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New Opportunities for Investments in Solar Energy

Explorative Study of a Novel Business Model for Small Investments in Solar Energy in Switzerland and in Portugal

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Abstract

The Solar energy is playing a fundamental role in the transition to a low carbon electricity production system. Driven by rapidly decreasing prices for solar installations in the last years, the solar energy market in Europe is currently undergoing a transformation. Subsidies such as feed-in tariffs are being phased out and replaced with the possibility to self-consume solar energy, earning a profit by buying less electricity from the grid. This change creates opportunities for new innovative business models such as the one examined in this study. Concretely, this study carries out an explorative case study to assess the financial viability of a business model for small-scale investors in off-site solar energy in Switzerland and in Portugal. Additionally, interviews with potential investors have been made to explore perceived advantages and disadvantages and to analyse how the saving and investment preferences of potential investors align with this business model. The study concludes that the examined business model is financially viable for medium sized projects in Switzerland but even more for large projects in in Portugal. However, a number of challenges have been identified. For instance, legal questions in regard to ownership and guaranteeing the continued operation need to be resolved. Additionally, very efficient management procedures by the implementing company are required to bring down administrative costs and to ensure its own financial viability, which is mandatory to earn buyers' trust and money.

Keywords: Solar Energy, Renewable Energy, Investment Decision Process, Sustainable Investment, Business Models, Switzerland, Portugal

Executive Summary

Problem statement

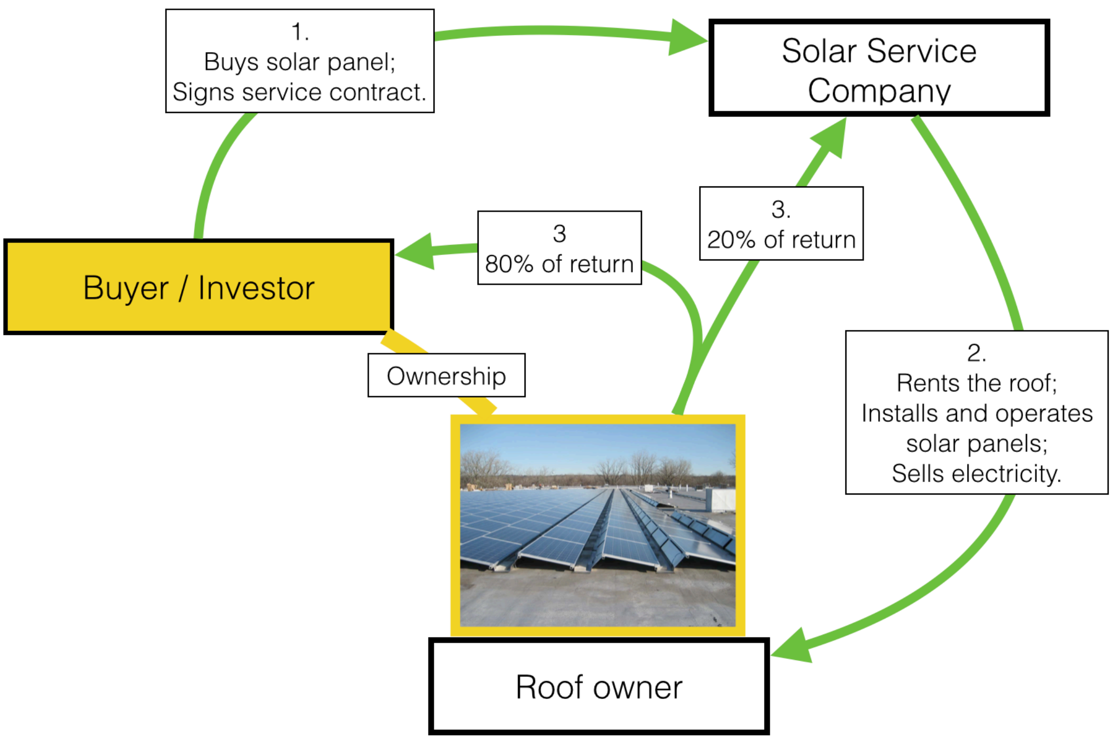
Solar energy has the highest energy potential of all renewable energy technologies and plays a key role in the quest to address climate change by replacing fossil fuels with less carbon intensive energy sources. Due to recent substantial price reductions it can now compete with fossil fuels in a growing number of countries. Consequently, the solar energy market is rapidly expanding on a global scale.

In Europe, a shift towards phasing out subsidies for solar energy takes place. In parallel, economic difficulties particularly in southern European countries (e.g. Portugal) reduce available public and private capital for investments in energy. At the same time, citizens of prosperous countries in central, western and northern Europe (e.g. Switzerland) can save significant amounts of money but face a dearth of profitable and safe investment possibilities. The concurrence of these developments creates opportunities for new business models. In this study the economic and legal viability of a business model for small-scale investors in off-site solar energy (SOIS) and investors' preferences are examined.

Research Questions

1. How viable is the SOIS business model in Switzerland and in Portugal from a financial and legal perspective?
2. How does the SOIS business model fulfil investment criteria for Swiss small scale investors?

Examined Business Model



The buyer purchases a panel from the Solar Service Company, which installs the panel on a roof, sells the electricity and transfers 80% of the revenue to the buyer while keeping 20% under a long-term contract. The business model is innovative because the buyers can invest small amounts of money in tangible solar panels, legally own and sell them as needed, increasing flexibility.

Methods

Literature research was used to define *business models,* to determine parameters of the Swiss and the Portuguese solar market and to provide theoretical insights into investment decision processes. Interviews with experts from the solar industry, banks and lawyers complemented these insights, allowing the author to identify legal challenges and to build valid financial models for four scenarios in both Switzerland and Portugal. Interviews with 20 potential customers provided insights into their saving and investment preferences and assessed perceived advantages and disadvantages of the SOIS business model.

Results

Results show that it is more profitable for buyers to have their panels installed in Portugal than in Switzerland. However, because potential buyers preferred little time investment and little risk over financial return, also the medium Swiss scenario may be acceptable for buyers.

Financial Viability Scenarios 1-4	**Switzerland small (5 kWp)**	**Switzerland medium (30 kWp)**	**Switzerland large (400 kWp)**	**Portugal large (400 kWp)**
Panel buying price	€546	€507	€468	€338
Net revenue per panel (25 years)	€112	€474	€240	€623
Payback time	20.8 years	13.1 years	16.6 years	8.9 years
Internal rate of return	0.5%	4.7%	2.4%	8.3%

The interviewed potential investors generally confirmed the hypothesised advantages of the SOIS business model. Namely they appreciate: a small and low risk investment opportunity in a concrete object providing an environmental benefit while limiting their administrative burden and yielding a better return than their current savings. A majority of interviewees said that they would consider buying a solar panel with the SOIS business model.

Perceived disadvantages include doubts about the financial viability of the Solar Service Company. Also, interviewees mention the need of the company to build trust and provide transparent information in order to overcome risk aversion and several misconceptions about solar energy such as long energy payback time and high cost of solar panels.

The study also finds a major legal challenge linked to guaranteeing the ongoing operation of the solar panels in the case of an insolvency of the Solar Service Company. Special Purpose Entities may provide a solution to this issue but this requires further research.

Conclusion

The author concludes that the SOIS business model may be financially viable and attractive to a significant group of interviewees provided that the legal challenges can be resolved.

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Abbreviations

BOS	Balance of System
CHF	Swiss Franc
CSR	Corporate Social Responsibility
EIV	Einmalvergütung (One-off investment grant)
EUR	Euro
EU	European Union
FIT	Feed-in Tariff

GW	Gigawatt
kW	Kilowatt
kWh	Kilowatt Hour
kWp	Kilowatt Peak
IRR	Internal Rate of Return
MIRR	Modified Internal Rate of Return
NPV	Net Present Value
PV	Photovoltaic
SOIS	Small-Scale Off-Site Investment in Solar Energy
SPE	Special Purpose Entity
SSC	Solar Service Company
TWh	Terawatt Hour
UPAC	Unidades de Autoconsumo (units of self-consumption)
UPP	Unidade de Pequena Produção (units of small consumption)
USD	US Dollar

1 Introduction

1.1 Problem Statement

Global low-carbon energy supply needs to increase three to seven-fold over the next 35 years in order to limit atmospheric concentration of CO_2, addressing climate change in line with scientific recommendations (IPCC, 2014). From all low-carbon technologies, solar energy has the largest energy generation potential and will play a crucial role in the required energy transition (IPCC, 2014; Massachusetts Institute of Technology, 2015).

On a global level, Germany has initially led the ongoing solar energy expansion but is now being overtaken by China, Japan and the US while more and more countries on all continents start installing significant amounts of solar power (IEA PVPS, 2015; Kurz, 2015; Morgan Stanley, 2014). Several authors suggest that it is technically and economically possible to have industrialised countries fully powered by renewables (Jacobson et al., 2015; Roselund, 2015). The biggest challenge to realise solar energy's potential is no longer technical but how to accelerate a positive change in the attitudes of people (Wüstenhagen and Menichetti, 2012).

In Europe, the solar energy market is being transformed rapidly. Given the decreasing costs of renewable energy in general and solar energy in particular and its rapidly increasing market share in recent years, many countries are reviewing and adjusting energy policies (International Energy Agency, 2015b). Subsidies for solar energy are being phased out (Patel, 2014), which triggers an important restructuring of the sector towards a situation where it will need to compete in increasingly liberalised markets, sometimes against subsidised nuclear (BBC News, 2013) and fossil fuels (Coady, Parry, Sears, & Shang, 2015).

While some countries and most notably Germany have managed to mobilise substantial private investments and reached significant levels of solar energy capacity (Parkinson, 2014), various countries in southern Europe did not capitalise as much on their much better solar resources (Tsagas, 2014). For example, Portugal has installed a cumulative capacity of only 281 MW at the end of 2013, considerably less than the 756 MW in much smaller and less sunny Switzerland (Jäger-Waldau, 2014). One of the reasons is the deep economic crisis in many of southern European countries triggering public budget constraints and a net loss of economic output and also income for individuals over the last 10 years (Eurostat, 2015b). Scarcity of both public and private capital impede investments in economically viable solar energy. At the same time many countries in central, western and northern Europe are economically well off (2015b). As an example, in 2013 Swiss citizens were able to save CHF 1 329 (EUR 1 227)[1] [2] on average (Bundesamt für Statistik, 2015a). Because this figure includes children, adults with a regular income can most likely save significantly more per year on average. Research indicates that they put much of these savings in bank saving accounts (Goldman Sachs Asset Management, 2014). However, in times of near zero interest rates this may not be a financially sound strategy. Figures for Germany indicate that

1 Swiss Francs have been converted to Euros at the rate of CHF 1 = EUR 0.92 during August 2015 throughout this study using data from the European Central Bank.

2 In order to avoid any confusion about how to interpret currencies and numbers, the author divides digits into groups of three separated by spaces and with a period as the decimal mark. This is in line with the European style recommendation for English language publications (Europa: Publication Office, 2015a; Europa: Publication Office, 2015b), which is based on a decision of the International Bureau of Weights and Measures (2003).

Germans currently have EUR 1.4 trillion in their bank saving accounts and lose about USD 13 billion a year because low interest rates fail to make up for inflation and fees (Seibel, 2012).

In many European countries, a significant share of the population lives in rented apartments. As an example, in Switzerland in 2012 only 37% of households owned the apartment or house they were living in (Neue Zürcher Zeitung, 2014). Therefore, they were largely excluded from the solar market and unable to take advantage of existing incentives for house owners to build solar energy installations.

The concurrence of dynamic solar energy markets in need for new investments, changing regulatory frameworks and the high percentage of tenants in several European countries with available saving capital that cannot build solar panels on their roofs creates needs and opportunities for new innovative business models. This thesis carries out an explorative case study of a novel business model that could potentially address these needs and may be able to take advantage of the current developments in the solar market.

1.2 Solar Business Models

Several business models for the deployment of solar energy have emerged and have been implemented in recent years.

Third-party ownership business model are very successful in the USA and provide house-owners with guaranteed cost-savings at no upfront costs (Coughlin & Cory, 2009; Drury et al., 2012; Overholm, 2015; Sherwood, 2007; Solar Energy Industries Association, 2012). In other countries, different regulatory frameworks and context variables have led to different business models. In Germany, the Host-Owned Feed-in Model (Strupeit & Palm, 2015) has proved to be very successful. In this model, home-owners finance solar installations and sell the produced electricity to the grid at a long-term guaranteed and profitable rate, known as a feed-in tariff (Couture & Gagnon, 2010; European Photovoltaic Industry Association, 2014; Klein, Held, Ragwitz, Resch, & Faber, 2007; Mendonca, Jacobs, & Sovacool, 2009; Ringel, 2006; Spertino, Di Leo, & Cocina, 2013).

Some business models are specifically catering to small-scale investors that do not want or cannot build solar panels on their own roof. Associations and cooperatives allow citizens, usually from a geographically defined area, to invest jointly in a project (Debor, 2014; Romero-Rubio & de Andrés Díaz, 2015) and are considered to be a very safe investment option (German Wind Energy Association, 2012). According to Fuhs (2015) the possibility to vote and influence the development of an organisation is a very important aspect of these business models. However, the possibility to participate in decisions clearly also requires more time and personal involvement than other forms of investment and may be considered an inconvenience by some citizens (Yildiz, 2014). Closed-end funds are another investment tool that enables investors to invest small amounts of money in renewable energy projects. However, they do not allow to have a say in business decision making and limit investors' liability if a project fails (Gross, 2013; Romero-Rubio & de Andrés Díaz, 2015). Closed-end funds also involve significant risks because they are served after the interests of banks and therefore shareholders generally lose all their investment in an insolvency of the project (Yildiz, 2014).

Other options such as crowdfunding (Veolis, 2015), opportunities to buy shares in local utilities' solar panels (Elektrizitätswerk Zürich, 2015) or the possibility for investors to buy claims to revenue from selling solar electricity (Greenxmoney, 2015) are emerging and may be interesting to small-scale investors.

