since the customer relationship relies on continuous meetings over a long period of time. In order to decrease the high purchase threshold that comes with heavy

investments, leasing is an alternative which allows USSI to perform big scale production. The customer relationships is also strengthened and grown by goodwill and the fact that USSI is a company that works for a better environment. The customers would approached either by direct selling or fairs, by broad marketing or through governments.

Hypothesis 1 also included key activities, key resources and key partners, but since they were not the main focus of this study they were only discussed briefly. The hypothesis was later confirmed and modified by Magnus Millingen (sales manager, USSI). USSI has close partnerships with companies delivering the different parts of *Oasis*, and want to build relationships with companies that can arrange the service in future solar parks. These services were discussed as possible future key activities for USSI. Millingen also gave some input that lead to minor changes in customer relationships. Further modifications of the first hypothesis regarding customer segments was to define off grid customer segments as mines in Chile, and on grid segments as energy companies at Hawaii and California. The customer segment only interested in the storage solution were excluded since the company was not interested in selling it separately in this early stage. Otherwise these new segments were well matched with the previous value propositions made for on and off grid customer segments.

Hypothesis 1, it's modifications and the costumer segmentation were summarised in BMC 1, see figure 4.6 and 4.7. The black writing shows the first hypothesis after a brief meeting with Lars Jacobsson, and the red markings represents the modifications made after the market segmentation together with inputs from Millingen. The incremental process leading to the BMC is shown in detail in appendix A.

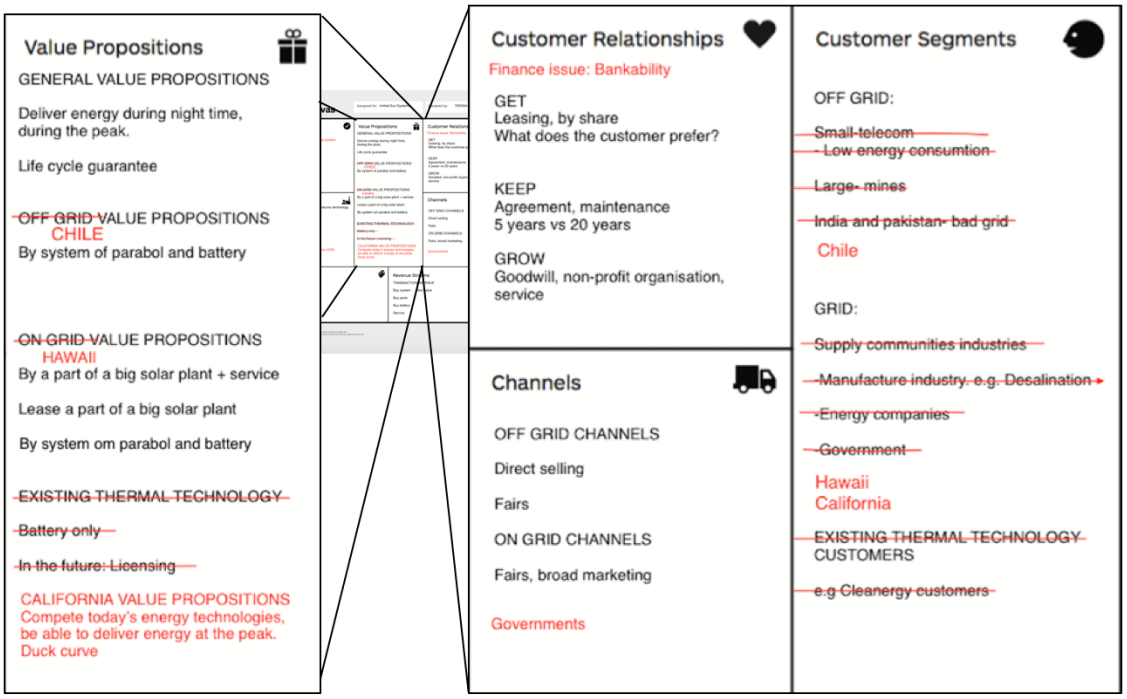

Figure 4.6: The right side BMC 1 created by hypothesis 1.

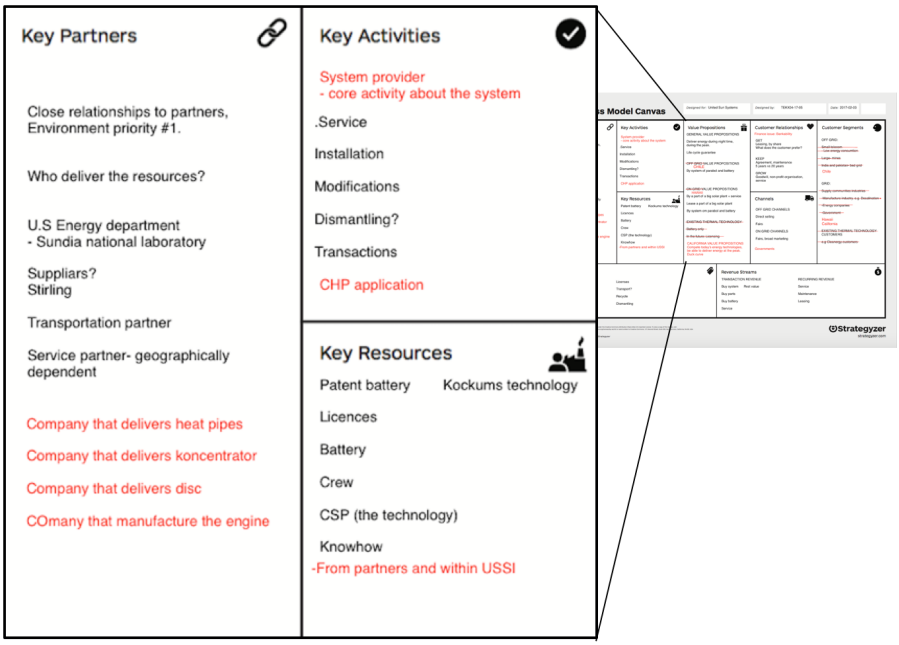

Figure 4.7: The left side of BMC 1 created by hypothesis 1.

4.6 Mail Example According to the Mom Test

Emails based on the Mom Test were sent to potential interviewees in order to set up a meeting. An email example, marked with the five important parts, is given below.

> Dear Mr. Mehos,
>
> My name is Anna, and I am part of a team of students conducting a market analysis on Concentrated Solar Power for our bachelor thesis at Chalmers University of Technology, Sweden.
>
> We are analysing the market potential for CSP technology with storage (***framing***), but are stuck in our research (***weakness***). According to NREL this seem to be within your expertise (***pedestal***) and we are really trying to find out more about how this solution is valued by the market (***vision***).
>
> Please let us know if you could spare any of your time to talk to us! (***ask***)
>
> Best regards,
> Anna Ljung

4.7 Iteration 1

The reasoning below is based on the interviews with Beth Tokioka (communication manager at KIUC), Mark Mehos (CSP expert at NREL), Veronica Rocha (from Hawaiian State Energy Office) and Kevin Davies (researcher at Maui University), for more details see appendix D.

The potential customer KIUC was looking for grid electricity during night time. Due to operating on a small island, KIUC's system solution requires small scale. *Oasis* would fill this requirement. According to USSI, their biggest competitors are solar tower and parabolic through. They are both large scale systems and could therefore never fit this customer's need. Small scale *Oasis* disfavour the competitive price, estimated 0,6 US cents per kWh large scale, but as mentioned Hawaii has high electricity prices and therefore *Oasis* might still be competitive.

Although the solution *Oasis* provides fits the customer need, the NREL's CSP expert Mark Mehos argued that CSP technology is not functional on Hawaii. He argued that the humid climate that occurs in areas close to the ocean together with particles in the air diminishes the Direct Normal Irradiation to levels lower than the required 2000 kWh/m^2, and therefore also lowers the efficiency of CSP. This

does however not effect PV to the same extent, since it does not have an energy threshold. He also mentioned the limitation of space, due to Hawaii consisting of small and rocky islands.

The researcher Kevin Davies emphasised storage as part of the solution for Hawaii to reach 100 percent renewable by 2045. He claimed Hawaii so far just used the easy solutions to gain 23 percent, so much more has to be done. The battery solution to PV is however today too expensive. He believes more storage solutions are required in the future. To conclude, Hawaii in general has a need for cost effective storage solutions.

The Hawaiian State Energy Office, who regulates the entire Hawaiian electricity market, said that they were investigating possible storage solutions and were therefore not interested investing for the moment according to Veronica Rocha. Further more, they do not trust CSP to function on Hawaii for the same reasons as Mehos mentioned. On the other hand, they are very interested in integrating PV in their systems. PV is easy to install and does not generate a spacial issue since it can be implemented on existing rooftops. The vast amount of PV they have today and the believe that it will continue to decrease in price could categorise PV on Hawaii as a technological lock-in, according to the definition given by Granstrand, (p.182, 2016). That is, *Oasis* will be locked out even though it might be superior in efficiency and storage.

Further on, the Hawaii State Energy Office strategic plan is to decrease the overall energy consumption. They are not in need of new capacity which results in a low capacity value according to Mehos validation model, which is explained more in the interview in appendix D. According to this model, CSP with storage has extra market value if the market is in need of new capacity. This is called the capacity value. Low capacity value, as in the case of Hawaii, consequently leads to lower value and difficulty in competing with other energy sources.

To conclude, the below points are the main reasons for excluding Hawaii as a first potential market segment of USSI's Oasis.