The scope of this study is one particular business model. The Small-Scale Off-Site Investment in Solar Energy (SOIS) business model is inspired by the US-based startup *Cloudsolar* (Cloudsolar, 2015). In essence, it allows buyers[3,] to purchase solar panels from a Solar Service Company (SSC)[4] and then to contract this company to install and operate the panels and to sell electricity over a given period of time against a share of revenues. The business model is innovative because the buyers can invest small amounts of money in tangible solar panels, legally own and sell them as needed increasing flexibility and potentially reducing financial risk. A positive side effect of this procedure that will be examined in this study is the possibility to install the panels in another country in order to realise additional benefits.

In this explorative study, it is hypothesised that the SOIS addresses some of the problems discussed above. Namely, it provides a safe and profitable way for tenants without access to a suitable roof and generally for savers in well-off countries to invest small amounts of money in solar power generation. It is assumed to reduce investment risk because buyers retain ownership over their panels even in the case of a default of the SSC. Additionally, it can mobilise new investments from people without roof-ownership and therefore provide a net increase of available funds to develop a viable solar sector in places that lack the necessary capital to do so on their own.

A rough and hypothetical breakdown of available capital in Germany as the largest country in Europe in terms of population and economic output demonstrates the potential of the model. As mentioned above, Germans have put EUR 1.4 trillion in bank saving accounts. Assuming investment costs[5] in Portugal are EUR 1.4 per Wp (compare to chapter 4.2.3), this capital could finance the construction of more than 1 000 GW of solar panels, annually producing 1 500 TWh of electricity almost equalling 2.5 times the gross German electricity production in 2012 (International Energy Agency, 2015a). This calculation is of course very much simplified and based on rather unlikely investment decision assumptions but it shows nonetheless that even a small fraction of the available capital would enable very significant investment in solar energy.

Several elements of this argument such as the availability of saved capital, structural change in the solar energy market and need of new capital in the solar power market as well as increasing profitability of solar investments in the long-term are based on hard facts. However, the model also relies on several assumptions. For instance, it is hypothesised that the model can offer acceptable financial returns on investment for the panel owner even if

3 The terms investors, buyers and customers are used interchangeably in this study. As a matter of fact the SOIS business model features elements of both activities. Customers buy, own and trade a solar panel much like they buy other long-term goods such as house property. However, since the panel earns a profit, the solar panel is also an investment object. From a psychological point of view the term buyer is preferred because investor can have a negative connotation of acting speculatively in non-transparent and risky transactions.

4 Henceforth the company that implements the SOIS business model will be referred to as the *Solar Service Company* (SSC).

5 Henceforth, *investment costs* refer to the combined cost of the solar panel and the non-module so-called balance of system (BOS) cost.

the SSC takes a share of revenues, that the possibility to own a tangible good such as a solar panel is attractive to the target buyer group and that it effectively protects the investment in case of default of the SSC. In other words, the question is if the SOIS business model responds to one or multiple needs of investors and if there is a significant group of investors potentially interested in such a business model. Also, being implemented in the USA (Cloudsolar, 2015) but untested in Europe, such a business model still has to prove its financial profitability and legal viability in the current changing market conditions in Europe. Being a new concept, these questions have not yet been answered in the literature and the study addresses relevant knowledge gaps.

1.3 Research Questions

This study aims at contributing to the understanding of the growing variety of business models in the solar energy market. More concretely, its objective is first to establish the financial and legal viability of the SOIS business model in Switzerland and in Portugal and second to research investment decision criteria, preferences and attitudes of potential customers in Switzerland towards this business model. Therefore, the two following research questions are being examined.

1. **How viable is the SOIS business model in Switzerland and in Portugal from a financial and legal perspective?**

2. **How does the SOIS business model fulfil investment criteria for Swiss small scale investors?**

1.4 Research Approach

The stated research questions will be answered using an explorative case study featuring four financial scenarios built on literature review and interviews as well as an analysis of potential investors' preferences in regard to the SOIS business model.

Literature review will be used to look into business model and investors' decision-making theory. This theory part will provide the necessary knowledge to define what elements of business models shall be examined and to deduct interview questions to be asked in the case study. See chapter 2 for detailed information.

Literature review complemented with the results from nine expert interviews will provide insights into the legal and financial aspects of the solar markets in Switzerland and in Portugal. This information serves to build a financial model featuring four scenarios. The three Swiss scenarios will look at different installation sizes subject to different subsidy schemes in Switzerland. The fourth scenario will look at the Portuguese market assuming the same size as the large-scale Swiss scenario ensuring comparability with the Swiss scenarios.

Findings in regard to the financial viability of the different scenarios as well as legal viability will allow extracting relevant questions and providing necessary background information for the 20 interviews with potential buyers of the solar panels. The interviewees will be asked about their criteria for investment decisions and their risk-taking preferences. The interviewer will also explain and provide information about the SOIS business model including regarding its financial and legal viability and then ask about perceived advantages and disadvantages as well as about general attitudes towards the SOIS business model. Additionally, interviewees will be asked whether they might accept to have their panels installed in Portugal.

Information on how these data has been collected can be found in chapter 3.

Switzerland and Portugal were chosen because of the Swiss financial saving capacity combined with relatively poor solar resources and the Portuguese excellent solar resources coupled with financial constraints and the recent passing of a new bill allowing self-consumption of produced solar electricity. Tenants and people without suitable roofs were chosen as the main target group because most existing business models and incentives focus on house owners and fail to cater to the interests and needs of the majority of people, which are tenants, in several European countries.

A discussion on the limitations and generalisability can be found in section 5.6.2.

1.5 Target Audience

This study targets a professional audience such as potential investors and companies active in the solar market in Switzerland and Portugal and also new companies planning to implement the SOIS business model. The examination of the subsidy landscape and financial market conditions may also offer interesting insights for solar professionals, policy makers and researchers that want to keep track of the very dynamic solar market and of new emerging business models. Therefore, the audience is expected to have a basic technical understanding of energy markets, electricity and of measuring the output of a solar panel as well as a basic understanding of economic terms and investment reflections.

1.6 Structure

After this introduction, the investment decision process as well as decision criteria of small-scale investors are examined from a theoretical perspective. Furthermore, business models and their typical components will be defined based on literature research. These insights are used to develop pertinent questions for the interviews with experts and potential buyers.

In the third chapter the data collection is presented and the use of literature research and semi-structured interviews for the case study are explained.

In the fourth chapter, the results of the explorative case study are presented. Four financial scenarios for different solar installation dimensions, three for Switzerland and one for Portugal are developed, legal aspects are elaborated and the investment criteria and attitudes of the target group of buyers towards the SOIS business model are explained.

In chapter five, the findings regarding the two research questions are analysed and discussed. Also, the methodological choices and generalisability of the study are reflected upon in this chapter.

Finally, in chapter six the major conclusions in regard to the research questions and suggestions for future research are presented.

2 Investment Decision and Business Model Theories

2.1 Investment Decision Theory

The purpose of this chapter is to present the theoretical debate on investment decision processes for renewable energy. This knowledge will then be used to deduct relevant interviews questions for the case study with a view to answer the second research question about the investment criteria for small-scale investors in solar energy and whether the SOIS business model satisfies these criteria.

Starting from the classical investment theory, where investors rationally balance risks and revenues (Markowitz, 1959), the author adopts Wüstenhagen and Menichetti's (2012) extended framework for renewable energy investments. The framework is complemented with a short elaboration on how psychological factors such as values, identity, emotional involvement as well as national cultural investment dispositions influence the depicted cognitive process.

The SOIS business model can be looked at under the angle of buying a good or making an investment. Purchasing a solar panel is a long-term buying decision similar to buying a car although with a lower cost to the purchaser. However, a solar panel pays back incrementally over time and over the duration of the investment provides a financial return, which may not be the case or not be the primary concern with most other goods. First and foremost, it is thus a financial investment and this will be the focus of analysis in this study.

2.1.1 Classical Investment Theory

According to classical investment theory, investors make investment decisions based on their rational preferences regarding risk and return, which are mostly determined by policy decisions and the market environment of a particular investment opportunity (Markowitz, 1959). This is pictured in figure 2-1.

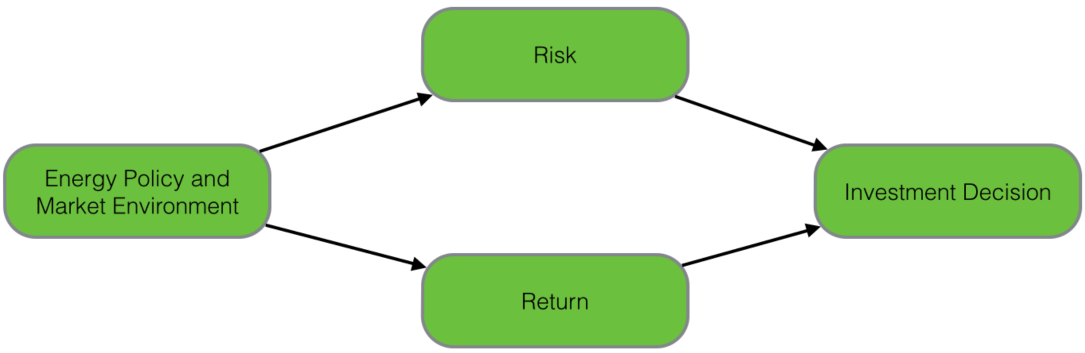

Figure 2-1. Neoclassical Investment Decision Model

Source: Wüstenhagen and Menichetti (2012)

Given the empirical fact that people sometimes make irrational decisions, this neoclassical theory has been challenged by behavioural economists, who focus on cognitive limitations and abilities of decision makers and how these affects economic decision-making processes (Brekke & Johansson-Stenman, 2008; Kahneman & Tversky, 1979; Pollitt & Shaorshadze, 2011). Masini and Menichetti (2013) provides further evidence that investors do not invest according to a purely rational evaluation of investment alternatives. Von Lüde (2013) notes that risk perception is highly subjective. Sachse (2008) confirms this view and shows that adding psychological factors to the standard economic factors significantly improves the explanatory power of her empirical model for making investment decisions. Sonnberger (2014) criticises the neoclassical theory on the ground that it does not delve into the motivation of investors for their preferences and argues that the theory needs to be complemented.

In the next sections, a non-exhaustive list of additional elements for a decision to invest in renewable energy identified in the literature will be presented.

2.1.2 Perceived Risk and Return

One important insight into investors' evaluation of risk and return is the understanding that the objective risk – which may be an entirely theoretical concept – is largely irrelevant and perceived risk and expected revenues matter above all for decisions under uncertainty (Wüstenhagen & Menichetti, 2012). Consequently, policy makers should focus on reducing perceived risks for investors in order to increase investments in renewable energy. Numerous authors elaborate on what determines the perception of risks and revenues by investors.

Apparently, investors perceive higher risks for business models that depend on subsidies that can be removed by policy decisions (Brandhoff, 2015). Generally, beliefs and trust in a specific technology as well as in the efficiency of the market shape perceived risks and expected revenues (Masini & Menichetti, 2012). Interestingly, the same authors conclude that perceived trust in technology is more important for investment decisions than perceived effectiveness and stability of policies. Stephan, Barasinska and Schäfer (2008) identify safety and liquidity as primary concerns. Sachse (2008) finds that worry (risk aversion), volatility, novelty and unpredictability of an investment are the most important factors for perceived risk. However, in her empirical research she finds no evidence that perceived risks and revenues alone explain the decision to invest (2008). Only by accounting for other psychological aspects can his model produce significant explanation value for investment decisions (2008).

2.1.3 Portfolio Aspects

Markowitz was among the first to argue that combining different assets reduces the risk of a portfolio (Markowitz, 1959). Stephan et al. (2008) confirms this and finds evidence that the acceptability of risk increases if an investor has a broad portfolio. From these insights Frijns, Koellen and Lehnert (2008) conclude that investments in solar energy can be seen as a diversification of the portfolio of an investor and thus lower the risk of that portfolio. This is also true for small-scale investors that have most of their savings in just one bank saving account, which as the recent financial crisis has shown, also involves a certain amount of risk. Therefore, according to Masini & Menichetti (2013) investments in renewable energy should not be considered by its stand-alone risks and returns alone but by its contribution to a portfolio's risk diversification. The same authors argue that because of this, investments into renewable energy as part of a diversification strategy may be reasonable even if risks for putting all savings in such an investment would be considered too high.

2.1.4 Socio-Demographic Factors

The link between demographic factors and the willingness to invest in renewable energy has been examined by numerous authors. Hochguerter, Allesie and Van Soest (1997) and Fessler and Schürz (2008) note that higher educated people with better salaries are more likely to invest in alternative investment options. Linked to this statement, higher levels of education and income seem to be positively related to buying renewable electricity (Diaz-Rainey & Ashton, 2011; Ek & Söderholm, 2008; Rowlands, Scott, & Parker, 2003; Sonnberger, 2014; Tabi, Hille, & Wüstenhagen, 2014; Welsch & Kühling, 2009). However, not all demographic factors seem to influence investment behaviour. Sachse (2008), states that age, gender, family status do not influence the perception of financial risks.

Concluding, the literature suggests that higher levels of education and income positively influence the likelihood of investing in renewable energy. Therefore, these factors may also increase the interest for the SOIS business model among such people. This is why in the interview sample (see chapter 3.2.3) people with above-average education level are over-represented.

2.1.5 Cognitive Aspects and Bounded Rationality

As stated in section 2.1.1, there are many indications that investors are in fact not as rational as classical investment theory suggests and rely on other criteria as well for investment decisions (Masini & Menichetti, 2013). Sachse (2008) finds no evidence in her empirical research that revenue and risks alone influence the decision to invest. Only by accounting for psychological aspects can her model produce significant explanatory value for investment decisions. In the following sub-sections examples for bounded rationality will be shortly presented.

Path Dependency

Path dependency is the tendency of individuals and organisations to repeat a certain behaviour based on positive outcomes in the past (North, 1990). In the investment field, it can slow capital investments into emerging sectors and notably into the renewable energy sector (Wüstenhagen & Teppo, 2006). One explanation is the so-called financial illiteracy making people stick to what they know and reluctant to adopt new saving instruments due of lack of knowledge and due to a high level of trust in their bank's recommendations (von Lüde, 2013). Focussing more on psychological aspects, Welsch and Kühling (2009) note that people repeat choices that are satisfying and only strive to optimise choices if results are clearly unsatisfactory. See also the elaboration of involvement in the next section. The fact that many Swiss often stick to loss-making savings accounts (von Lüde, 2013) indicates that lacking return on investment alone is not enough unsettling to make them change their behaviour. Or in other words, loss-making saving behaviour may be acceptable because to break with what is apparently *normal* would entail even higher dissatisfaction (2013).

Values and Involvement

Many citizens value environmental protection, regional benefits and participation when making investment decisions (Fuhs, 2015). Sonnberger (2014) provides some detail for this line of argument. According to him, values only come into play if a decision requires a high level of involvement. Involvement can be defined as follows: "Involvement implies attention to something because it is somehow relevant or important" (Ratchford, 1987, p. 25). Solomon, Russell-Bennett and Previte (2012) identify a "high probability of a wrong purchase and a high subjective importance of the potential negative consequences" as factors for high involvement (p. 134). Sonnberger (2014) points out, that investment in solar may trigger involvement because choosing and changing an investment instrument is generally considered to be an important decision with significant potential negative consequences. Therefore, it can be assumed that values may interfere with rational decision making in investment decisions.

Loss Aversion

In his empirical study Sachse (2008) indicates worry about loss, volatility, novelty and unpredictability as the most significant factors determining risk perception (2008). She also provides evidence that a positive reputation of an industry as well as the target country of an investment influence the investment decision but has no influence on the perceived risk.

Status

Welsch (2009) notes that investment into solar systems is driven by a desire for status (Mercedes-Benz on the rooftop). The interviews will examine whether status is an important motivator for the target group of this study. Related to status, Bollinger and Gillingham (2012) identify a peer effect by comparing solar instalment levels per zip code. According to them: "a one percent increase in the zip code installed base increases the adoption rate by just over five percent, with the exact value depending on the current adoption rate in the zip code" (2012, p. 31). He also notes links to socio-demographic variables that are often related to zip codes (see section 2.1.4).

Belief in Technology

It sounds obvious but needs to be highlighted: Beliefs in the technical viability of a technology play a fundamental role for investment decisions into that technology (Masini & Menichetti, 2013).

Interest

Fessler and Schürz (2008) point to another very obvious psychological phenomenon: interest. Interviewees in his study frequently pointed out that they are just not interested enough and too lazy to constantly keep up with their investment. In line with the involvement discussion above, they choose instruments that do not require time effort and that are already known to them, namely savings accounts.

National Saving Preferences

Specific national cultural dispositions in regard to savings and investment are thought to play a significant role in investment decisions. In the following, results from a survey that was carried out in Switzerland by Goldman Sachs (2014) will be presented. According to this survey Swiss citizens put safety first as far as savings are concerned. First and foremost they have their savings in bank saving accounts - despite very low interest rates currently at 0.11% on average (Schweizer Banken.info, 2015). According to Goldman Sachs (2014) more than 60% have not changed their saving policies lately. Only after safety concerns have been satisfied and a large enough stock is secured may people consider riskier options such as equity. 30% are currently somewhat invested in equity and only 10% in corporate bonds. Asked about how they would invest additional money, the highest percentage would buy real estate followed by the ones putting more in savings accounts. Only 20% would buy more equity, less than share of Swiss that already have invested in equity, which indicates a tendency to divest from equity.

2.1.6 Framework for Investment Decision Making

As announced in the introduction to this chapter, this section collates insights into one framework of how small-scale investors make a decision to invest in renewable energy.

Figure 2-2. Investment Decision-Making Framework

Source: Author, inspired by Wüstenhagen and Menichetti (2012)

The core of the framework is the insight that decisions are not based on rational consideration or facts regarding risk, revenue, demographic variables or portfolio aspects, pictures outside the bubble in the framework. Rather decisions are made in a cognitive process influenced by bounded rationality that alters these factual elements with psychological factors such as interest, path dependency, status, culture, belief in technology, values and risk aversion, picture inside the bubble. The outcome of this process is a notion of a perceived risk of an investment and of an expected return as well as other perceived advantages and disadvantages. These are then considered in order to make a decision for or against an investment and for or against a particular business model.

This understanding is fundamental to recognise the importance of interviewing people and learning about their attitudes and perceived advantages and disadvantages. In other words: without this insight serving as a justification for interviews, the study may have limited itself to comparing the return and risks calculated in the financial model to the ones associated with bank accounts and then concluded about the investment likeliness of investors. Interviewing potential customers and asking them about their attitudes and preferences allows the author to explore the relevancy of psychological factors and cognitive processes.

2.1.7 Conclusion in Regard to the Interview Questionnaire

The insights from this chapter, synthesised in the decision-making framework provide a suitable base for developing interview questions. Questions ask about past saving behaviour, investment motivations and criteria, attitudes and interest towards the environment, solar energy technology and alternative investment instruments, importance of status, community and ownership and perceived advantages and disadvantages of the SOIS business model.

2.2 Business Models and Their Contextual Environment

In this section first a definition of the term *business model* and an overview of typical criteria for evaluating business models are provided. Insights from this section help determining the aspects of the SOIS business model, that this study will focus on. More detailed information about the SOIS business model and how it relates to insights from this section are provided in section 4.1.1.

Several authors state that despite the recognised practical importance of business models, little academic research deals with them (Hedman & Kalling, 2003; Zott & Amit, 2010). Consequently, there is also a lack of a generally accepted definition of what a business model is (Al-Debei & Avison, 2010). Morris, Schindehutte and Allen (2005) note that the diversity of definitions create challenges for determining core components, typologies and criteria for good business models. Mäkinen and Seppänen (2007) suggest that a business model explains how a company can operationalise its strategy. According to Raphael and Zott (2001) "a business models depicts the content, structure, and governance of transactions designed so as to create value through the exploitation of business opportunities" (2001, p. 511). Adding more details and focusing more on decisions and competitive advantages, Morris et al. (2005) define business models as "a concise representation of how an interrelated set of decision variables in the areas of venture strategy, architecture, and economics are addressed to create sustainable competitive advantage in defined markets" (p. 727). Summarising, it is retained that, business models concisely describe what the business is and how the business is organised in order to create economic value and a sustainable competitive advantage in a defined market.

Several authors suggest sets of elements of business models (Hedman & Kalling, 2003; Wirtz, 2010); Raphael 2001; Zott 2010). This study adopts the concept developed by Morris et al. (2005). These authors develop a concept comprising six components on the basis of a meta-analysis of 18 scientific studies on business models. Their concept is presented in table 2-1.

Table 2-1. Components of Business Models

Components of business models	Questions to ask
The offer	How does the firm create value?
The market	For whom does it create value? Nature and scope of the market and customers.
Internal capabilities	What skills does the company have, what is it particularly good at?
Competition	What is the company better at than the competition?
Finances	How will the firm make money? What are fixed and variable costs, margins, etc.
Growth	What is the time, scope and size ambition of the company / of the entrepreneur?

Source: Morris et al. (2005)

Morris et al. (2005) then go on and identify three levels where the components can be analysed. This study focuses on the first, the foundation level and does not present the proprietary and the rules levels. In order to achieve the research objective and answer the research question, the following components will be prioritised.

- *The Offer* links to the second research question and is basically what the SOIS business model offers and how it works. More information can be found in section 4.1.1.
- *Finances* refers to the first research question about financial viability and is looked at in the case study in section 4.2.
- *The Market* refers to the second research question about the target customers and their needs. Further inside is gained through the interviews, whose results are presented in section 4.4.

It is important to note that business models do not succeed or fail because of their strengths and weaknesses alone. On the contrary, they are always implemented in specific contexts that often play a decisive role for their performance. For the SOIS business model, factors such as electricity prices, incentive structure, technological progress but also culture, mentalities and the availability of capital as well as saving opportunities determine whether or not it can be successful in the market or not. This is why, the research questions and linked to them, the data collection aim at providing information about the contexts in which the SOIS business model is examined.

3 Data Collection

In this chapter it will be explained what data was collected with what method and ethical considerations will be presented. Based on the two frameworks described in the earlier chapter, data has been collected on the offer, the market and the finances of the SOIS business model as well as on the investment decision processes, preferences and attitudes of potential customers.

3.1 Literature Research

Literature research provided background information on financial and legal aspects of the business model as well as on investment needs of potential buyers. Information from scientific, corporate, governmental and media sources was collected and reviewed. Based on the results of the literature research, relevant interview questions were developed and relevant interview partners were identified.

3.2 Interviews

The main goal of the interviews was to complement the information gained in the literature research regarding the legal and financial viability and to find answers to the second research question; investment criteria for investors in solar energy and if the SOIS business model satisfies these criteria.

3.2.1 Semi-Structured Interviews

Newton (2010) notes that every interview type can be placed somewhere between two poles structured and unstructured. Highly structured interviews involve a rigid, closed questionnaire whereas unstructured interviews amount to a loose discussion or even just an observation. For this study, semi-structured interviews were carried out allowing for some flexibility when asking and discussing the topic but also providing some structure to ensure that all relevant issues were raised and collected in a systematic manner (Balkissoon, n.d.).

3.2.2 Interviews Rounds

Two rounds of interviews were carried out. First, six experts from Switzerland and three experts from Portugal in the fields of solar installations, policy, financing and legal issues were interviewed. The list with expert interviews can be found in annex 1. It was particularly important to ask practitioners because the solar industry and the policy frameworks are evolving rapidly and much of the available literature is outdated very quickly. The experts were asked to complement and update insights from the literature research regarding the current costs and prices and general market conditions and regarding the legal viability of the SOIS business model. This allowed the building of the financial model that underpins the explanation of the model to the potential customers with realistic figures and data.

In a second round, in view of answering the second research question whether the SOIS business model caters to the needs of potential investors, 20 interviews with individuals from Switzerland that could be buyers were carried out.

The set of questions are briefly presented in section 3.2.4. The questions can be found in annexes 2, 3 and 4.

3.2.3 Sampling and Generalisability

Sampling describes the way interviewees are chosen. Flick (2009) differentiates different sampling methods. Complete collection aims at interviewing the total set of relevant people. This method was not feasible in this case for obvious reasons. Neither could a statistical representativeness be achieved for this study as this would have required several hundreds of interviewees. Instead, theoretical sampling was used for both interview groups. Theoretical sampling means selecting cases, in this case interviewees, according to specified criteria according to their relevancy and not according to statistical representativeness (Flick, 2009). For the expert interviews this criterion was obvious, they need to have an in-depth understanding of the field.

For the group of potential investors, the goal was to find interviewees with an above-average interest in renewable energy investment. The reason for this goal was that uninterested people may not have been ready to make the mental effort to reflect about advantages and disadvantages. More importantly however is the reflection that such people are simply not a target group for the SOIS business model as required in the second research question. This criterion was controlled for with an introductory question about what interviewees think about climate change. Furthermore, 15 out of 20 interviewees chosen were between 30-40 years old. According to Gerpott and Mahmudova (2010) younger people are more likely to have a positive attitude towards green electricity. At this age most people have finished education and only just start having a steady income. It is thus self-explanatory that younger people have less available income to invest in property. As a matter of fact, only 3 out of the 20 interviewees own their current flat, less than in the average population. If interviewees are less likely to own houses and to be able to install solar panels on their own roofs than older age groups, they may be more susceptible to buy solar panels to be installed elsewhere. Also, chosen interviewees have an above-average educational background and are generally able to save money. These demographical criteria increase the likelihood of investing in renewable energy and considering alternatives to bank saving accounts (Ek & Söderholm, 2008; Hochguertel et al., 1997), see chapter 2.1.4 for more details. Further, an equal participation of women and men in the interviews was aimed for.

The subsequent table 3-1 presents demographic information about the sample group.

Table 3-1. Demographic Information About the Interview Sample Group

Demographic categories of interviewees	**Number of interviewees per category out of 20**
Gender (women)	9
Age	
20 - 30	2
30 - 40	15
40 - 50	3
50 - 80	0
Education	
University or equivalent	16
Professional degree	4

Source: Author

For people that corresponded with these criteria, the author used convenience sampling, meaning interviewing people that were available to him. Convenience sampling is suggested by Patton (2002) in case of limited resources in time and staff to carry out interviews.

For the expert group theoretical saturation was used as a criterion when to stop conducting further interviews. This means that no additional relevant data is expected to be found with additional interviews (Glaser, Strauss, & Strutzel, 1968). With regard to the second, bigger interview group of potential buyers, the author found increasingly repetitive answers and first signs of theoretical saturation although it is possible that more interviews would have yielded some more additional relevant information. Limited time availability can therefore be considered as a limiting factor for the generalisability of the study.

3.2.4 Interview Design

The expert interviews started with questions about the solar market situation, prices, costs, subsidies, market outlook, etc. This block was followed by other thematic questions on subsidies, legal and tax aspects. Questions were tailored to the specific expertise of the interviewees. Finally, experts were also asked about perceived advantages and disadvantages of the SOIS business model. These questions allowed to gain a broader understanding of how the SOIS business model may be perceived in the market and complemented insights from the interviews with potential buyers.

The interviews with the potential buyers proceeded in four blocks. First, questions about what people think about climate change and what they would be ready to do about it allowed to ascertain their general environmental attitudes. Second, questions about their investment attitudes, criteria and experiences allowed the author to address the second research question. Third, questions about their opinions on associations and stock market investments as well as their perceived advantages and disadvantages of the SOIS business model helped determining to what extent the SOIS business model answers their investment needs.