- The humidity decreases the Direct Normal Irradiation, which lowers the Oasis efficiency and thereby higher electricity price
- Hawaii State Energy Office, the regulator of the entire electricity market on Hawaii are currently not interested in CSP.
- PV lock-in

Hypothesis 2: Hawaii's energy need is small scale renewables that can deliver energy anytime of the day. USSI has the potential to deliver this and this is therefor the new value proposition. Figure 4.8 illustrates a new BMC made on lessons learned from the interviews conducted with actors in the Hawaiian market. The black writing is left from the previous BM and the red markings are the changes made.

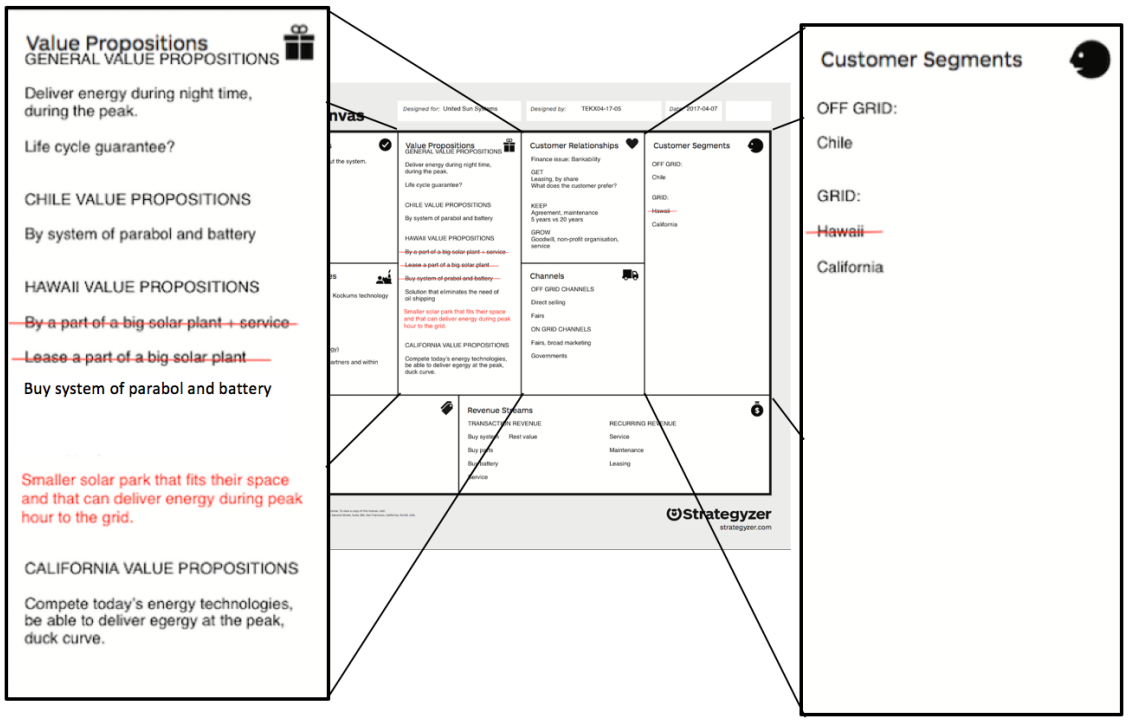

Figure 4.8: BMC 2.

4.8 Iteration 2

The Chilean mining energy market has been hard to get in contact with due to language barriers, and difficulties in breaking down and identifying different actors within an energy procurement process. However, there is some information to be extracted from a conversation with Victor G. Fainberg, intermediary and consultant at St Louis & Co, as well as indirect information from experts who have been contacted regarding Hawaii, see appendix D.

Veronica Rocha at the Hawaii State Energy Office recommended using technologies such as CSP Stirling in industrial environments with a lot of space and low air humidity. She further suggests Chile as a potential market based on her previous work with CSP. Mark Mehos, CSP expert at NREL, claims however that even though the market is great in theory, slow processings and difficulties in obtaining contracts makes it hard for actors to construct new facilities in Chile.

Fainberg gave valuable insights emphasising the need for foreign companies to gain a better understanding of the procurement process in South America. He further claimed that it is impossible for companies to expect advance payments for their product. Rather, he proposed that foreign companies uses agents while providing them with *Letters of Credit*, that is a bank guaranteeing the seller that the buyer has sufficient founds. This could be a suitable solution for *Oasis* as it gives a better understanding of the market as well as it eliminates language barriers.

Hypothesis 3: Chilean mines as a potential customer segment remains since the email conversation with Fainberg confirmed this part of hypothesis 1. The segment was however precised to big/medium scale mines and extended to other industries being interested in *Oasis* as well but in smaller scale. The value proposition was changed by means of that the storage should be an option an not always included. Figure 4.9 represents the third BMC.

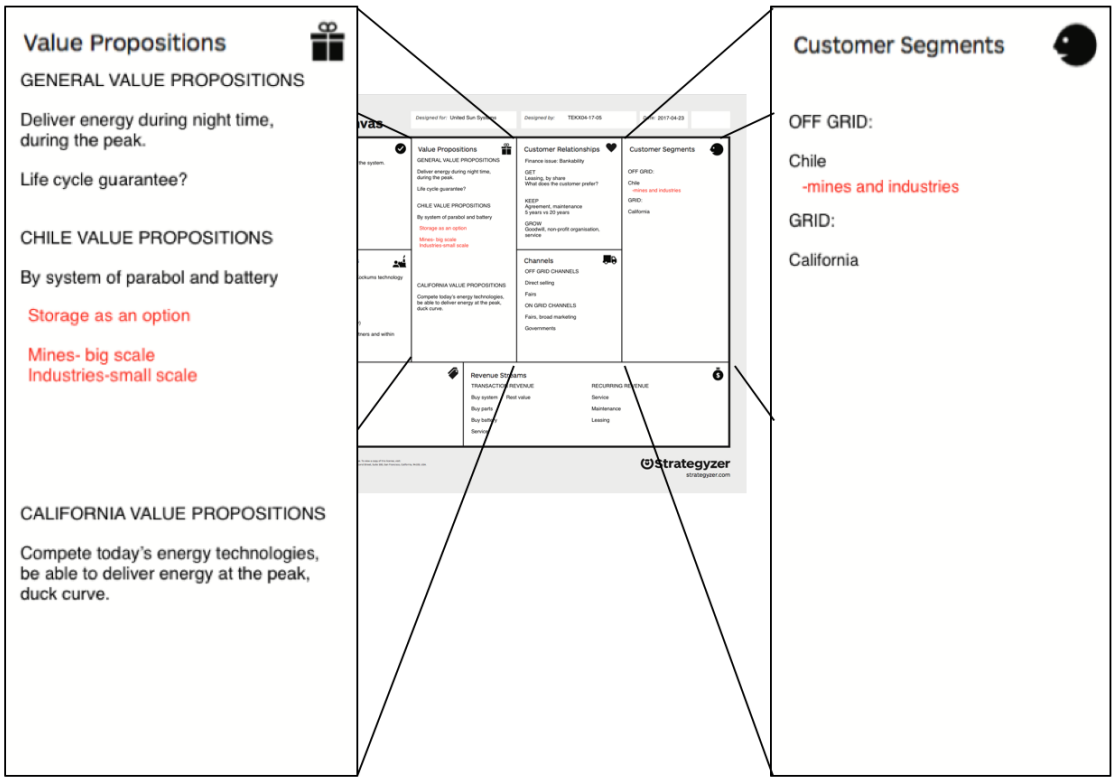

Figure 4.9: BMC 3. Black writing illustrates the previous BMC and the red markings represents the modifications.

4.9 Iteration 3

California turned out to have a low response rate. The insufficient amount of responses lead to difficulties in interactions with the Californian market. The discussions in this section will therefore be based on, the interview with Chris Hinton (Solar Portfolio Manager at Sempra Renewables), and what Mark Mehos and Dr. R K Pachauri (former chairman of Intergovernmental Panel on Climate Change) said in general about California, but also include aspects from the market identification that was conducted, see appendix D.

According to Mehos, California has a plan where it does not need more capacity than it currently has. Mehos implies that this would present a bigger challenge in relation to a market where you can expand the grid, as for example Marocco. Hinton described how they are currently working with PV as a solar energy source

due to economic reasons. When the issue of thermal storage was discussed with Hinton, he talked about the storage as an important issue of the future solar energy market. Dr. Pachauri agrees with Hinton's view and states that energy storage will be the most important factor in terms of solar energy. He also states that California possesses economical benefits for actors in this area and that it would be difficult for president Trump to hinder the development of renewable energy significantly.

California is a well developed market with many actors benefiting economically from renewables. From the conducted interviews, the issue of energy storage is relevant for the Californian market since our interviewees all touched on that subject. Although it is recommended that more research and interviews should be conducted for the Californian market in order to be able to draw any conclusions. As a result of this, the BMC for the Californian market will not be updated.

4.10 Other Interview Results

All the interviews were conducted by using open questions and therefore additional information and interesting facts occurred. Mehos mentioned China and Morocco to be suitable markets for CSP since they are in an expansion phase. Further on, Kåberger added that other potential market segments could be the Canary Islands, Japan and India for the same reason. Kåberger means that the advantages gained by entering these markets would be that USSI would not have to compete with existing energy technologies but only function as an extension of the grid. Several interviewees suggested industries that required heat as potential costumers. The aforementioned information did not result in iterations in the BM due to being outside the project scope. It is however discussed in the Implications and Further Research chapter.

4.11 Process Summary

With an initial market identification as a basis, a first hypothesis was stated. This first hypothesis was tested by interviewing different actors significant to each segment. Learnings from the interviews lead to a revised BMC and new hypotheses, and this iterative process was repeated. The final knowledge about the three customer segments and related value propositions is summarised below. Some knowledge is validated and confirmed by several actors, whereas some statements are only based on one source.