Fourth, demographic questions allowed the author to check whether the sample corresponds to the desired sample. Questions in the first three blocks included a mix of open questions where discussions were possible and closed questions where participants were asked to rank different options or indicate preferences in order to produce numerical indications.

3.3 Ethical Considerations

The study was conducted independently from any organisation. Interviewees were chosen as outlined in chapter 3.2.3. The author takes care that the opinions of individual interviewees cannot be linked to their name.

4 Results: Case Study

In this chapter, drawing on the literature research as well as on the interviews with experts and potential buyers, the author elaborates upon: legal aspects, financial viability of different scenarios in Switzerland and in Portugal and investment criteria and attitudes of the target buyer group towards the SOIS business model.

4.1.1 The Small-Scale, Off-Site Investment in Solar Energy Business Model

The core principles of the SOIS business model are inspired by the US company *Cloudsolar* (Cloudsolar, 2015) and have already been presented in the introduction. This section presents the model in more detail and elaborates on the individual elements.

The three key actors in the SOIS business model are the buyer of the solar panel, the Solar Service Company (SSC) and the roof-owner. They work together in the following way.

1. The client buys the panel from the SSC. The costs include a proportional share of other necessary items such as mounting racks, inverters, wiring, meters, etc. The panel and equipment price and specifications are presented in section 4.3;
2. A long-term service contract is signed regulating the obligation of the SSC and the rights of panel owner;
3. The SSC undertakes to find a suitable roof to install the panel. In the two examined countries (Switzerland and Portugal) it is not possible to have the panels installed on a plot of land, refer to section 4.2 for more details;
4. The SSC relieves the panel owners from any administrative effort, deals with all regulatory issues and permits and signs a contract including a power-purchase agreement with the roof-owner and with the utility for the sale of the excess electricity. These contracts guarantee the continuing use of the roof for 25 years, regulate insurance and liability questions and ensures that the roof owner buys a maximum of the electricity produced by the panels. See section 4.2 for more details about the need for self-consumption;
5. The SSC regularly pays out 80% of the returns from selling electricity to the panel owner and keeps 20% for its activities;
6. The service contract between the buyer and the SSC also foresees the possibility for the panel owner to take the panels down or to sell them at any time against a fee.

The process of the SOIS business is visualised in the following figure 4-1.

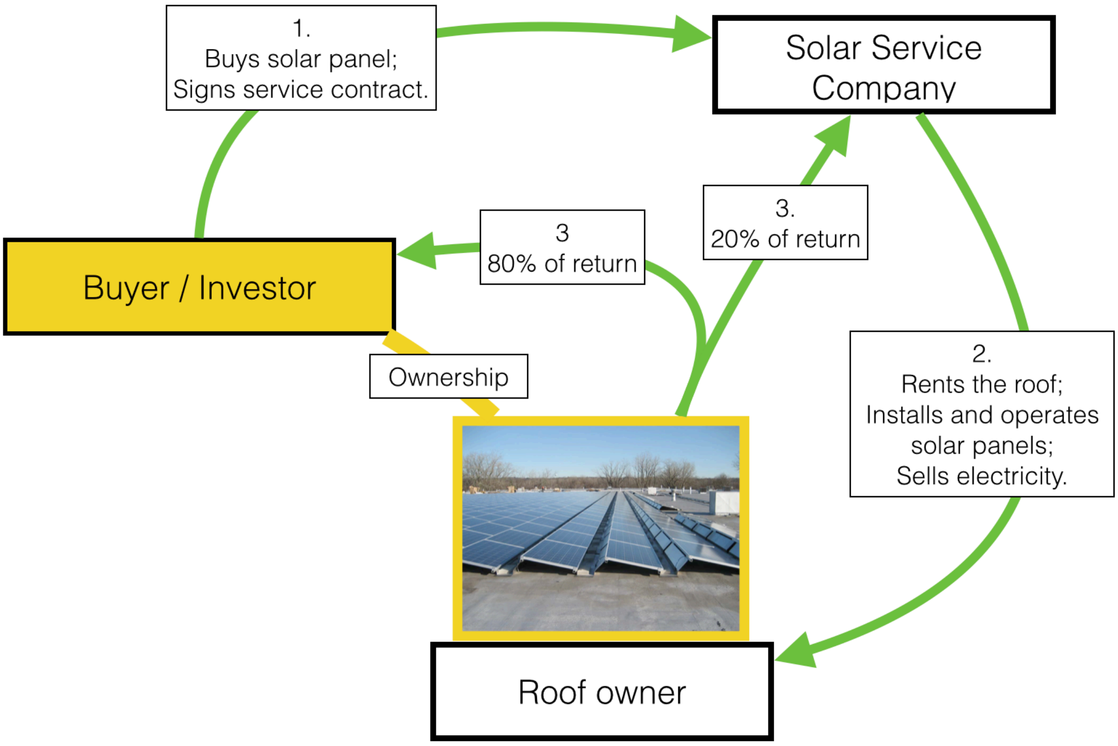

Figure 4-1. Representation of the Small-Scale Off-Site Investment in Solar Energy Business Model

Source: Author

Compared to other business models that allow citizens to invest in renewable energy, in the SOIS model, the buyer does not become a member of an association or buy stocks in the SSC but legally owns the solar panel. This ensures that the buyer's investment is not lost should the SSC go out of business and thereby reduces the overall risk for the buyer. However, in such a case, significant transaction costs may occur. The fact that the buyer owns a share of the various system components that cannot be physically recovered is inherent to this business model. This constitutes an additional risk for a panel owner that wants to uninstall her or his panel and bring it home. However, it does not pose a financial risk if the panel is sold to a new owner but remains in the same location because the sale price includes the value for the system components. It can be expected that the second case is much more likely for the average panel-owner.

In the following table 4-1 the SOIS business model will be defined using the components presented in chapter 2.2 in table 2-1.

Table 4-1. Business Model Components Applied to the SOIS Business Model

Components	Foundational Level
The Offering	The SSC creates value by selling the service of installing, operating and managing solar panels for their owners. It also creates value for the roof-owner by selling renewable electricity cheaper than current market prices and guarantees a stable price over 25 years.
The Market	Customers are small savers without roof ownership and the capital and time resources to invest in a solar installation themselves but with an interest in renewable energy generation.
Internal Capabilities	The company can efficiently manage a great number of people and panels and develops a network of interested roof-owners.
Competition	Competition comes from associations and investments in stocks as well as a number of emerging business models as mentioned in the introduction.
Finances	The SSC keeps a share of the revenue of the managed panels.
Growth	Various growth ambitions and strategies may be possible. Refer to the introduction for an approximate indication of the potential market and to sections 4.3.3 and 5.2.6 for an analysis of the financial viability of the SSC.

Source: Author

4.1 Legal Aspects

While the basic model is very straightforward – the buyers buy the panels and are thus the owners – reality is more complicated. Experts, including two lawyers confirm the findings from the literature research that the SOIS business model – guaranteeing ownership to many small buyers – is new in Switzerland and creates new legal challenges.

The legal experts confirm that the ownership of the panel can be regulated between the buyer and the SSC. However, it is more difficult to guarantee the control of the panel against the roof-owner. In Switzerland, installed solar panels are considered to be part of the roof and therefore of the building. In case the ownership of the roof changes during the contract period, the control over the panels may be given to the new roof owner, which may not be bound by a rental contract. According to the legal experts it is therefore necessary to register the right of the continuing use of the roof in the public land register, which requires the consent of the roof owner and is subject to a significant fee. For practical and financial reasons, it is not possible that all panel owners sign contracts with the roof-owner and obtain the required entry in the land register. This would also be incompatible with the goal of the business model to spare the buyers from any administrative time effort.

Hence the SSC needs to secure the land register entry and the contract with the roof owner. However, in this case, the rights are with the SSC and not with the panel owner. Should the SSC become insolvent, the right to continuously use the roof may also be at risk.

While the SSC can issue certificates of ownerships to the owner, it may be not be able to legally guarantee the continuing operation of the panels if it should go bankrupt. In other words, this legal issue makes the extra level of ownership protection, (compared to alternative business models) aimed at by the SOIS business model difficult to achieve.

There is however a possible solution mentioned by the experts. The SSC may create a Special Purpose Entity (SPE) that is solely responsible for a particular project. SPE's are created by one or multiple companies for a very specific purpose such as implementing a project (Schäfer & Kuhnle, 2006). They do not usually have other, independent activities and are often controlled by their owners to a great degree. However, they are usually *bankruptcy remote* meaning that its assets and operations are protected in the case of an insolvency of the parent company (Cohn, 1997). For the purpose of the SOIS business model, a SPE would sign the contract with the roof owner and the land register entry and operates the panels instead of the SSC. It would be legally and risk-wise separated from the SSC and could continue to operate independently if the SSC should become insolvent (Colman, 2013). This way, the buyers may be protected against a roof-owner change and a bankruptcy of the SSC and only be exposed to the risk related to the particular project where their panel is located. It is important to note that many details of this potential solution need to be worked out by legal experts.

During the time available for this study, it was unfortunately not possible to discuss legal aspect with experts in Portugal. However, one solar installer well acquainted with the legal situation confirmed that the new bill has provisions that allow and support investment by foreign capital givers on roofs owned by another party.

4.2 Variables of the Financial Model

In this section, the numerous variables used in the different financial scenarios for implementing the SOIS business model in Switzerland and in Portugal are presented and explained. In the last subsection the results of a simulation sheds light on the revenues the SSC can expect by implementing the model and on its financial sustainability.

For the scenarios numerous assumptions need to be made for two main reasons. First, the models cannot draw on existing projects and data but deals with an uncertain future; and second, figures indicated by the literature and by experts differ to a significant degree. Assumptions involve subjective decisions and thus need to be justified. For this study, the author deals with this challenge by triangulating information from different sources. Additionally, in order to prevent over-optimistic financial scenarios, conservative figures are chosen from the band of possible values. For the purpose of this study, conservative figures mean to ensure that real world figures would unlikely be worse for the financial viability of the model than the ones chosen in the model for an average case.

The financial model for all four scenarios can be found in annexes 5 to 8.

4.2.1 Technical Terms

In the subsequent two sections the reader can find some indications and justifications of the measures used in this study. However, it is beyond the scope of this study to delve into the details of electricity or investment measures. The author also provides some links to additional information on the matter.

Electricity Output of a Solar Panel

The nominal power of a solar panel is commonly measured in Kilowatt Peak (kWp). It ensures comparability by defining exactly the ambient and radiation test conditions for solar panels in order to determine their output. Refer to (PVCalc, 2015) or (Solar Facts and Advice, 2013) for more information.

Investment Calculation

In order to compare the different financial scenarios, the Net Present Value (NPV), the Internal Rate of Return (IRR) and the Modified Internal Rate of Return (MIRR) are calculated.

The NPV indicates whether an investment has a positive return taking into account the time value of money, which is lower in the future according to the chosen discounting interest rate. A positive NPV is generally considered to be a condition for the financial viability of a project (Schmidt, 2015). The model assumes that the target group's opportunity cost and therefore the cost of capital is very low at 1% because the alternative is to let the money sit in a bank saving account.

IRR is a commonly used measure indicating the interest rate that causes the NPV to equal zero (Phalippou, 2008). If a project features a higher IRR than another project, it indicates a higher potential return of that project while holding the NPV constant at zero in both cases. However, according to various authors, the IRR has multiple shortcomings that are addressed by the MIRR. Notably, the IRR assumes that the rate of return of reinvested receipts equals its own rate (Lamba*,* 2010) while the MIRR allows to specify this rate of return (Kierulff, 2008). For this business model, it is more realistic to assume that receipts go back to the panel owner's bank saving account and thus the IRR may significantly overestimate the real rate of return of an investment. The trade-off is that the MIRR requires the analyst to specify the expected rate of return on the receipts. The higher this rate, the higher the long-term return of the investment. Defining the rate is tricky because long-term interest rates are very difficult to predict and no reliable sources have been found. Federal bonds yields can be used as a proxy, Swiss bonds currently yielding 0.5% over 30 years (Investing.com, 2015). However, their current yield underestimates interest rates on bank saving accounts approximately by 0.5%. Considering this, the author corrects the return rate by 0.5% and assumes an average return on the receipts from the solar panels of 1% over 25 years.

Investment Costs

Investment costs refer to the solar panel prices as well as to the Balance of System (BoS) costs, which include other equipment such as inverters, wires, brackets, installation equipment, labour for construction and planning and overhead costs of involved companies. Today, panel costs Germany account for about 50% of investment costs (Wirth and Schneider, 2015). Therefore, further panel price decreases have a limited effect on investment costs without parallel decreases of BoS costs.

The investment costs indicated in this study cover all of the above items. The cost of a panel as calculated in section 4.3 includes a per panel share of BoS costs. In the case of the panel owner wishing to remove her or his panel from an installation, this constitutes a financial risk because a majority of the investment value cannot be physically detached from the installation and may be lost. See section 4.1.1 for more information on this issue.

4.2.2 Financial Scenario Switzerland

This section presents the conditions in the Swiss solar market that determine the financial viability of the SOIS business model if implemented in Switzerland. Data was collected from industry sources, publicly available information from the Swiss government and expert interviews. The financial incentive structure in Switzerland is different for varying project sizes and the financial model developed for this study features three different scenarios in terms of installation dimensions. The considered sizes include 5 kWp for scenario 1, 30 kWp for scenario 2 and 400 kWp for scenario 3. More details can be found in the subsequent paragraphs.