Hawaii does not seem to be an interesting market for USSI. The water particles in the air caused by humid climate decreases the Direct Normal Irradiation and will thus make CSP less efficient and not optimal. This combined with the fact that USSI's technology has to be produced in big scale in order to be competitive makes Hawaii unattractive in terms of this specific technology. However, a demand for small scale renewables with storage is present.

The customer segments on the Chilean market such as mines and other industries have potential. The value proposition for these customer segments should include variations in scale and provide storage as an option. The mapping of their procurement process has proven to be difficult and has to be taken into account by USSI.

California is a well developed market with many actors. The grid is well established with both PV and CSP technology of different kinds. The interviewees all agreed that storage will be an important future factor for solar energy. The BMC for California could not be updated due to difficulties in reaching out to actors and getting useful responses.

The methods and their outcomes are discussed in the next chapter, as well as how alternative methods could have affected and changed the outcome.

5
Discussion

The methodological nature of this project led to discussion mainly regarding the methods. A discussion of each method's pros and cons are presented together with an analyse of their effect on the outcome. This analysis serves as a base for an argumentation whether the methods used in the project are the most suitable in order to answer the problem statement and fulfill the purpose. In order to state this, hypothetical alternative methods are suggested and compared to the methods carried out during the study.

Apart from the methods this chapter also contains discussion about the challenges and problems that came up during the project as well as how they were handled or suggests to be handled in a similar bachelor theses further on.

5.1 The Customer Development Process

The Customer Development Process showed both pros and cons for the project. When using this method it is important to understand who the different actors on the market are, that is the buyer, influencer, competitor and decision maker. Thus, this process is dependent on and affected by the amount of contacted actors. Hawaii, California and Chile are far away causing trouble due to time zones, but the language has also been a struggle when trying to get in contact with Chile. The main purpose of the Customer Development Process is to get out of the building and meet customers in order to make iterative value propositions changed due to customer requests. Due to the fact that the markets that has been investigated is located geographically far away it has been hard to fulfill this purpose completely. The information that actually was generated however has been very useful since this has been information that would be hard to get in other ways.

In hindsight, a different approach to California and Chile could have resulted in more responses. Regarding Chile, the language barrier seems to be the key. When the emails were translated into Spanish, using Google Translate, some contacts responded. However all but one contact did not continue to reply, and no meetings succeeded to be set up. An intermediary in Chile might be useful to gain a better view of the actors within a network. An intermediary in Chile could also be helpful when navigating through regulations and understanding the procurement process. Hence, a lesson learned from this study is therefore the importance of understanding the obstacles of different markets. It is important to consider whether it it easy

or not to get in contact with different markets. Some of the companies on the Chilean market that were contacted were American, so it was probably not only the language that made it hard to get in contact with actors on the Chilean market. One reason could be that the actors were contacted by students and not companies' representatives. Assisting students might not be the priority of big companies, but business to business interaction between a potential buyer and seller might be of more interest. In the beginning of the study it was discussed whether to contact the actors as students or as representatives from USSI. Since some contacts were competitors to USSI it was decided to get in touch with different actors as students.

The process of developing value proposition turned out to be more difficult than expected. At first it started out with a broad and theoretical value proposition which the thought was to narrow down and become more specified during the customer development process. The idea was that through contacting and reaching out to many customers it could gradually be polished and therefore turning the initial value proposition into something much more concrete and specific. Unfortunately the answering frequency from the customers turned out to be very low and it was of great difficulty to develop a concrete value proposition since this should be based on the customers needs and problems.

Since this is a company with a finished product ready for commercialisation when the project started, it can be discussed weather Customer Development Process is suitable or not. There are however evident advantages. Thanks to the interviews it was possible to determine whether to validate or exclude a hypothetical segment, in this case Hawaii. The challenges when trying to contact California and Chile brought light to how hard it is to get a hold of these markets. If the method instead would have been a market research without interaction with market actors these results would probably not been generated. Furthermore, the iterative approach of working made it possible to steer the project in directions learned throughout the process, thus not have to follow a predetermined path that might be complicated to change. In conclusion, the interactions and iterative processes have been and can be valuable in this kind of projects.

5.2 The Business Model Canvas

The Business Model Canvas could have been fully exploited if the work with creating value propositions had proceeded further. It was however very useful during the project in means of creating a broad overview of the project and document the iterations as the project went on. The Canvas was also a useful tool when communicating with USSI. The broad overview worked as a summary of the progress of the study which made is easy to have a dialogue with the company.

The use of Business Model Canvases helped direct the process. In the beginning the BMC was too broad and general, which made it hard for the reader to understand what information the canvas really contained. This lead to specifications in order to clarify the content of the canvas.

The BMC served its purpose in this study well and it did not lack anything in order to fill its function. Therefore, there is no reason to use another tool for this kind of projects.

5.3 Interviews

The use of the Mom Test turned out to be successful when the interviews were prepared and carried out. By interviewing according to a stated model it was much easier to focus on important things such as what kind of information to get from the interviews. The open questions did not reveal *Oasis* initially. This resulted in broader, unbiased answers presenting approaches that had not earlier been considered. Straight forward questions has a tendency to give a more limited response according to the Mom Test.

Forming individual question templates for the actors within each area aided in summarising and comparing the interview results. By using the template and modifying the questions depending on who was interviewed, the workload was reduced without compromising the important part in creating tailored questions for each interviewee. The Mom Test did not only show to be helpful when preparing and carrying out the interviews, but also when writing emails to the actors on the different markets. It also provided a successful template for writing emails which facilitated the process.

The interviews that were conducted were recorded and summarised in order to share the facts they generated to the team. According to Fitzpatrick (2013) this is an important step when working with the Mom Test, and it showed to be really helpful to keep everyone up to date during this study. Unfortunately the response rate from Chile and California was much lower than the response rate from Hawaii. This was not expected, especially not from California since the language is not a barrier. Despite reaching out to dozens of interesting actors including bigger companies, experts and energy departments, barely no answers were received. This did not provide with enough valuable information to either confirm or exclude this market, nor did it give enough information for developing a value proposition.

There are many other interview techniques, in this project however a limitation to the Mom Test was taken in order to be able to both learn the method properly and then use it. The method is easy to understand and practice but it is important to mention the fact that the Mom Test is designed for startups. It is not fully applicable in this study since there is no possibility in changing the technology of the product. Moreover, since the Mom Test is developed for Business to Costumer interactions rather than Business to Business, it is difficult to apply all the Mom Test's features such as "casual meetings". The fact that the method still generated satisfying answers indicates that the method has been valuable in the study.

Alternative methods to interviews are surveys and written email conversations. These methods might have generated more answers form California and Chile. The

emails that were sent out throughout this study expressed a wish for an interview which might have caused the receiver not to answer due to lack of time. Perhaps a survey of some kind would have been more useful in those cases. Maybe, if the receiver would have been able to choose to answer some questions online with a three minute guarantee, they would have done so. This however could have lead to a more limited result since the interviews covered more than the questions that were prepared beforehand, and modified throughout the interview thanks to open questions and sub-question.

Although USSI and the team had similar views in what results that were wanted from the interviews, they had different opinions on how the questions should be formulated in order to generate the desired answers. USSI recommended using straight forward, hypothetical questions such as "How much are you willing to pay for this solution?", a question that the Mom Test states as bad. An alignment of views, both theoretical and practical, is important for the progress of a study of this kind and needs to be taken into account by students when interacting with companies.

5.4 Market Identification

It was necessary to narrow the scope of the study in order to be able to know where to begin the Customer Development Process. The way in which this was done, by specifying requirements and identifying which market that fulfilled these requests, worked well and resulted in three markets; California, Hawaii and Chile. More concrete study results could have been achieved if the scope was narrowed down to one or two markets. This way, more team members would focus on each market, which might have led to more information and clearer results regarding customer segments and their value propositions. That would however place a greater importance in carefully investigating the markets to avoid putting all focus on a market that would turn out to be unsuitable for the product.

The importance of micro climate, i.e. climate in local areas, was not taken into consideration during the market identification as this aspect was realised in a later stage of the study. Hawaii was supposed to be in an area of high Direct Normal Irradiation, but the market identification was not done thorough enough to realise the humidity on the islands is on most areas to high and diminishes the Direct Normal Irradiation.

Before focusing on California, Hawaii and Chile, three other markets were investigated but then excluded, since the company wanted a different approach on the study. Better communication towards USSI could have explained the potential of the excluded markets. The excluded markets were also mentioned in the interviews, which implies that investigating them further from the beginning would have been interesting. Alternatively, these markets could have been included in the Customer Development Process along with California, Hawaii and Chile. Thus, mails could have been sent to them as well. In that way the markets with high and positive

response rate could have been chosen. This might have resulted in validated segments where concrete value propositions could have been developed.

A different approach could have been to change the direction when the response rate turned out to be low from California and Chile. Instead, the market research regarding the Canary Islands and Australia could have been used to contact actors, as they might have a higher response rate. If fully following the methodology and being dynamic over time, the interviewees' suggestions on alternative market segments should have been taken into consideration during the study, switching the focus onto other markets. Instead of doing so, this study focused on validating and/or rejecting the current hypotheses of the chosen markets. This is an insight that was realised in the end of the study and could not be acted upon in time. Although this should be taken into consideration in a similar study.

The sources which has been used to carry out the market identification is considered unbiased and credible. Naturally the company has provided with information, but it has been verified to a greater extent by independent sources. If this had not been done, the results generated from the market identification could have been considered less trustworthy.