Subsidies and the Role of Self-Consumption

Since 2008 Switzerland incentivises solar power production with a feed-in tariff (FIT) essentially guaranteeing a selling price to the producer for 20 years that allows him or her to make a profit (Couture & Gagnon, 2010; Klein et al., 2007; Mendonca et al., 2009; Ringel, 2006). Contrary to the well known example of Germany, the Swiss FIT scheme has always been capped and therefore financing has not been able to keep up with a rapidly expanding list of applications. Much of the available funds are now tied up for financing the early projects and little money is left for new ones. The result is a massive waiting list of 3-4 years for receiving the FIT. While a recent increase in 2014 will reduce the waiting list (Bundesamt für Energie, 2014), all interviewed industry experts agreed that new projects must not count on the FIT to ensure their profitability. The FIT is financed through a levy (Swissgrid, 2015) on the consumer electricity bill at currently CHF 0.011 per kWh (EUR 0.0101 per kWh) and is adjusted in accordance to the price development of solar energy, thus rapidly decreasing for new installations.

In 2015 a new instrument, the so called one-off investment grant (Einmalvergütung EIV) has been established. The EIV directly contributes to the investment cost of a solar energy installation up to the size of 30 kWp (Swiss Federal Office of Energy, 2014). The EIV is 30% up to approximately 9 kWp installations and decreases to below 25% for 30 kWp installation according to a formula that can be found in annex 6. There is no preferential feed-in tariff but the installers have the right to self-consume the electricity produced and so to save on their current electricity bill. There is no cap and no waiting list although it will be limited by the availability of funds at some point in the future (2014).

This means that there is currently no reliable incentive scheme for installations bigger than 30 kWp in Switzerland. As a result of the factual absence of a FIT for new installations and considering the information about the EIV it is clear that the financial viability of any new solar installation in Switzerland is closely linked to the ability of the roof-owner to self-consume the electricity produced. Self-consumed electricity replaces electricity otherwise bought from the grid and thus provides much higher revenues than electricity sold into the grid, see next section for more information. Experts and installers estimate that a well-managed residential house can have a self-consumption of up to 40% (Spiezsolar, 2015), while bigger installations on commercial buildings can have higher rates of self-consumption (PV magazine Deutschland, 2012). For this study the following rates for self-consumption as presented in table 4-2 have been assumed:

Table 4-2. Rates of Self-Consumption in the Four Financial Scenarios for the SOIS business model

Nominal system sizes for the four financial scenarios	Rate of self-consumption
5 kWp	35%
30 kWp	80%
400 kWp (Switzerland and Portugal)	80%

Source: Author

Production and Revenues

Multiple sources and experts indicate the average output of solar panels in Switzerland per year with 1 000 kWh per 1 kWp of installed capacity (Gloor, 2014; Spiezsolar, 2015) and the current average efficiency per panel with 16%. These figures are therefore used in the financial model.

The factual self-consumption requirement mentioned in the previous section excludes solar on-ground installations and therefore no land leasing or purchase costs is factored in the model. However, it is assumed that the electricity is sold to the roof-owner at a 5% discount relative to the price she or he currently pays for electricity from the grid. A discussion of benefits for roof-owners can be found in section 4.2.4. As indicated in section 4.1.1, the scenarios are calculated with the assumption that the SSC takes a share of 20% of effective panel revenues as a compensation for setting up, maintaining and operating the panels.

In regard to electricity prices, a study carried out by Prognos AG on behalf of the Swiss Agency for Energy expects an average price increase for consumers of 0.3% per year over the next 25 years (Kirchner et al., 2012). The Swiss National Bank (2015) expects negative inflation until 2016 and then projects slowly increasing inflation at 0.5%-1% in the following years. Taking into account the effects from the ongoing market liberalisation in Switzerland, which are difficult to predict, the financial model conservatively assumes an annual average 0.5% increase for electricity prices and inflation combined over the next 25 years.

Projects without the FIT can self-consume produced electricity and sell excess electricity into the grid at utility-defined prices. The value of self-consumed electricity is equivalent to the price of electricity bought from the grid. Switzerland does not have a liberalised electricity market for small and medium consumers and prices fluctuate between the regions and the quantity of electricity procured. For small installations in scenario 1 and 2, the value of self-consumption was calculated using the end-consumer prices in the Canton of Berne, which is CHF 0.23 per kWh (EUR 0.21 per kWh) (Eidgenössische Elektrizitätskommission, 2015). For scenario 3 prices for a medium sized company in the canton of Berne was used at CHF 0.177 per kWh (EUR 0.163 per kWh) (2015).

The price for selling excess electricity to the grid varies between regions. For this study, the currently valid prices for the canton of Berne, which are CHF 0.107 per kWh (EUR 0.1 per kWh) for scenario 1 and 2 and CHF 0.059 per kWh (EUR 0.05 per kWh) for scenario 3 have been assumed (Bernische Kraftwerke, 2015).

Gross revenues for the scenarios are calculated using the Modified Internal Rate of Return (MIRR). According to Schmidt (2015), the MIRR equals the compound rate the original investment would have needed to earn in a bank account in order to match the rate of return of the project in question. In other words, compounding the investment costs with the MIRR outputs the gross revenue of a project over a given period of time including reinvestment of receipts as explained in section 4.2.1.

Project Costs

The Decree on energy publishes reference prices for investment costs (see section 4.2.1) for solar installations of different dimensions in Switzerland (Energieverordnung, 2015). However, according to experts, these prices are considered to be best case scenarios and not average market prices. Therefore, the average of the prices indicated by the experts will be used for the three scenarios as presented in the following table 4-3. It is important to point out that these prices depend very much on the characteristics of each location and can differ significantly from project to project.

Table 4-3. Investment Costs per kWp in the Three Swiss Financial Scenarios for the SOIS business model

Nominal system sizes for the three Swiss financial scenarios	Investment costs per watt peak
5 kWp	CHF 3 (EUR 2.8)
30 kWp	CHF 2.5 (EUR 2.3)
400 kWp	CHF 1.8 (EUR 1.7)

Source: Author

Private house owners can deduct investments in solar panels from their taxable income, which depending on the income can result in a net reduction of investment costs of 15%-25% (Spiezsolar, 2015). However, according to interviewed industry experts, buyers of panels according to the SOIS model are not be able to deduct their purchase from income taxes because they are not investing into their property. This cost reduction has thus not been included in the financial model.

Solar Panel Maintenance and Degradation

Experts indicate that solar PV installations have annual maintenance requirements of 1% of the investment costs. This amount has been considered for the financial model.

In a report analysing several studies providing 2000 data points over 40 years, Jordan and Kurz (2013) find that the annual median degradation of solar panels is about 0.5%. Degradation means the output is reduced by this amount compared to the preceding year.

According to the same authors, real degradation rates may be distorted for two reasons. First, some underperforming panels with above average degradation rates may have been replaced in the examined samples leading to an underestimation of degradation and failure rate. Second, compensating for this distorting effect, current panels have reduced degradation rates. According to Roe (2012), the industry standard is to guarantee 90% output after 10 years and 80% output after 25 years. This means that the industry is certain that average degradation rate is lower than 0.8% per year. The same author suggests that 2% degradation in the first year and then 0.5% per year should be expected. For this study, a degradation rate of 0.65% per year is assumed.

4.2.3 Financial Scenario Portugal

In this section, the financial scenario for a 400 kWp project in Portugal is presented.

Subsidies and the Role of Self-Consumption

Following the new bill DL 153/2014 (Ministerio do Ambiente, Ordenamento do Território e Energia, 2014) that entered into force on 2015-01-01 (ICF Consulting Limited, 2015), Portugal has now two different schemes for the production of solar energy.

The UPAC (unidades de autoconsumo, units of self-consumption) scheme allows consumers to install solar panels, to self-consume produced electricity and to sell excess electricity into the grid at 90% of current spot market prices. There are no subsidies involved in this scheme. Systems cannot exceed the contracted amount of electricity of a consumer but there is no size or production cap on the national level (Associação Portuguesa de Empresas do Sector Fotovoltaico, 2015a). Different permits and fees apply for different system sizes. The 400 kWp installation size assumed in this scenario triggers an installation tax of EUR 750 (Associação Portuguesa de Empresas do Sector Fotovoltaico, 2015b). There is an additional compensation tax that applies for UPAC-C and UPAC-D[6] installations as soon as combined UPAC installations exceed one percent of national grid capacities (2015b). When this happens, UPAC-C and UPAC-D installations need to pay 30% of the so called Costs of General Economic Interests (Custos de Interesse Economico Geral: CIEG) according to their installed power. The CIEG is basically all costs not related to the production of electricity and the grid. As soon as a level of three percent is reached, 50% of the CIEG needs to be paid as a compensation per installed kWp. The CIEG varies between 20% for industrial consumers and 30% for domestic consumers of the total price of electricity. According to this analysis, this compensation may significantly reduce profitability particularly for medium and large project over the long term (Ministerio do Ambiente, Ordenamento do Território e Energia, 2014). However, according to the interviewed experts it is not currently a main concern of installers because the installed solar energy capacity is well below 1% of total installed capacity.

The UPP (unidade de pequena produção) scheme allows to produce and sell electricity into the grid for a tariff based on a reference price and a bidding system. As with the UPAC scheme, UPP systems cannot exceed the contracted amount of electricity of a consumer. Contrary to the UPAC system, there are two caps. The maximum connection power is

6 Installation sizes greater than 1.5 kW.

capped at 250 kWp and the national annual installation volume is capped at 20 MWp (2014). Because of the uncertainty associated with these caps and because of a generally higher profitability of the UPAC scheme (Associação Portuguesa de Empresas do Sector Fotovoltaico, 2015b), this study focuses on the UPAC scheme.

As in the Swiss scenarios, self-consumption is very important for the UPAC scheme to be profitable. According to interviewed Portuguese experts, UPAC projects will generally be sized to guarantee a very high rate of self-consumption. Therefore, for the financial model developed in this study, a rate of self-consumption of 80% is assumed.

Production and Revenues

The average solar insulation in Portugal is at least 1 500 kWh per m^2 (Solargis, 2015). Assuming a 16% efficiency and a standard size of 1.62 m^2, an average panel can produce about 390 kWh per year.

As in the Swiss case, the financial model includes a 5% discount for electricity sold to the roof owner and a 20% share of net revenues for the SSC. See section 4.2.4 for more details.

The photovoltaic association predicts that electricity prices will annually increase by 3% in Portugal (Associação Portuguesa de Empresas do Sector Fotovoltaico, 2015b), which corresponds to past developments. However, the interviewed experts highlighted the unpredictability of prices and recommend to be cautious about factoring in high price increases. This view is confirmed by a report from the PV Parity Project (2012), which compares the electricity price projections from the EU, Greenpeace, the International Energy Agency and the European Photovoltaic Industry Association. Basically, the report finds that electricity prices are likely to increase up until 2030 and may then stabilise or even decrease. However, all analyses agree that prices in 2050 will be higher than today (2012). The long-term inflation target of the European Central Bank is below but close to 2% but inflation has been lower for several years now (European Central Bank, 2015). It is expected to rise to 1.5% in the next few years (Price Waterhouse Coopers, 2015). Therefore, favouring a conservative approach, the model assumes 1% annual rise of electricity prices and 1% inflation.

In Portugal, the value of unpurchased electricity due to self-consumption is much higher than the benefit from selling electricity into the grid. Portugal has a liberalised electricity market and consumers can freely change their electricity providers. Therefore, according to experts, prices paid by consumers vary significantly according to their negotiation power and skills. At the upper end are private households that don't usually shop around for better prices and pay around EUR 0.22 per kWh. Estimations of experts in regard to electricity prices paid by businesses differ significantly ranging from EUR 0.09 to EUR 0.16. The financial model assumes average electricity prices of EUR 0.12. Prices for UPAC excess production sold on the common Iberian electricity exchange on the other hand are well known. They fluctuate around EUR 0.05 (OMIP, 2015) and sellers receive 90% of that. The model sets the price for excess electricity to EUR 0.04 per kWh.

Project Costs

System prices in Portugal are significantly lower than in Switzerland. One expert indicated a price of EUR 1 per Wp installed capacity for solar parks bigger than 100 kWp. Another expert agreed in principle but specified that administrative costs may increase the price to 1.5 EUR per kWp. The model assumes a price of 1.3 EUR per kWp.

Solar Panel Maintenance and Degradation

Portuguese industry experts concur with Swiss experts that 1% of the project costs need to be set aside for maintenance annually. In regards to solar panel degradation the same value as in the Swiss case (0.65% of output per year) is assumed.

4.2.4 Interests of the Roof-Owner

It was not possible to inquire with roof-owners about necessary incentives for accepting solar panels on their roofs. However, Roselund (2015) as well as a Portuguese expert mentioned that companies may be interested not only in discounted prices but also in guaranteed long-term price stability and reputation benefits that the SOIS and the fact that renewable electricity is used may be able to offer.

It is assumed that roof-owners receive a discount on self-consumed electricity of 5% compared to the price they would pay to the utility for purchasing the same amount of electricity. This results in the following income per panel

Table 4-4. Yearly Income for Roof-Owners in the Four Financial Scenarios for the SOIS business model

	Yearly income in EUR for roof-owner according to SOIS business model		**Yearly income in EUR for roof-owner per panel according to standard German rent rates**
Scenarios	**per project**	**per panel**	**per panel**
5 kWp	19.29	0.97	1.74
30 kWp	253	2.21	2.35
400 kWp Switzerland	2 506	1.64	1.67
400 kWp Portugal	2 881	1.87	1.93

Source: Author, Solarcontact (2015) and Sonnenenergie (2011)

No prices for Switzerland or Portugal have been found but a typical long-term rental fee for a roof in Germany is about 5% of the yearly revenues of the solar panels (Solarcontact, 2015; Sonnenenergie, 2011), which corresponds approximately to the assumed 5% discount on the electricity price for the roof-owner with the exception of the 5 kWp Swiss scenario.

4.3 Results of the Financial Model

Results from the model with above listed assumptions and variables indicate that the SOIS model may be financially viable in Switzerland in some cases but that it is much more financially interesting to install solar panels in Portugal.