5.5 Alternative Method Approach

Finding potential markets could have been done by a market research without interaction with actors on the different markets. Not being dependent on answers from actors could result in more markets being identified on the behalf of not being as thorough. It also gives more independence to the study compared to the Customer Development Process, which is solely built on interview results. The challenge would have been to get credible information and concrete facts that is up to date. Some facts are hard to get and easy to miss, others are only locally available. One big risk when only performing this kind of market research is that the success or failure of finding fitting customer segments shows up late in the commercialisation process. Feedback from the customers are not collected until after marketing. As a result invested time and resources might be wasted.

USSI had already been contacted by several customers before the project started. USSI did not show that much interest in these customers since they did not request storage. What *Oasis* offer is new to the market and therefore USSI meant that the customers that had been in contact with them did not really understand the full value of *Oasis*. The study did not lead to finished value propositions but by starting from these customers the first market research would not have been necessary. By using these customers and directing the focus more towards developing value proposition, the chances of developing a finished value proposition by the end of the study might have been greater. The idea was however to generate a complete different view of the Oasis potential than what USSI already was aware of.

6
Implications and Further Research

The outcome of this study suggests that there are several possibilities to further research in how to reach commercialisation for USSI. This section describes the possibilities ahead and how the company could proceed in commercialising *Oasis*, both within market segments already evaluated as well as alternative markets. Further on, this section will describe possible applications that could be considered in order to find new customer segments. Lastly, a BMC will be presented as a suggested continued work for USSI.

6.1 California and Chile

California can not be validated due to the segment mapping not being complete. More insight about who the actors are and their roles is needed. The different participants in the procurement process thus needs to be distinguished further.

Mehos (CSP manager at NREL) claimed in his interview that California will be in need of new capacity in five years due to coming gaps in energy distribution, also called the Duck Curve. This insight is valuable, but has to be confirmed from other sources, preferably from the actors in California. This could answer the question whether the market is temporarily saturated or not.

Chile has through market research been identified as a suitable market, and although little information has been received through interviews this market should be investigated further to achieve a better understanding of the Chilean mining industry's energy market and who the actors are. During this thesis there has been challenges when identifying actors within the Decision Making Unit in Chile, as well as getting replies from companies, experts and government.

Therefore it is suggested that USSI takes advantage of local agents initially to build a network while gaining a better understanding of the market. Fainberg (Intermediary and Consultant at St Louis & Co) strongly suggested that foreign companies' lack of understanding of how the procurement process functions is the major reason why they fail, which is another reason to make use of local knowledge.

6.2 New/Other Market Possibilities

Both market research and interviews suggested that there might be many other segments suitable for *Oasis*. Unsaturated markets could be of particular interest as they do not require fossil fuels to be excluded in favor of renewables. Emerging markets in developing countries such as India, Morocco and China are good examples of such. More mature markets may focus on cost savings to a further extent, while also having a more specific agenda for their energy procurement development, as was shown for private rooftop solar in Hawaii.

Regulations can be an obstacle when entering a market, thus excluding potential areas for further research. As mentioned earlier in the Method chapter, a publication by VICE (2014) was helpful in order to understand that the energy market can be complex. The article discusses the obstacles that energy companies face in Australia when building big scale parks on the grid. Proposed solar farms need a signed agreement from distributors, but the distributors are not interested in solar and there are no regulations forcing them to sign such an agreement. The procurement process needs to be investigated further to determine if on grid customers exist or if possible segments lies off grid.

Given these obstacles could be avoided, there are great potential for USSI both within off grid industries and in urban areas. Recent updates from CSP Today demonstrates that Australia's energy market is starting to loosen up. The state of South Australia has secured a loan to build a CSP plant with eight hour storage (CSP Today, 2017).

Hawaii was believed to be a promising market due to being an Island nation depending on expensive imported fossil fuels. Although this thesis has resulted in excluding this market, there are other similar areas that can be investigated. The Canary Island is just as dependent on imported oil but have larger unoccupied areas as well as lower humidity, making it a promising area for further market research. This has been confirmed by Kåberger (Professor in Energy and Environment at Chalmers University of Technology) who believed CSP to be a suitable technology for The Canary Islands.

6.3 New Applications

A different approach to finding potential customer segments is focusing on applications where CSP has a technological advantage in relation to other energy sources.

USSI could possibly gain an advantage of marketing their product as a robust technology with the help of the Stirling engine. This could increase the credibility of their product against heavy manufacturing industries. Potential customers within industry are those that need both electricity and heat, such as metal manufactures.

USSI already claims that *Oasis* can be used for desalination, especially off grid. This should be investigated further as a possible solution for customer segments in dry areas. Resorts is another possibly off grid segment, as some of them are currently dependent of importing fossil fuel and wish to be independent from the electricity grid. Resorts would most likely buy few unit systems.

6.4 Continued Work

As there are several alternatives for further research concerning USSI's commercialisation a future BMC is suggested below, with the ambition of acting as a guideline for future work, see figure 6.1. It is of importance to take into consideration the challenges presented in this thesis when continuing this work, such as language barriers and procurement customs. Using the Mom Test could provide with new revelations and thus give a better output when conducting interviews.

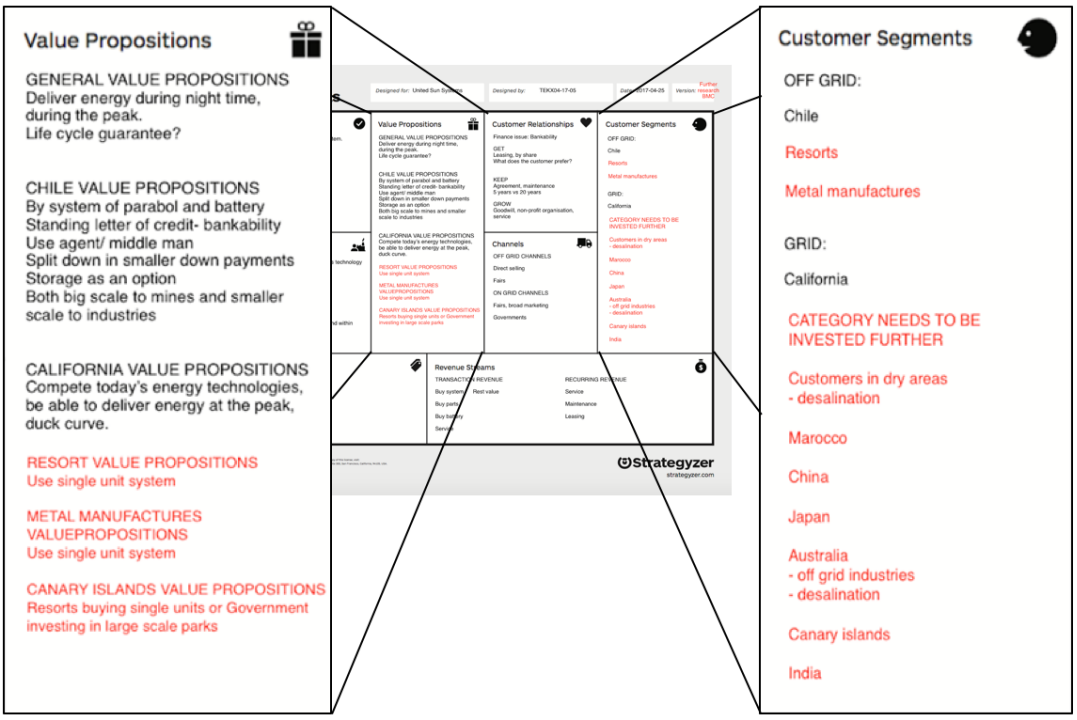

Figure 6.1: Suggestion for further research.

7
Conclusion

This study set out to identify customer segments and create value propositions to each segment by applying the Customer Development Process. A major finding was that there is a clear interest in renewable energy with storage which implies that markets are requesting what *Oasis* has to offer. There were markets that showed to contain suitable customer segments as well as markets that, considered to the outcome of the study, are not recommended for commercialisation of *Oasis*. The purpose was fulfilled by means of partially confirming Chilean mining industries as potential customer segments. The Hawaiian market was identified as a non potential market which was a valuable learning experience. Value propositions based on market identification and interviews were created for both Chile and Hawaii, concluding that the part of the purpose regarding creation of value propositions was fulfilled.

Since the purpose is considered to have been fulfilled, it implies that the Customer Development Process is applicable also for technology-push products. The interviews conducted during the study were facilitated by the Mom Test which has shown to be a helpful tool in terms of understanding customers' needs and creating fitting value propositions. The Business Model Canvas served its purpose by creating a broad overview helping to apply the modified hypothesis in business model. The market identification was considered necessary when starting out with such a large scope.

Conclusions drawn from applying the method shows that in order to get the full effect, it is important to get out of the building in order to be able to meet people face to face to get a clear picture of the customers situation. By just conducting interviews via Skype and emails the full potential of the Customer Development Process was not fully utilised.

Despite the fact that the purpose of finding customer segments and creating value propositions is fulfilled there are still things to be done in the commercialisation process of *Oasis*. The customer segments that has been recommended as an outcome of the study need to be further investigated. USSI is also recommended to investigate markets outside the scope of the study and strive to understand their procurement processes. In some cases USSI is suggested to find local partners that could serve as a intermediary. To conclude there are many different possibilities to find the market fit for *Oasis*.