4.3.1 Results for the Four Financial Scenarios

Table 4-5 shows the results for the four scenarios. For easy comparison, CHF in scenario 1-3 have been converted to EUR.

Table 4-5. Results of the Four Financial Scenarios for the SOIS business model

Results of the Four Financial Scenarios for on the SOIS business model	**Scenario 1 Switzerland 5 kWp**	**Scenario 2 Switzerland 30 kWp**	**Scenario 3 Switzerland 400 kWp**	**Scenario 4 Portugal 400 kWp**
System properties				
Number of solar panels	20	115	1 539	1 539
Nominal Power of one solar panel	260 Wp	260 Wp	260 Wp	260 Wp
Level of self-consumption	35%	80%	80%	80%
System production per year	5 200 kWh	29 900 kWh	400 140 kWh	600 210 kWh
Production per panel per year	260 kWh	260 kWh	260 kWh	390 kWh
System Information				
Investment costs after subsidies and taxes	€10 048	€53 739	€662 722	€520 932
Gross system revenue (including reinvestment of receipts) over 25 years	€12 113	€104 068	€1 004 587	€1 480 351
Net system revenue (including reinvestment of receipts) over 25 years	€2 068	€50 262	€340 931	€959 419
Panel Specific Information				
Buying price / investment cost per panel	€5046	€507	€468	€338
Gross revenue per panel over 25 years	€658	€982	€708	€961
Net revenue per panel over 25 years	€112	€474	€240	€623
Gross revenue for owner per panel per year	€26	€39	€28	€39
Investment Information				
Payback time (including reinvestment of receipts)	20.8 years	13.1 years	16.6 years	8.9 years
Internal Rate of Return	0.5%	4.68%	2.4%	8.3%
Modified Internal Rate of Return	0.75%	2.67%	1.67%	4.3%
Net Present Value	€-604	€27 340	€119 668	€633 399
Information for roof-owner				
Income for roof-owner per panel per year	€0.97	€2.21	€1.63	€1.87

Source: Author calculations

Reinvestment of receipts refers to the fact that with the SOIS business, the panel owners regularly receive receipts from the sale of electricity of their panels. These receipts are then reinvested somewhere. In this financial model, it is assumed that receipts are put in a bank saving account at an interest rate of 1%. See section 4.2.1 for more information on this interest rate. For a discussion of these results see chapter 5.2.

4.3.2 Robustness Analysis

While in the preceding section, the most likely assumptions have been chosen, this section provides an analysis of the robustness of single parameters. Parameters that greatly influence financial viability are changed allowing to determine their impact on profitability while all other parameters are held constant. By doing that, the robustness test allows to identify the most relevant parameters for the standard financial model and the parameters that involve the greatest financial risk. Using the Modified Internal Rate of Return ensures comparability between different calculations. Table 4-6 present potential negative impacts from worse than expected parameters.

Table 4-6. Robustness Analysis of Four Financial Scenarios With Worse Than Expected Parameters

Robustness Test Modified Internal Rate of Return (MIRR) for Panel owner	**MIRR Scenario 1 Switzerland 5 kWp**	**MIRR Scenario 2 Switzerland 30 kWp**	**MIRR Scenario 3 Switzerland 400kWp**	**MIRR Scenario 4 Portugal 400kWp**
Standard financial model prediction	0.75%	2.67%	1.67%	4.27%
-0.5% annual decrease of price of electricity	0.12%	2.09%	1.1%	2.85%
20% lower electricity baseline price	0.14%	1.68%	0.66%	3.29%
20% higher investment costs / lower panel output	negative	0.35%	negative	2.42%
20% lower self-consumption	0.33%	2.09%	0.94%	3.54%
Costs of General Economic Interests (CIEG) of 30%	-	-	-	3.87%
Costs of General Economic Interests (CIEG) of 50%	-	-	-	3.58%
50% higher discount for roof-owner	0.61%	2.45%	1.44%	4.04%
10% higher share for SSC	0.21%	2.13%	1.13%	3.71%

Source: Author's Calculations

In the Swiss context, higher investment costs are the biggest financial risk for panel owners. Also, lower initial electricity prices severely restrict the financial viability of the SOIS business model. Given the higher initial MIRR, the Portuguese scenario is generally much more robust. The biggest risks are higher investment costs and an annual decrease of the electricity price. The proposed compensation tax in the Portuguese scenario reduces return by 0.4% once the lower threshold is passed and by by 0.69% once the higher threshold is passed. It is interesting to note that even a much higher compensation of the roof-owner being one of the biggest financial uncertainties of the developed financial model has a relatively weak negative impact.

In Table 4-7 results for better than expected parameters and their impacts on the financial model are presented.

Table 4-7. Robustness Analysis of Four Financial Scenarios With Better Than Expected Parameters

Robustness Test Modified Internal Rate of Return (MIRR) for Panel owner	**MIRR Scenario 1 Switzerland 5 kWp**	**MIRR Scenario 2 Switzerland 30 kWp**	**MIRR Scenario 3 Switzerland 400kWp**	**MIRR Scenario 4 Portugal 400kWp**
Standard financial model prediction	0.75%	2.67%	1.67%	4.27%
2% annual increase of price of electricity 4% in Portugal	1.71%	3.57%	2.56%	5.47%
20% lower investment costs / higher panel performance	1.87%	4.02%	2.7%	5.27%
10% higher self-consumption	1.13%	2.94%	2%	4.59%
No discount for roof-owner	0.89%	2.89%	1.89%	4.48%
10% lower share for Solar Service Company	1.23%	3.16%	2.15%	4.76%

Source: Author's Calculations

In Portugal faster than expected increasing electricity prices significantly improve financial return of the SOIS business model. Lower than expected investment costs have the biggest potential to improve the financial viability of the SOIS business model in Switzerland. Again, the compensation to the roof-owner has the lowest influence.

The robustness test also controlled for different shares of revenues for the SSC. A 30% share reduces the MIRR by about 0.5% in all scenarios, leading to very low values (0.21% - 2.13%) for the Swiss scenarios. In the Portuguese case, such a strategy leads to a MIRR of 3.71%. The robustness of the financial model is discussed in section 5.2.5.

4.3.3 Financial Viability for the Solar Service Company

It is important to note that the SOIS business model not only needs to provide a satisfying financial return to buyers of the solar panels but also to the SSC. Only a financially sustainable company can reliably offer the services customers rely upon, namely continue operating the panel, deal with the roof-owner, sell electricity and buy back the panels if need be. Therefore, this section provides the results of a simple financial simulation indicating the revenues the SSC can expect from implementing the SOIS model.

In the small installation Swiss scenario, income for the SSC per panel and per year is only CHF 5.8 (EUR 5.3). Therefore, the 20 panels installed in this scenario would net a mere CHF 145 (EUR 133) per year. This amounts to approximately four paid hours for an employee in Switzerland to deal with the management of the installation and communicate with 20 customers.

A more detailed simulation uses figures and assumptions from the most financially interesting scenario, in which the solar panels are installed in Portugal.

Assuming that the SSC has a slow start installing one project at the end of the first year of existence, two projects in the second and then four projects through the fifth year. Such a development would result in the SSC managing about 21 400 panels, 15 locations (including potentially 15 SPEs) and 10 000 customers after five years. According to the financial scenario for Portugal for a 400 kWp project, the SSC's 20% share equals EUR 13 200 per project and per year and so, the SSC may have an income of 178 200 EUR after five years.

In terms of expenses, no detailed modelling has been carried out in this study. Nevertheless, assuming a startup scenario with a very small SSC, it can be assumed that overhead costs are relatively low at around 10% of revenue and marketing expenses are around 10% of revenue (Schweizerische Eidgenossenschaft: KMU-Portal, 2012). The SSC also needs to make significant initial investments in expertise regarding legal and contractual matters as well as regarding a suitable software platform. However, the biggest expense for a service oriented company is salaries. Swiss annual average gross wage is around EUR 79 000 (OECD, 2015) not including the company's share of 17% social security costs (Handelskammer Deutschland - Schweiz, 2010). Even if the SSC may be able to employ staff at lower wages, (unofficial) minimal salaries levels in Switzerland are significant, the biggest Swiss retailer paying a minimal gross salary of EUR 48 000 (Migros, 2014). The minimum capital to register a limited liability company in Switzerland is CHF 20 000 (EUR 18 500) (Schweizerische Eidgenossenschaft: KMU Portal, n.d.), so this is assumed to be the starting capital. All these assumptions lead to the following hypothetical financial model for the SSC as presented in Table 4-7.

Table 4-7. Scenario for the Financial Viability of the Solar Service Company

Business Years	**Revenue SSC in EUR per year**	**Expenses SSC in EUR per year**				**Capital in EUR**
Starting Capital		**Salaries**	**Marketing**	**Expertise**	**Overhead**	18 500
1. year: 1 project	3 300	4 000	3 000	12 000	2 000	800
2. Year: 3 (1+2) projects	26 404	12 000	4 000	8 000	3 000	204
3. Year: 7 (3+4) projects	72 611	43 000	6 000	12 000	8 000	3 815
4. Year: 11 (7 + 4) projects	125 419	87 000	12 000	12 000	12 000	6 234
5. Year 15 (11 + 4) projects	178 227	125 000	18 000	16 000	16 000	9 461

Source: Author

The discussion of the simulation and of the figures can be found in section 5.2.6.

4.4 Characteristics and Attitudes of the Target Buyer Group

In the following sections, available information regarding the size, the investment attitudes and interest of the target customer group of the SOIS business model will be presented. Information is based on 20 interviews conducted by the author in July and August 2015 in Switzerland and complemented with insights from the literature.

4.4.1 Target Group Size

In the introduction, it was established that Swiss citizens are able to save CHF 1 329 per year on average with people with a regular salary probably significantly exceeding this amount. Taking into account this information and considering the relatively low price for a panel of CHF 400 to CHF 500 (EUR 370 to EUR 460) it is safe to assume that there are enough people with sufficient purchasing /saving power in Switzerland for the SOIS business model to take off.

Switzerland features one of the highest rate of people who rent the apartments they live in. While the rate of house-owners is slowly increasing, in 2012 only 37% of the population owned their flats or houses. Together with Germany this is the lowest rate in Europe (Eurostat, 2015a). This means that a big majority of Swiss do not have the opportunity to decide whether or not to install solar panels on the roofs of the buildings they live in. Also, many of the people that own a flat do not have a suitable roof for installing solar panels.

It can be concluded that there is a significant potential target group of people with enough capital and without a possibility to install solar panels on their roofs.

4.4.2 Environmental Awareness

In order to determine interviewees general environmental awareness, they were asked whether they consider climate change to be a relevant issue. All interviewees agreed that climate change is happening and is a serious challenge and only one doubted about the human involvement in climate change. When asked about what measures they would personally be willing to take, driving a smaller or no car received highest marks among the interviewed people. Most would also be willing to pay higher energy prices and invest in renewable energy. However, eating less meat and flying less seem to be the hardest options.

4.4.3 Interest in Sustainable Investments

Regarding the size of the sustainable investment market, a financial expert working in this field stated that he considers this market segment a large and rapidly growing niche.

In the sample group, 17 interviewees stated that they would be interested in buying solar panels, a much higher rate than the 9 persons declaring that environmental protection is a motivation when deciding about investments. This confirms the notion from chapter 2.1 that interest and trust in a technology may be important drivers for such buying decisions.

4.4.4 Saving and Investment Behaviour

From the interviews some interesting conclusions can be drawn. 13 out of 20 interviewees expressed some degree of dissatisfaction with current returns on their savings, the others either did not know or did not care much about returns. Pretty much in line with these findings, 11 have been looking into alternatives to bank saving accounts. However, it seems to be difficult for the interviewees to identify suitable alternatives. In order to simplify things, two broad alternatives were presented to the interviewees. Investment in stock markets and membership including investments in associations.

In regard to stock markets, most recognised that they may offer more return than bank saving accounts but 8 out of 20 indicate that they do not accept the additional risk they associate with stocks. Several have also made negative experiences themselves or they know others that have lost money with investments in stocks. Other worries include excessive time requirements to make informed stock market investment decision and reluctance to participate in a little understood market that some interviewees felt is delinked from the real, economy and human needs, potentially contributing to repeating economic crisis. Only three persons do not express explicit negative feelings although many of the eleven that are looking for alternatives to bank saving accounts consider or have considered to invest in the stock market.

In regard to investing in associations, the picture is quite different. 9 view them in a positive way and like that they contribute to community development. However, a clear majority declared that they consider such schemes and the participation possibilities they offer or require to be potentially too time consuming.

Asked to rank a list of possible criteria for general investment decisions, interviewees equally preferred little risk and little personal time investment. Therefore, in table 4.8 the two criteria as first choices and then high financial return as the third choice, followed by social and environmental benefit are displayed. Multiple participants further mentioned transparency, innovation, long-term thinking and trust into the financial partner as additional criteria for an investment decision. One person with a particularly strong reluctance to invest time mentioned that she would only invest if the opportunity was good and big enough to make a relevant difference to her personal finances.

Table 4-8. Interviewees' Priorities for Investment Decisions

Rank	General Priorities for Investment Decisions
1	Little risk
1	Little personal time investment
3	High financial return
4	Social and environmental benefits

Source: Author based on interviews

All questions related to investing specifically into renewable energy ranked significantly lower. Reduction of dependence on foreign energy suppliers ranked highest, trailed by knowing people who can recommend it, the possibility to physically consume renewable energy and lastly the possibility to demonstrate green mindedness. From these results it is clear that such renewable specific criteria are not very relevant to people. This confirms their statements that environmental benefit is not very important for general investment decisions.

4.4.5 Attitudes Towards Solar Energy

Most interviewees state that they do not know much about solar PV. Three out of 20 have a good understanding of the political aspects of the solar market and claim to have a good technical understanding because they have already or are in the process of installing solar panels on their own roofs. Three people are concerned that solar panels may have important negative environmental impacts and a long energy payback time. The average number (on a scale of 1-5, 5 being the highest value) regarding the knowledge was 2.8. However, it is interesting to note that even without much knowledge, participants state that they have a positive attitude towards solar energy, the average rate being 4 out of 5. Solar energy is linked to innovation, progress and seen as a future proof and helpful technology to deal with energy challenges and climate change. Two interviewees are concerned about aesthetical issues of solar panels in regard to valuable architecture and city landscapes. A clear majority is pleased that the SOIS business model does not rely on long-term subsidies but most of these interviewees also state that they would not mind if this was the case. Overall, despite some worries, the sample group has a clearly positive attitude towards solar energy and it is not surprising that 18 would consider investing in solar energy.

4.4.6 View on Proposed Business Model

As a preparation, the author presented a simple visualisation of the SOIS business model to the interviewees and used the ensuing short discussion to ensure a proper understanding of the basic principles. Additionally, interviewees were given estimations of the financial return based on the results of the financial models as displayed in table 4-5.

Asked about their views on advantages and disadvantages of the SOIS business model, interviewees shared the following interesting perspectives.

Advantages and Disadvantages

In the following two tables 4-9 and 4-10, the most important advantages and disadvantages, interviewees associate with the SOIS business model are presented. The figures in the second column represents how many people out of 20 have mentioned that particular advantage or disadvantage in the discussion.

Table 4-9. Perceived Advantages of SOIS Business Model

Perceived Advantages of SOIS Business Model	**Number of interviewees (out of 20) mentioning an advantage of the SOIS business model**
Environment benefit	8
Simple and concrete	7
Requires little time and knowledge	6
Little risk	6
Innovative model	6
Can invest small amounts	4
Financial benefits	3
Transparency	3
Control and ownership	3
Increases awareness for electricity transition	3
Long-term perspective	2
Crosses borders	2

Source: Author, based on interviews

Interviewees rank environmental benefit of the SOIS business model higher than they do in regard for their general investment preferences. This will be discussed in section 5.5. As expected, they value the combination of simplicity and concreteness (in the sense that they want to know where their money is going), little time investment, little risk including the possibility to invest small amounts of money, innovativeness and a higher return than on their bank saving account. In their eyes, the combination of these factors offered by the SOIS business model offers an advantage compared to the two mentioned alternatives, associations and stock markets.

Table 4-10. Perceived Disadvantages of SOIS Business Model

Perceived Disadvantages of SOIS Business Model	Number of interviewees mentioning a disadvantage of the SOIS business model
Doubts about stability and financial viability of the SSC	8
Long-term perspective	4
Doubts about stable or rising electricity prices	4
Doubts about scaling possibility and financial return for investors	3
Worries about exit possibility	2
Risk to put panels abroad	2
Worries that technological progress reduces the value of their panels	2
Doubts about guarantees for construction work, installation and equipment other than solar panel	1
Doubt about legal ownership protection	1
Doubt about enough available roofs in Switzerland	1
Too small financial impact to be worth the time	1
Cannot use output themselves	1
Responsibility to own panel	1

Source: Author, based on interviews

It is obvious that worry about the stability and sustainability of the Solar Service Company is a major issue. Interviewees mention that such a new company has not yet proven itself and may have a difficult time earning the trust required to gain customers. Related to that is the worry that the company may have difficulties to scale up its business in such a way that it can generate enough revenue for itself and become financially sustainable in the long-term.

Interestingly, the fact that the SOIS business model requires a long-term perspective is perceived both as an advantage and as a disadvantage. Furthermore, it is clear that even interviewees that do not mention it explicitly as a disadvantage would like to have a guaranteed and attractive exit option. Linked to that issue is the worry of technical obsolescence of purchased solar panels.

Three interviewees correctly identified changing electricity prices as one of the major operational risk for the financial viability of the investment.

Generally, interviewees raised few disadvantages, only 31 entries compared to 55 entries for advantages.

Role of Ownership

In regard to the feature of the SOIS model to own a panel, four people stated that while they would like it, they do not consider this to be important. Six interviewees stated that this feature would make them feel good and three stated that it would make them feel even great. One person noted that she would perceive ownership more as a burden and a responsibility she would not like to have. Several people have no particular opinion about it, likely because the model, although explained and discussed remains too abstract.

Exit Possibility

In the explanation of the of SOIS business model prior to the interview, it was highlighted that the SSC may guarantee to offer to buy back panels from owners still allowing them to make a profit. In the discussion of the semi-structured interview many interviewees have indicated that they consider 25 years to be a rather long contract period and that this possibility would be very important to them.

View on Scenarios with Different Locations of the Solar Panel

All but one interviewee would consider having their panel installed in another country such as Portugal. Interviewees liked the additional social, development and financial benefits but some pointed out that they would prefer to be able to choose where their solar panel would be located. Reasons given include the wish to use solar power themselves, providing benefits to the local industry and the notion that Switzerland should realise its solar potential much better.

Interviewees feel that installing their panels abroad increases overall project risks and require more trust to the SSC and the need for better information about the project prior to investment. Some also mentioned the wish to see the SOIS business model work in demonstration projects before buying solar panels themselves.

In regard to the country their solar panels might be installed in, interviewees have no preference. In their view, southern European countries all trigger more risk than Switzerland and provide similar benefits.

5 Discussion

In this chapter, the results from the case study will be analysed, the pertinence of the theory and of the conceptual framework will be discussed and limitations will be presented.

5.1 Interpretation of Legal Viability

Regarding the legal viability, important challenges have been brought up in the case study in section 4.1 that may require some adjustments to the SOIS business model. Specifically, it may be difficult to guarantee the continuing operation of the panel in the case the SSC goes bankrupt because it owns the right to put the panels on the roof of a third party. A special purpose entity (SPE) has been suggested as a possible solution to this.

Now, what are the implications of this issue? Even though buyers may not be able to have the legal title to put their panels on a particular roof, they still own them. The mentioned issue may be a legal challenge but not so much a problem for the buyers from the psychological point of view. Indeed, as noted in the case study only just over half of the interviewees believe that owning the panels reduce the business risk. They correctly assume that even if the panel owners keep on to their panels, a bankruptcy of the SSC would inflict significant transaction costs on them if they want their panels to continue to operate. However, this risk does not prevent them from being interested in the model, they just don't see ownership as a significant advantage in terms of risk. What does matter to most people in terms of ownership, is the possibility to sell the panels. The SSC is well advised to guarantee that possibility in the service contract with the buyers.

As highlighted in several interviews, it comes down to the question if potential buyers trust the sustainability of the SSC. Without trust, people will not buy the panels, particularly not if they are located in another country. With trust, they may also be willing to rely on the SSC for access to a roof for their panels and they may accept the risk of transaction costs should the SSC become insolvent. Ownership for the buyers would then be limited to legal control, the right to sell them and to receive receipts.

As suggested by legal experts, the company may decide to create a project specific SPE that handles the contract with the roof owner and other local project partners. It was not possible for this study to follow up in detail on this legal construction. However, discussing the idea with two lawyers, it appears that a SPE may alleviate the above-mentioned challenge in some important aspects. While it does not fundamentally change the rights of the panel owner it nevertheless adds a layer of security by isolating the project from the fortunes of the SSC and ensures that the project can continue to run even if the SSC should become insolvent. If these advantages materialise, SPE may become a central part of the SOIS business model.

It was unfortunately not possible to talk to Portuguese lawyers but the author suspects that that legal challenges brought up in this study may be similar in Portugal.

Also related to legal viability are regulatory risks to the SOIS business model. It may be surprising that such risks have not been identified as major challenges by experts nor in the literature. Reasons may include the fact that the model does not rely on long-term subsidies and that the current shift in Europe to a policy framework encouraging self-consumption seems to be very broad and stable and does not impose costs on the state making it more unlikely to be reversed. Also, both Switzerland and Portugal are early solar energy markets and the discussion of costs and benefits of solar energy to the electricity system may only emerge at increasing total installed solar generation capacity as has been the case in the more mature markets in Germany or in the USA. That being said grid-related regulatory costs can constitutes a long-term risk might have been underestimated by the interviewed experts looking at shorter time spans.

5.2 Interpretation of Financial Viability

Four different scenarios have been presented in chapter 4.2. and will be discussed in this section. In short, the SOIS model can be financially viable. However, this does not apply to all scenarios and depends on the assumptions chosen.

Conservative assumptions notably for solar radiation, the rate of self-consumption, investment costs, future electricity prices, returns on reinvestment of receipts and inflation contribute to making the interpretation of the results reliable and help avoiding an overestimation of the financial viability. It is possible that real bottom-line figures would be better than the ones assumed and analysed here.

5.2.1 Small Scenario Switzerland

The first scenario for small installations in Switzerland is not financially viable for the buyer given current financial incentives. The model indicates a net revenue of CHF 112 (EUR 103) for an investment of CHF 546 (EUR 505) equalling 0.8% return (indicated as Modified Internal Rate of Return MIRR, see section 4.2.1) over 25 years. Looking at the model, the main reason for this outcome is the low self-consumption for small installations that are most likely located on residential houses and the relative high investment costs per panel. The 30% subsidy cannot make up for these two disadvantages. Another critical issue with the small installations scenario is lacking financial viability for the SSC. See section 5.2.6 for a discussion of this issue.

Given the very low return, the model has also been calculated with no SSC or roof-owner each taking their share and the buyer taking 100% of revenue. This was done in order to check for the validity of the financial model. Many people are investing at apparently satisfying returns and the financial model should be able to explain that in order to be valid. It turns out that after removing SSC and roof owner from the model, the financial return expressed as MIRR is still quite low at annually 1.78% over 25 years. However after adding the 15% tax reduction discussed in section 4.2.2, the model becomes more interesting and earns a MIRR of 2.8% and an IRR of 5%. Therefore, private house owners with suitable roofs should not invest in the SOIS model but rather invest themselves, strive for a high self-consumption and not forget to claim the tax deduction in order to make a decent profit. This simulation also suggests that the developed financial model is valid.

5.2.2 Medium Scenario Switzerland

Despite the reduced one-off investment grant from 30% to 21.8%, this (30 kWp) scenario is financially viable. CHF 474 (EUR 436) net revenue over 25 years translates to a MIRR of 2.67% and a clearly positive NPV. This return is significantly higher than on today's bank saving accounts in Switzerland. Therefore, this scenario might be acceptable for buyers whose alternative is to let their money on savings accounts and who value local and environmentally friendly investments.

The reasons for the significant improvement over the small installation scenario are the cheaper system prices but above all a much higher self-consumption rate. The medium sized installation is assumed to be located on a commercial roof whose owner is consuming most electricity during daytime and hence is able to self-consume 80% of the electricity production of the panels.

5.2.3 Large Scenario Switzerland

In the large installation size scenario (400 kWp), there is no subsidy available and consequently the financial viability suffers. Panels in this scenario earn CHF 240 (EUR 220) over 25 years equalling a MIRR of 1.67% meaning it is less profitable than scenario 2 but more profitable than scenario 1. In this scenario, due to the bigger project size, panels are significantly cheaper at CHF 468 (EUR 433) compared to the small installation size scenario at CHF 546 (EUR 506). On the other hand, electricity prices for medium sized companies and thus the value of the produced electricity is lower. Therefore, without the subsidy, big installations implemented with the SOIS business model may not be financially viable for people that look for a decent return of investment. It is also important to note that roofs of that size may be difficult to find in Switzerland.

Profitability for such large installations may be difficult to improve. Given the fact that panel prices are now the lesser cost part of total investment costs and very high labour costs in Switzerland, the investment costs cannot be expected to decrease much in the near future. This analysis was confirmed by all interviewed experts. Increasing self-consumption may be one way to boost a project's profitability. Another element that can be influenced up to a certain degree is solar radiation. Switzerland is small but features significant differences in altitude. Solar radiation increases in higher locations. At the same time these places tend to be cooler, increasing solar panels' efficiencies and sunnier because there is less fog. Finding locations in suitable regions may increase electricity production up to values normally found in southern Europe. However, big commercial roofs tend to be available more easily in big cities mostly located in lower altitudes, limiting the potential of such a strategy.

5.2.4 Scenario Portugal

Compared to all examined scenarios in Switzerland, installing panels in Portugal is clearly more interesting from a financial point of view. In the calculated financial model for Portugal (400 kWp), one panel can earn EUR 623 resulting in a MIRR of 4.27% over 25 years, which is considerably more than in all Swiss scenarios.

Estimated investment costs are EUR 0.38 per Wp lower than in Switzerland but this positive effect is almost nullified by lower electricity prices for commercial locations. The most significant reason for the better financial viability is the difference in solar radiation, which is at least 50% higher in Portugal compared to Switzerland. This fact causes such a large advantage that only a very unlikely combination of significantly worse than predicted other variables could weaken the financial result to the level of a Swiss installation.

These current figures do not take into account a potential future compensation tax. However, even after including the higher rate of the tax it was found that the 400 kWh project can still earn a MIRR of 3.6%. See section 5.2.5 for a discussion of the robustness of the financial scenarios.

The Portuguese financial scenario looks very interesting for Swiss panel buyers that are willing to accept a greater geographical distance and possibly higher perceived risks. As already mentioned in section 5.1 this depends very much on the level of trust that the SSC is able to build with its customers. According to the interviews, it can be expected that a significant number of buyers may be willing to have their panel installed in Portugal. It is also worth pointing out that there are close relationships between Switzerland and Portugal. In 2014, there were 262 000 Portuguese citizens without Swiss passport living in Switzerland (Bundesamt für Statistik, 2015b) making them the third biggest group of foreign nationals. Accounting for naturalised Portuguese, they may well number around 300 000. This group may be particularly interested in such an investment opportunity in their country of origin.

Another condition is the ability of the SSC to identify roof-owners with sufficiently big roofs and willing to engage in a long-term commitment to have solar panels installed on their roofs against a reasonable renting fee or preferential electricity prices. No detailed analysis of this condition has been carried out and experts differ on the interest of companies. One Portuguese expert stated that companies may be very interested in a contract that guarantees stable electricity costs in the long-term, while another expert thought that available incentives may not be sufficient for companies to engage in such long-term contracts.