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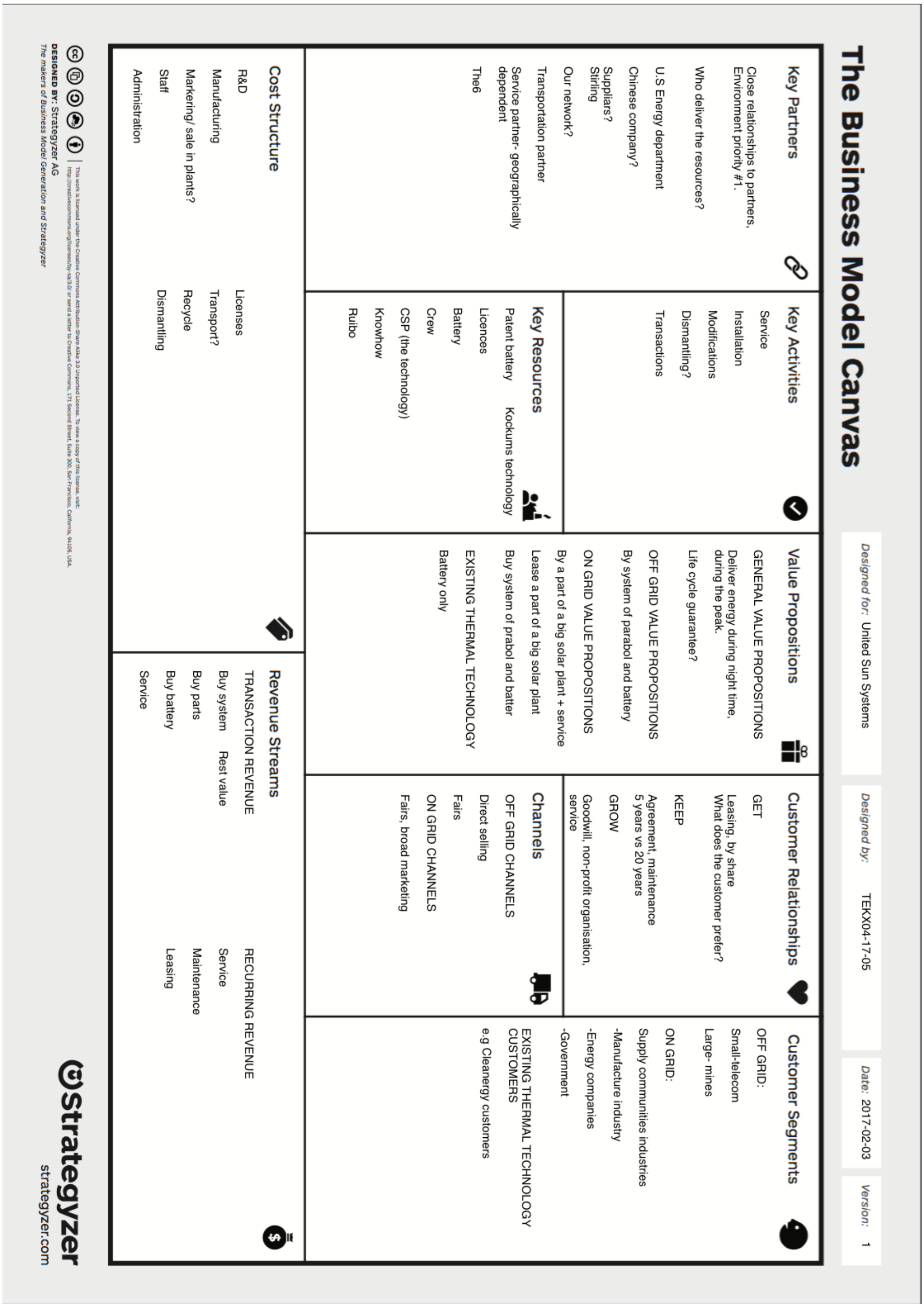
A

The Incremental Process Leading to the First Business Model

The first hypothesis and the modified hypothesis are presented in three BMCs below. The first one includes the first hypothesis, the second one inlcudes both first hypotheses (black writing) and modifications (red writing and markings). The third BMC inlcudes the modified hypothesis and is therefore the BMC that worked as a starting point when starting the iterative process in conducting interviews.


The Business Model Canvas
Designed for: United Sun Systems
Designed by: TEKX04-17-05
Date: 2017-02-03
Version: 1
Key Partners
Close relationships to partners, Environment priority #1.
Who deliver the resources?
U.S Energy department
Chinese company?
Suppliars? Stirling
Our network?
Transportation partner
Service partner- geographically dependent
The6
Key Activities
Service
Installation
Modifications
Dismantling?
Transactions
Key Resources
Patent battery
Kockums technology
Licences
Battery
Crew
CSP (the technology)
Knowhow
Ruibo
Value Propositions
GENERAL VALUE PROPOSITIONS
Deliver energy during night time, during the peak.
Life cycle guarantee?
OFF GRID VALUE PROPOSITIONS
By system of parabol and battery
ON GRID VALUE PROPOSITIONS
By a part of a big solar plant + service
Lease a part of a big solar plant
Buy system of prabol and batter
EXISTING THERMAL TECHNOLOGY
Battery only
Customer Relationships
GET
Leasing, by share
What does the customer prefer?
KEEP
Agreement, maintenance
5 years vs 20 years
GROW
Goodwill, non-profit organisation, service
Channels
OFF GRID CHANNELS
Direct selling
Fairs
ON GRID CHANNELS
Fairs, broad marketing
Customer Segments
OFF GRID:
Small-telecom
Large- mines
ON GRID:
Supply communities industries
-Manufacture industry
-Energy companies
-Government
EXISTING THERMAL TECHNOLOGY CUSTOMERS
e.g Cleanergy customers
Cost Structure
R&D
Manufacturing
Markering/ sale in plants?
Staff
Administration
Licenses
Transport?
Recycle
Dismantling
Revenue Streams
TRANSACTION REVENUE
Buy system
Rest value
Buy parts
Buy battery
Service
RECURRING REVENUE
Service
Maintenance
Leasing
DESIGNED BY: Strategyzer AG
The makers of Business Model Generation and Strategyzer
Strategyzer
strategyzer.com

The Business Model Canvas

Designed for: United Sun Systems | *Designed by:* TEKX04-17-05 | *Date:* 2017-02-03 | *Version:* 2

Key Partners

Close relationships to partners, Environment priority #1.

Who deliver the resources?

U.S Energy department
- Sundia national laboratory

Suppliars?
Stirling

Transportation partner

Service partner- geographically dependent

Company that delivers heat pipes

Company that delivers koncentrator

Company that delivers disc

COmany that manufacture the engine

Key Activities

System provider
- core activity about the system

.Service

Installation

Modifications

Dismantling?

Transactions

CHP application

Key Resources

Patent battery

Kockums technology

Licences

Battery

Crew

CSP (the technology)

Knowhow

-From partners and within USSI

Value Propositions

GENERAL VALUE PROPOSITIONS

Deliver energy during night time, during the peak.

Life cycle guarantee?

~~OFF GRID~~ VALUE PROPOSITIONS
CHILE

By system of parabol and battery

~~ON GRID~~ VALUE PROPOSITIONS
HAWAII

By a part of a big solar plant + service

Lease a part of a big solar plant

Buy system of prabol and batter

Solution that eliminated the need of oil shipping

~~EXISTING THERMAL TECHNOLOGY~~

~~Battery only~~

~~In the future: Licensing~~

CALIFORNIA VALUE PROPOSITIONS
Compete today's energy technologies, be able to deliver energy at the peak.
Duck curve

Customer Relationships

Finance issue: Bankability

GET
Leasing, by share
What does the customer prefer?

KEEP
Agreement, maintenance
5 years vs 20 years

GROW
Goodwill, non-profit organisation, service

Channels

OFF GRID CHANNELS

Direct selling

Fairs

ON GRID CHANNELS

Fairs, broad marketing

Governments

Customer Segments

OFF GRID:

~~Small-telecom~~
~~- Low energy consumtion~~

~~Large- mines~~

~~India and pakistan- bad grid~~

Chile

GRID:

~~Supply communities industries~~

~~-Manufacture industry. e.g. Desalination~~

~~-Energy companies~~

~~-Government~~

Hawaii
California

~~EXISTING THERMAL TECHNOLOGY~~
CUSTOMERS

~~e.g Cleanergy customers~~

Cost Structure

R&D

Manufacturing

Markering/ sale in plants?

Staff

Administration

Licenses

Transport?

Recycle

Dismantling

Revenue Streams

TRANSACTION REVENUE

Buy system Rest value

Buy parts

Buy battery

Service

RECURRING REVENUE

Service

Maintenance

Leasing

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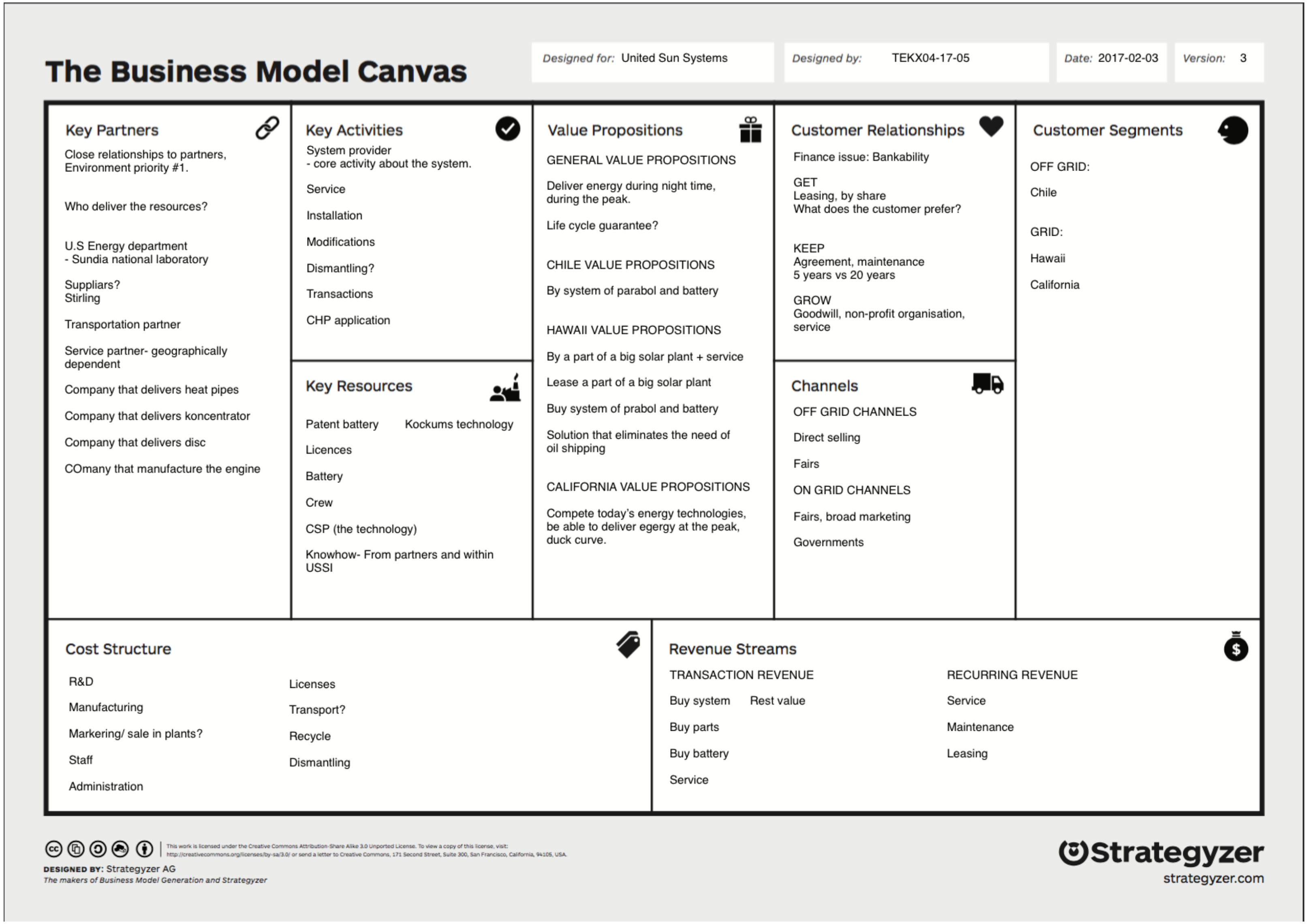
The makers of Business Model Generation and Strategyzer

Strategyzer
strategyzer.com


The Business Model Canvas
Designed for: United Sun Systems
Designed by: TEKX04-17-05
Date: 2017-02-03
Version: 3
Key Partners
Close relationships to partners, Environment priority #1.
Who deliver the resources?
U.S Energy department - Sundia national laboratory
Suppliars? Stirling
Transportation partner
Service partner- geographically dependent
Company that delivers heat pipes
Company that delivers koncentrator
Company that delivers disc
COmany that manufacture the engine
Key Activities
System provider - core activity about the system.
Service
Installation
Modifications
Dismantling?
Transactions
CHP application
Key Resources
Patent battery
Kockums technology
Licences
Battery
Crew
CSP (the technology)
Knowhow- From partners and within USSI
Value Propositions
GENERAL VALUE PROPOSITIONS
Deliver energy during night time, during the peak.
Life cycle guarantee?
CHILE VALUE PROPOSITIONS
By system of parabol and battery
HAWAII VALUE PROPOSITIONS
By a part of a big solar plant + service
Lease a part of a big solar plant
Buy system of prabol and battery
Solution that eliminates the need of oil shipping
CALIFORNIA VALUE PROPOSITIONS
Compete today's energy technologies, be able to deliver egergy at the peak, duck curve.
Customer Relationships
Finance issue: Bankability
GET
Leasing, by share
What does the customer prefer?
KEEP
Agreement, maintenance
5 years vs 20 years
GROW
Goodwill, non-profit organisation, service
Channels
OFF GRID CHANNELS
Direct selling
Fairs
ON GRID CHANNELS
Fairs, broad marketing
Governments
Customer Segments
OFF GRID:
Chile
GRID:
Hawaii
California
Cost Structure
R&D
Manufacturing
Markering/ sale in plants?
Staff
Administration
Licenses
Transport?
Recycle
Dismantling
Revenue Streams
TRANSACTION REVENUE
Buy system
Rest value
Buy parts
Buy battery
Service
RECURRING REVENUE
Service
Maintenance
Leasing
DESIGNED BY: Strategyzer AG
The makers of Business Model Generation and Strategyzer
Strategyzer
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B

Interview Questions

This appendix presents the templates for the interview questions. The goal of each interview question was to receive insights and knowledge in certain areas depending on whom the interview was conducted with. The questions for each interview may have been slightly adjusted for specific interviews, but the purpose of receiving certain information remains the same.

B.1 Template 1 - Authorities

Regarding authorities, the goal was to receive information about how the market looks considering regulations and subsidies. Here follows the intentions of the interviews.

- How do authorities find parties to work with, which channels do they use and how does the process look like for new companies trying to enter the energy market?
- Find out how subsidies and how regulations affect the development of renewable energy as of today.
- What types of incentives do authorities have for investing in renewable energy?
- Are there any political impact?
- At what times do people need their energy?
- Do authorities experience any problems with solar energy today or any other source of renewable energy for that matter?
- Do they value a solar energy storage solution so high that they already have a request today for that type of solution?

The interview questions were constructed based on these. Here follows some example questions.

- How does your energy procurement work?
- How do you regulate the energy market and what does a typical market entrance process look like?
- Why do you invest in renewable energy and how do you think the future will be for renewable energy?
- What is the time of delivery for energy?
- What challenges do you experience with solar energy or other renewable energy sources?
- How would you value a solar power storage solution?

B.2 Template 2 - Large Scale, On Grid

The interview for large scale, on grid was conducted with large energy companies. The goal was to receive an insight whether they are potential customers and how they look at renewable energy and storage as the future. The detailed information we wanted to receive from the interviews are summarised below.

- Are they potential customers and do they consider renewable energy sources to be the future?
- Why do they use different renewable energy sources in their energy portfolio? Is it to handle the duck curve?
- How have they delivered energy to customers during the evening and at night time? Would they be willing to pay extra to have renewable energy sources at night?
- Who are their distributors and are they forced to deliver to distributors in order to get on the grid?
- How do they obtain financial assurance and who are their investors?

The interview questions were constructed based on these. Here follows some example questions.

- Why are you currently investing or not investing in renewable energy?
- Why do you work with so many sources of renewable energy? Have you worked with fossil in the past?
- How have you delivered energy to your customers during the evening and at night in the past?
- What regulations and subsidies are you dependant on?
- What position are you in within the energy network?
- In what way do you finance new projects?

B.3 Template 3 - Experts

Regarding experts the goal was to see their thoughts of the storage problem and their view on solar energy in the future. Here follows the intentions of the interviews.

- What are their views on the storage problem?
- How do they think renewables will develop in the future.
- What do they consider an attractive market?

The interview questions were constructed based on these. Here follows some example questions.

- What are their views on the storage problem?
- How do they think renewables will develop in the future.
- What makes a market attractive? High electricity prices, imported energy?
- How are the oil companies reacting to the development of renewables?
- How have the renewables developed over time? Faster or slower than it should have?

B.4 Template 4 - Small Scale, Off Grid

The interview for small scale, off grid was conducted with mines. Here the thought was to see if they had a need for storage and what their energy usage looks like. Here follows the intentions of the interviews.

- Are there any interest in solar energy? Are they more interested in PV or CSP?
- Are they experiencing a storage problem?
- How do they value a 24 hour energy distribution?
- Have they invested a lot in energy production?

The interview questions were constructed based on these. Here follows some example questions.

- Are they using renewable energy today? How does it work?
- Why or why did you not invest in renewable energy?
- Which energy sources are the most suitable for the industry?
- What is their energy consumption during the night? Do they operate 24/7?
- How do they procure their energy?

C

Contacts

This appendix represents a table containing all contacts we have tried to get in touch with.

Name	Role	Organisation
California		
		California Energy Commission
Chris Hinton	Solar Portfolio Manager	Sempra Renewables
		UC Solar
Jennifer Z. Rigney	Senior Director of Corporate Communications	BrightSource Energy
Margot Gerritsen	Associate Professor, Energy Resources Engineering	Stanford University
Mark Cappelli	Professor, Mechanical Engineering	Stanford University
Chris Hinton	Solar Portfolio Manager	Sempra Renewables
Philip Jones	Principal Mechanical Engineer	Cogentrix
Katherine Potter	Vice president, Communications	Ausra
		California Solar Thermal
		NRG Energy
		Southern California Edison
		Solar City
		San Diego Gas and Electric
		Pacific Gas and Electricity
		eSolar
		SolarReserve
		Abengoa
		Solar Millenium
		Pintail Power
		Recurrent Energy
		Alion Energy
		EDF Renewable Energy
		Pacific Northwest National Laboratory

Hawaii		
Dean Kimurra		Keahole Point, CSP project on Hawaii
Darren Towle		Keahole Point, CSP project on Hawaii
Kevin Davies	PhD Mechanical Engineering	
		Hawaiin electric industries
		Hawaii natural institute
Daisy Isla		
Kristen Jamison		
Marika Metz-Hall	Department of Business, Economic Development and Tourism	Hawaii State Energy Office
		Maui: Hawaiian elecrtic
Veronica Rocha	Renewable Energy program Manager	Hawaii State Energy Office
Beth Tokioka	Communication Manager	Kauai Island Utility Cooperative (KIUC)
		SolarCity
		Tesla
Chile		
	Owns/operates/ joint venture mines in Chile	Anglo American
		Codelco
Ezequiel Ferrer	Contact at Aste1B CSP Project	SolarPaces
info	Copper mines in Chile	Glencore Xstrata
Anna Krutikov	Focus on sustainability	Glencore Xstrata
		Grupo Ibereólica
		SolarPaces
Victor Fainberg Alberti	Developer and consultant. Interested in CSP and selling systems as an intermediary	St Louis & Co
Paulo	Shown interest in USSI's Parabolic Dish system	
Mary Grikas	Vice President of Global Communications	SolarReserve
Luis Rejano		Abengoa Solar
		Centro de Energias Renovables
Andrés Rebolledo Smitmans	Minister of Energy	Ministry of Energy Chile

		Instituto de ingenieros de minas de chile
Prof. Manuel Caraballo	Professor in Environmental Mineralogy	FCFM- Department of mining engineering
Prof. Francisco Gonzalez	Ph.D. in Mining Engineering	FCFM- Department of mining engineering
	Santiago Office	Sandvik
		BHP Billiton
		SunEdison
Domain Experts		
Tomas Kåberger	Department for resource theory in physics	Chalmers University of Technology
Mark Mehos	Group Manager, thermal systems and CSP manager	National Renewable Energy Laboratory
Greg Glatzmaier	CSP expert	National Renewable Energy Laboratory
Dr R.K Pachauri	Former chairman of the intergovernmental panel on climate change	
Björn Laumert	Founder and leader of a research group for CSP	KTH - Royal Institute of Technology
John Mathews	Writer of "The Greening of Capitalism". Expert in dynamics of emerging renewable energies	MGSM - Macquarie University Australia

D

Interviews

This part of the appendix will present all of the interviews that were conducted during this bachelor thesis. The table below, in which the questions and answers are presented, will not provide any analysis or recommendations of the answers, just the answers.

D.1 Sempra Renewables

Sempra Renewables is an American company active within the field of renewable energy sources, wind- and solar power more exactly. The interviewee at Sempra was Chris Hinton, who works as a Solar Portfolio Manager. He and his smaller team of analysts are working with managing solar projects. Tasks include optimising output as well as minimising costs to generate the maximum value for the operational projects. They do what they can in order maximise the value from their investments.

Ultimately in the future, we would like to fully get away from natural gas. There aren't many options that have more flexibility than natural gas for as little as it costs. It is therefore going to take a long time to get off natural gas and to get an entirely, 100 percent renewable grid. That would take a lot of more renewables and lot more batteries.

It is becoming a big topic and has gained a lot of attraction during the past few years. Prices has dropped quite rapidly, both solar panels but also battery technologies. This has led to a more cost competitive to deploy batteries.

According to Hinton, you have to put a few key pieces together in order to be able to work with a renewable energy project. He says that it is not just as simple as saying that you want to build a renewable project somewhere in the US. He then moves on to talk about those key pieces and the first one is the access to power lines, which is quite important in order to build a project. Secondly, Hinton argues that you need access to land in order to start and build the project, but not just any land, land with enough sunlight to support the project, if it is a project within solar energy. The last piece Hinton talks about is a type of environmental permit as he describes it. This means that you must apply for that permit at the local government of the location where you want to start and build your project. Hinton ends with concluding all of the key pieces which are power grid connections, the

land to build on, the resources, the environmental part, and the different permitts. Hinton then argues that they need to all come together to form a value proposition. Working with PV due to economical reasons. According to Hinton the economic cost to build PV is considerably lower. Cost of developing PV has decreased sharply for the past couple of years. They have checked on Solar thermal but it was not as economic, especially the operational expense that comes with the projects.

When Sempra Renewables decides on whether or not they are going to invest in a certain project, they use a proforma model where the different costs and revenue streams are inserted. He then argues that the proforma model is being used to find the return on investment, hereby referred to as ROI, for a particular project. According to Hinton, they do not only look at ROI but also net present value and internal rate of return. These key performance indicators are used to determine if Sempra Renewables should invest in a certain project.

Solar power will be as competitive as other sources. Although moving to a 100 percent solar is not the best economic option. You want to be open to a mix of renewable sources, and they have to make sense and fit in. You might have a location where it is windy and not sunny, therefore you would like to have wind power station. As a conclusion it it not optimal to only depend on solar energy, but rather on a mix of renewable energy sources.

D.2 Hawaii State Energy Office

Interviewed March 16th 2017.

The Hawaiian State Energy Office is the governmental department of energy and responsible for the country's renewable energy development.The interview was conducted with Veronica Rocha, the Manager for the Hawaiian Renewable Energy Program who are responsible for providing energy initiatives and technical initiatives. Rocha holds two Stanford Degrees, as well as a bachelor in mechanical engineering and a master in business administration. During 2011-2012, Rocha was a regional Sales Manager at Sopogy, a Hawaiian based Concentrated Solar technology company.

Rocha believes that the challenges in CSP in Hawaii lies in the amount of DNI (Direct Normal Irradiation) and in finding geographical space. She explains that the water particles in the air caused by high humidity and clouds prevent a sufficient level of DNI for CSP to be effective.Rocha further says that there is'nt enough space on the Hawaiian Islands for CSP technology. Instead, she says that CSP would be more ideal for heat requiring industries such as mines.

Rocha explains that they issued a solicitation for energy storage a few years ago, and that they are currently in the process of revaluing that proposal and how much of that utility that is currently required.

They are pursuing procurement for both larger scale renewable energy and issuing incentives for small scale individual renewable energy production.

The small scale private rooftop solar market is supported by an energy metering tariff. This enables excess privately produced solar to be distributed on the grid and credited to the costumer through a lesser energy bill. The citizens are thereby getting full market price compensation for their energy without having to pay for any operative costs of upholding and administrating the grid.

Their energy market is divided into small scale energy connected to the grid supported by tariffs, and larger scale energy bigger than 5MW (mostly in Oahu). To install large scale energy facilities, utilities are required to pursue a competitive procurement through Requests for Proposals to the government by telling what capacity, resources and characteristics they are looking for. They proposals are then reviewed and possibly approved by the Public Utilities Commission. If approved, the utilities then have the permission to to issue the Request for Proposal and ultimately award the most competitive proposal.

When asked about how she believes that the market for renewables has developed, she says that what she sees is a typical increase in renewables during huge rushes in periods with high fossil fuel prices in combination with incentives carried out by the government during 2009. Since then, she says that the market has slowed down, especially in regard to the falling oil prices. Rocha also says that the grid wasn't prepared for the surge in renewable energy and intermittent energy production that comes with renewables. She believes that we're going to see a new increased interest in solar in the years to come through an increase in procurement and through new incentives and tariffs.

D.3 Kevin Davies

Interview conducted March 20th 2017.

Kevin Davies has a PhD in Mechanical Engineering with focus on novel dynamic and simulation techniques to renewable energy. For several years he has been involved in different projects concerning electric vehicles, among others at Ford. He has also evaluated the effects of intermittent renewables on the Hawaiian Islands electric grids.

The big challenges for Hawaii to become 100 percent renewable in terms of energy sources is the cost and the storage issue. The mandate on Hawaii might not fully understand the cost implication of that kind of goal. Hawaii is today 23 percent renewable, and there is a long way to 100 percent since they so far only have used the easiest and cheapest ways, "the lowest hanging fruit", and they are running out of those alternatives.

Since solar PV and wind, which are the most common types of renewable at Hawaii today, are intermittent (varying and cannot provide energy all hours) a need for some kind of storage is crucial in order to reach the 100 percent goal. Also here, Hawaii has gone the easy way and are using biofuel, since lithium batteries are so expensive; between 20- 40 billion dollars for a battery that has roughly a life span of only 10 years. It's a risky investment since new, more effective and cheaper, technology might emerge in e few years. But biofuel has not the potential to cover the full energy demand.

So far, the development in renewables has been much influenced and continues to be influenced by costs and prices. Since the PV has dropped in prices rapidly the past years this is the technology that has increased the most. PV also has the potential to continue to drop due to economies of scale in streamline production. CSP and wind on the other hand, both consist of a lot of material that will not likely reduce in costs the same way. CSP also uses machinery and techniques that are already considered as optimised; for example, the heat engines have been used for over a century and improvements are only minor. From a financial and business point of view – the cheapest way is the most interesting way. And especially a significant and cost effective energy storage solution will be a big deal in the future.
(Kevin believes that)Trump's influence on the renewable energy market development can either ease or increase. National funding to research in those areas, for example to US Department of Energy, will be cut down; but on the other hand Trump's ministry wants to increase military spending, and a lot of these additional funding towards energy. And if renewable companies become profitable and can provide a product that is superior to today's fossil technology, Trump will most likely stand behind renewables as much as anything else. He is all about business and money.

D.4 Kauai Island Utility Cooperative (KIUC)

Interviewed March 21th 2017.

KIUC is the electricity provider on the Kauai Island.They are included in the HECO companies. Being a cooperative service means that they are membership owned. Their Communication Manager, Beth Tokioka, was the interviewee.

The island aim to be 70 percent renewable by 2030 and has a clear strategic plan to reach it. Different from the rest of Hawaii, Kauai is limited on having wind power due to endangered bird species. There is nor any geothermal energy or any possibility for economies of scale with biomass. This leave Kauai with solar and hydro projects. The challenge with PV/Solar is that the daytime energy is saturated. Additional challenge that the KIUC experience is that all projects have long lead time due to being regulated by the PUC.

The KIUC believe storage to be a part of the solution. Recently a Tesla system with solar and battery came on line in order to integrate renewable also during the peak nighttime hours. This system will deliver 13 MW for of a total of four hours,

that is still majority of nighttime is depending of diesel. They have a second solar plus battery project with Tesla coming on line next year (20MW). Right now they consider more solar+battery system or hydro pump-storage project to reach their ambitious goals.
The KIUC is like all the other HECO companies regulate by the PUC. They are however considering moving out from under the authority of them.

Member generated rooftop solar is successfully integrated to their grid.
The KIUC, as mentioned before, owned by its members whatever excess capital is returned to them. They aim to establish a rate structure that is fair between different classes of members.

> "There may be other technologies that will evolve in coming years that we could consider deploying." - Tokioka

D.5 Victor G. Fainberg

Interviewed April 25th 2017.

Owner of St Louis & Co, a company in Chile dedicated to development and consulting. Fainberg himself is an enthusiastic fan of CSP and tries to intermediate between buying actors in South America and providing actors of CSP. The account below is regarding both the Argentinian and Chilean market.

According to Fainberg the big challenge for implementing CSP in Argentina is the process of deciding contract agreements. According to him, the culture of making economical deals in Argentina does not come to terms with the way foreign companies are accustomed to. Since CSP plants are complex and extensive projects they require substantial investments. Fainberg writes that foreign countries needs stock in advance, while Argentine companies cannot afford one time payments in beforehand. He further states that he needs a contract for six months for selling CSP products with a standing LC during this period.

Fainberg's idea of the best value proposition would be to manufacture CSP systems that generate between $200kWh/month$ to $1500kWh/month$ and sell to large and medium-sized companies, which need to produce their own energy. The system should be a hybrid, that is both natural gas and solar. Further, the storage system can be offered as an option.

When comparing Argentina and Chile, Fainberg comments that Chile has come further in reducing their on grid energy prices. However, he still believes that large and medium-sized companies need to produce their own energy, especially in Argentina.

Fainberg states that one main advantage to CSP versus PV is the high concentration of energy production. This means fewer acres are required to develop the CSP plant.

D.6 Dr. R K Pachauri

Interviewed March 10th 2017.

Dr. R K Pachauri started his academic career within energy politics which led him to environmental issues where he working with climate change. Dr. Pachauri was the former chairman of the Intergovernmental Panel on Climate Change from 2002 to 2015. During that time, the Nobel peace prize was awarded the IPCC.

They will use their power, money and influence to make sure that renewables are not developed. Fossil fuel would not want renewable energy to come in the way, they want to continue with the easy profits. Unfortunately some leaders that are trying to move into renewable energy sources from fossil fuel don't seem to be able to control the industry. There are very little happening in terms of transitioning form fossil to renewables.

Storage are relevant for both PV and CSP. Need to develop both types of storage, since we will need both of these techniques. He sees a huge market for both and doesn't see competition between these two. Storage can make a huge difference, not only for solar but for all kinds of renewable energy sources. It is by far the most critical part in renewable energy development.

Important for governments to create conditions in order to make renewable energy more attractive. Believes that the government are the lagging factor in developing renewable energy. If they had put mot effort and valued this higher the development would have been better and faster. Governments are not internalising the costs of fossil fuels. The externalities from fossil fuel should be accounted for. The costs of using fossil fuel based energy sources should be a lot higher. Governments have not done this. Thinks that renewable energy should have developed a lot faster than it has.

Don't know how Trump will act since no action has been taken so far. It could be difficult to make bigger changes since there are economical benefits for actors in this area. There are lots of decentralised supporters. Parts of US like California and Texas has lots of renewable energy and individual benefits. It makes economic sense. People see the economic benefits of this.

In terms of value proposition for different markets Dr. Pachauri believe that different value propositions should be considered for different markets. Different societies have to adopt different methods. Lot of variation all over the world based on social-economic conditions.

D.7 Prof. Tomas Kåberger

Interviewed March 17th 2017.

Tomas Kåberger has an PhD in Physical Resource Theory, a Docent in Environmental science and a MSc in Engineering Physics at Chalmers University of Technology where he currently serves as a Professor of Industrial Energy policy. He also serves as Distinguished Visiting Expert of bio-energy technology at Zhejiang University in Hangzhou.

During his career, Tomas Kåberger has, among other things, been involved in helping companies provide fuels and technology in the bio-energy industry and sustainable energy solutions. Kåberger has also been politically involved by serving on board of Swedish and European Environmental Citizen's organisations, several Swedish Government Committees developing energy and environmental legislation. (Renewable Energy Institute, 2017)

According to Kåberger the main challenge today is to start the development and manufacturing of CSP. This, in order to build experience about the cost reduction that is proven so be possible in theory. This has been a big challenge for many actors like Repasso, Cleanergy and USSI.

Kåberger also states that storage will be an important subject in the future. It is important to investigate how to deliver energy during night. The energy production that is provided from PV does not match this energy demand. When the sun decreased, the demand increases. This could be solved by CSP- a technique that is able to store energy during day and deliver energy during night. This generates a greater value for this energy than the PV can offer. The fact that CSP gets cheaper when installed with storage than without storage makes it even more attractive.

A draw back for CSP is that one have to decide from the beginning if one want to have storage or not. Whereas it is possible to add a battery to existing PV. Another difference between the two techniques is that CSP will need maintenance while PV is quite self running.

In Europe the big energy companies looses market shares due to the fact that renewable energy has resulted in lower energy costs. The energy political problem is to liquidate the old technologies in a good controlled way. This slows the development down in Europe, United states and in Japan. China and India is handling this pretty well since they do not have to replace old energy sources with renewable but expand the existing network by installing renewable energy techniques. That is installing renewables without directly out compete existing older techniques. Islands like Hawaii and the Canary Islands could also benefit from this by installing renewables instead of importing oil for energy production. The same stands for other regions around the world were it is easy to install renewables due to low resistance.

Both large scale and private scale is going to be interesting- one can make a point in not comparing the two techniques by means of competition and state that CSP stands for an other,- or an additional possibility than PV.

The renewable energy market is changing rapidly and PV reduces in price very quickly. CSP has therefore followed back a bit. Actors developing CSP needs to present themselves in a good way to keep up. An important competition factor is that CSP with storage produces cheaper energy than CSP without storage. This since the energy storage is cheaper than the Stirling part of the CSP so when the exploitation on the Stirling engine increases the kWh cost reduces which can pay for the storage. At the same time as CSP gets cheaper with use of storage PV always gets more expensive with storage.

Kåberger thinks that Trump might be able to delay the development of renewable energy since Trump tempts to remove restriction on for example carbon and decrease the energy departments budgets by 1/3. Thus of course effects the federal science and development of the United Stated which in turn also effects all industries in the US. He doubts however that Trump would be able to stop the development due to the economic competitiveness of renewable energy, the fact that the federal governance in this area are not so big and the fact that the American Armed Forces is also a big advocate of renewables.

Kåberger does not agree with Veronica Mehos when it comes to the place and role of CSP for Hawaii. He means that Hawaii already have fields of PV and this also need space. CSP has a higher efficiency per unit area than PV. He means that it might be a problem if there are strong winds at Hawaii though, Cleanergys CSP though could manage some pretty big hurricanes.

D.8 Mark Mehos

Interviewed March 22th 2017.

Mark Mehos is group manager for the CSP and thermal storage department at the National Renewable Energy Laboratory. He joined NREL already in 1986 and since 2013 one of his main tasks is to quantify the additional value that CSP with storage provide.

Mehos claims that the duck curve is what will be the biggest challenge (note: will be) for renewable energy sources. He believes that renewable can still penetrate the market, but "the duck" is happening a lot faster than expected. Additional problems that came up is an inflexible electricity grid, considering renewable energy having an uneven generating in its nature.

One part of the CSP challenge lays in its cost, see paragraph Economics below. Furthermore, Mehos explained why CSP is not suited for Hawaii or, more general,

areas close to ocean. These areas have high humidity and particles in the air and due to CSP being dependent on direct irradiation from the sun rays, compered to PV that benefit from all rays, this condition diminishes the direct beam and therefore the efficiency of the CSP.

Mehos state that storage is an important part of solving the duck and generally people in the business are talking about storage. He also mention that California has a big market pull for storage, but mainly because they have so much PV in the system.

Mehos believe that the decision makers are aware of the duck curve and the problem renewable energy sources have, but not how to asset the problem. He once again spoke of the importance to realise storage is one part of the solution and another way could be export the extra energy produced during, for solar, day time. Most critical the electric system has to be flexible.

Trump being the USA's new president will probably not change the subsides for solar panels etc, believe Mehos. However the taxes for CO2 emissions may be affected.

Mehos and his team claim they have quantified the additional value CSP with storage provide. Compared to PV, which loses it value during the peak hours, CSP do not. The value spring from mainly two sources: the capacity value and the energy value. The energy value is the cost of next generation technology and the operational value. This is driven by what the fuel source is. The capacity value is the ability to asset a new plant that meets the peak. The capacity value is therefore very dependent on the markets need for capacity. Generally speaking adding these two values adds up to five to six cents higher value than PV, but the cost for CSP is still higher than the extra value.

Markets with high capacity value is due to the valuation process good markets to launch the CSP projects on. Mehos say that California is not in a need for new capacity, but they plan to extend the capacity in five years. Morocco however has a growing need. China is also a growing market. Mehos believe Chile to be a good market in theory, but recent events make him say it is tricky to get contracts there. PV and battery is definitely a big concurrent to CSP with storage.