5.2.5 Robustness of Financial Model

The robustness test in section 4.3.2 allows an appreciation of the sensitivity of the financial model to changes in important parameters. However, it depends on the extent of the change of the individual parameters. Therefore, the following analysis has a limited generalisability.

It is important to note that the robustness test as such does not say anything about the probability of such unexpected changes in parameters. That being said, some changes are more likely to occur than others. For instances, based on available information, it is relatively unlikely that electricity prices decrease significantly in the future. On the other hand, it can reasonably be expected that investment costs continue to decrease in the following years (GMT Research, 2015). This means that it is likely that the SOIS business model becomes more financially viable over time.

The importance of investment costs and of electricity prices for financial viability has been made very clear in the robustness analysis. Furthermore, it seems that the compensation to the roof-owner is much less influential or, in other words, even a significantly higher compensation for using a roof would not make the SOIS business model unviable. Likewise, the analysis shows that the planned compensation tax in Portugal does not render the SOIS business model unviable. This even more so because for the calculation of the effect it was assumed that a project would need to pay the compensation over the full 10 years. However, in reality, there is an undetermined transition period. It will take several years to reach the 1% and 3% thresholds and projects that are commissioned in the next years will face a significantly shorter or – if the market develops slowly – no compensation tax period. See section 4.2.3 for more details. For projects implemented in the future and thus paying compensation for the full 10 years, lower investment costs may partly compensate for the compensation tax.

An increase of the share of revenue for the SSC by 10% reduces financial return in Swiss scenarios below acceptable levels. However, in the Portuguese scenario, a MIRR of 3.71% may be acceptable for panel owners. In fact such a strategy may be even desirable for them because it significantly improves the financial viability of the SSC and thus reduces their investment risk.

5.2.6 Financial Viability for the Solar Service Company

One important aspect of financial viability concerns the SSC itself. Particularly in the case of small installations – even if they would provide a decent return for buyers – the SSC may not be able to manage a multitude of small project without spending over-proportionally high overheads on a per panel basis.

The author has run a hypothetical financial simulation (see chapter 4.3.3) of how the SSC might be able to scale up business activities using figures from the Portuguese financial scenario. It is important to note that the assumptions are highly hypothetical and have a startup setting in mind. Nevertheless, it allows to gain a general understanding of the salaries that the SSC would be able to pay. In the case study it was found that the SSC may be able to pay EUR 1250 000 in salaries after five years of operation. This would allow to employ two staff at average or three staff at low Swiss salaries, which besides new project development would need to manage about 23 000 panels, 15 locations (including potentially 15 SPEs) and 10 000 customers assuming that every buyer purchases 2.3 panels on average. In the robustness analysis, it has been calculated that a share of 30% for the SSC would result in an income of EUR 267 340 after 5 years providing significant additional resources for managing and developing the business.

No effort has been made to inquire into the organisational challenges of the SSC but it is obvious that the financial viability of the SSC depends very much on its ability to efficiently manage all these panels and customers and automate and simplify processes. However, it also becomes clear that even a very efficient SSC may not be able to generate sufficient income to finance salaries in the start-up phase from its share from panel revenues alone. Therefore, it needs to rely partially on non-salaried work, find other sources of income or start with more capital giving it more time to become profitable.

In terms of the roles the SSC may fill out, several possibilities are feasible. It may, as was mostly hypothesised in this study, restrict its role to simply be a service provider, outsourcing tasks such as legal advice, solar panel installation and controlling, website management, etc.

But it may also decide to develop competencies in one or several of these fields. If it was able, for example, to build the solar parks itself, it could eliminate a significant source of value loss because solar installers have their own margins. If it could hire a legal expert, it may save significant cost related to the development and implementation of contracts with roof-owners, owners and potentially the creation and management of SPEs. But all of these choices require great effort and may strain scarce resources particularly in the start-up phase.

Given the assumptions, the financial viability of the SOIS business model for the SSC particularly in the startup phase needs to be questioned. However, the chosen scope and the available data do not allow to draw more detailed conclusions regarding this question. Further research will be suggested in the conclusion.

5.3 Reflections on Business Models Components

The study sheds light on the four business model components mentioned in chapter 4.1.1. It has become clear that the SOIS business model creates *value* for the SSC by working as a service provider relieving panel owners from time investment, reducing risk and providing additional financial return on their savings in exchange for a share of revenues from their panels' electricity production. In regard to the *market* component, the existence of a group of interested small-scale investors can reasonably be assumed based on the analysis of 20 interviews, provided that the SSC manages to address their worries and needs. In regard to internal capabilities, the study has produced insight in some conditions for the SSC to succeed. Namely, it needs to scale up fast and to establish an efficient customer and panel management system in order to keep administrative cost per panel in check. Compared to associations, the SOIS business model allows to invest in solar energy without committing time and engage in decision making. Compared to shares, interviewees liked the reduced risk and the more concrete investment object. Finally, the *financial* model developed indicates financial preferences for medium sized projects in Switzerland or, promising a significantly higher return, for big projects in Portugal. Sticking to Morris' et al. (2005) terminology, the key to successfully implementing the SOIS model is to develop unique solutions that cannot easily be copied and that provide a sustainable competitive advantage.

5.4 Reflections on Investment Decision Theory

In chapter 2, investment decision-making theory has been presented. Based on this theory, it was deemed important to have the second round of interviews ascertaining investment criteria, attitudes, perceived advantages and disadvantages of the SOIS business model of potential customers in order to assess their interest to invest. The case study confirmed the notion that psychological factors and cognitive processes influence rational assessment of risk and returns.

Following the logic of the investment decision-making framework, participants in the interviews were given information about the SOIS business model and then supposed to process this information according to their attitudes and preferences and finally indicate their investment criteria, perceived risks, advantages and disadvantages in order to draw a conclusion about whether they may be interested to invest. The interviews confirmed the hypothesis that real risks and returns are not very important to this group of potential investors since they rarely ever asked for details on risk and financial return. Responses generally highlighted the importance of the psychological factors included in the investment decision-making framework. One exception may be status. According to the results, status is not a relevant factor for or against the SOIS business model. However, interest and belief in solar technology as well as ecological values of the interviewees clearly contributed to the positive attitude towards the SOIS business model. Likewise, national, in this case, Swiss investment culture probably has a positive influence on the perception of the SOIS business model by favouring a conservative, risk averse strategy, as well as a reluctance to engage in the stocks market and to invest time in managing money. Path dependency, on the other hand, works against the SOIS business model because in the interviews it became clear that most people while being unsatisfied with current returns of their savings are not enough upset to put in much energy for searching for alternatives. The discussions with interviewees further showed that investment decisions are not completely based on perceived risk and expected return. Several interviewees stated that they did not consider risk to be particularly low but that they would still be interested for other reasons. It can be concluded that other advantages and disadvantages (see next section) play an important role in investment decision making.

While some interview questions explore the reasons for interviewees' opinions, no attempt to comprehensively analyse all psychological aspects has been undertaken because interviewees refer to a hypothetical situation that does not require the same level of reflection than would a real decision. The fact of not analysing real decisions and their criteria and motivations is a major limitation of the study. Maybe future research can take up from here and use it to analyse real decisions.

On the other hand, the gained understanding of investment decision processes has several important consequences for the SOIS model. First, the willingness to engage with the SOIS business model depends a lot on the trust of investors to the SSC, a fact that was highlighted by multiple interviewees. Therefore, trust building is highly important for this business model to succeed and should be prioritised. Second, worries about a variety of risks need to be taken into account. The interviews show that many potential buyers lack information and believe in a significant number of half-truths and misconceptions that may contribute to an overestimation of technological and financial risk. Worries about technological obsolescence of solar panels and energy payback time can easily be alleviated with appropriate information. The Fraunhofer Institute (2014) shows that solar panels in southern Europe produce as much energy as was needed for their production in about one year. Also, the same author demonstrates that panel efficiency improvement is a linear and relatively slow process and therefore, that today's panel will most likely still be technically viable in 20-30 years. However, this needs to be given proper attention by the SSC and managed by pursuing a transparent and proactive communication policy towards its potential and actual customers.

5.5 Reflections on Buyer's Preferences

The interviews brought up many good questions and insights on the perception of advantages and disadvantages of the SOIS business model.

What seems to be particularly relevant is the strong preference for not investing time and attention to deal with saving and financial matters. Many participants seem to prioritise less time investment over higher financial return. It is interesting to note that low interest rates, rather than changing interviewees' saving behaviour seem to change their expectations for financial return on their savings. In the discussion, multiple interviewees noted that they do not expect money in their savings accounts to multiply but to keep its value. Although it is possible that financial return becomes more important for other investments than bank saving accounts, the author did not find such indications for small-scale investments during the interviews. While the limited value of financial return may seem surprising it can probably at least partly be explained by the fact that the SOIS business model does not ask buyers to make strategic investment decisions with a big overall impact on their personal finances. Rather, it gives them the opportunity to invest small amounts of money. The author believes that this feature is instrumental for the buyers' tendency to value environmental benefit and innovativeness of the SOIS business model value proposition. Also, it may reduce perceived risk much more than any legal construction aimed at protecting the owners' panels.

This has consequences for the added value that the SOIS business model may be able to offer. Namely, the possibility of investing a small amount of money as well as the aspect of not requiring much time effort and small risks seems to be more important than providing a high return. If this analysis is correct, even relatively low-return projects in Switzerland may be acceptable to customers. Such projects would also add additional value to those buyers that – while accepting that their panel be installed in Portugal – expressed a preference to have it nearby in Switzerland. Independent of return expectations, interviewees are distinctively risk averse and risk perception has been confirmed in the interviews as important investment decision factor.

Interviewees are concerned about the stability and the viability of the SSC. Being a new company pursuing a new business model, the SSC needs to focus on transparent information and trust building with its customers. However, it is likely that it will only be able to build trust and to reach beyond the early adopters if it can build successful demonstration projects.

The case study provides a somewhat ambiguous picture in regard to the role of ownership. While the possibility to own a solar panel seems to be attractive to most interviewees, it does not seem to make a big difference to them. Most rather consider this feature as *nice to have*. However, this does not mean ownership is irrelevant. To the contrary, the possibility to own and control a panel including the possibility to sell it at will may favourably distinguish the SOIS business model from alternatives such as associations and stocks. Also, as suggested by the theory in section 2.1 and confirmed in discussions with the interviewees, psychological factors may make a significant difference in deciding for or against investing in one particular business model.

As already stated in the previous section it is important to deal with several misconception about solar panels that are commonly believed even by people with generally positive attitudes towards solar energy.

5.6 Methodological Discussion

This study pursued a qualitative approach combining literature research with two sets of interviews. In the following, the author will reflect on the methodological approach and the generalisability and limitations of the study.

5.6.1 Methodological Approach

The literature research was useful to determine important factors for the investment decision process and thereby to identify appropriate questions for the interviews with potential buyers. Also, it yielded essential data and inputs for the calculation of the financial scenarios and for the interviews with experts both in Switzerland and in Portugal.

The interviews with experts were essential to complete, update, confirm and triangulate data obtained in the literature research and brought up important legal challenges (see chapter 4.1) specific to the new elements of the SOIS business model that were not covered in the literature.

The interviews with potential clients allowed addressing the second research question and determine the clients' preferences and attitudes towards solar energy in general and towards the SOIS business model in particular.

Both data collection methods successfully provided the data that allowed to carry out the case study. The case study was a suitable method to analyse several components of the SOIS business model. Overall, the author concludes that the chosen methodological approach was appropriate to reach the goal of the study and allowed to analyse the research questions.

5.6.2 Generalisability and Limitations

Using a qualitative methodology with a limited sample of interviewed people, the study does not aspire to statistical representativeness of its results. Also, the limited time available restricted the number of people that could be interviewed.

A number of important choices in regard to the sample have been made (see chapter 3.2.3). These choices produced a sample in a rather narrow age span that features an above average education, concern about the environment and interest in solar energy. This is in line with the declared aim to interview people that may be potential initial customers of the SOIS business model. This aim was fulfilled but the procedure also has downsides. The study's conclusion whether the SOIS business model meets to investment criteria of potential buyers is also limited to this relatively narrow sample of people. The study's results may be generalisable to the overall population only to a limited extent. Overall, this seems to be a legitimate trade-off in order to have higher involvement of interviewees.

Another limitation is the generalisability to other countries. Some answers from the interviews with potential investors may be specific for Switzerland. Therefore, more research would be needed in order to determine other nationalities preferences and attitudes for the SOIS business model. See chapter 6.

The study did not examine all elements of the SOIS business model relevant to its successful implementation, which may negatively impact its generalisability. Due to time constraints, the financial viability of the SSC has not been researched in detail and the developed scenario in section 4.3.3 relies on assumptions that could not be backed up with real data. Also, the study did not look into the organisation challenges of managing a great number of clients, panels and projects. Furthermore, the study has delivered only limited insights regarding the interests of the third important party to the SOIS model: the roof-owners. While it may be reasonable to assume that the multiple, including but not exclusively financial, benefits are attractive to them, more information about their interests and requirements are needed to assess the overall viability of the model.

These limitations lead to several suggestions for further research in the concluding chapter 6.

6 Conclusions

In the concluding chapter, the author summarises the results, reflects upon their relevancy and on how the study is able to answer the research questions. Also, suggestions for future research will be presented.

6.1 Answers to Research Questions

This study has examined the small-scale, off-site investment in solar energy business model (SOIS). It used literature research and two sets of semi-structured interviews with experts and with potential investors to answer the following two research questions:

1. How viable is the SOIS business model in Switzerland and in Portugal from a financial and legal perspective?
2. How does the SOIS business model fulfil investment criteria for Swiss small-scale investors?

In regard to the first research question, the study concludes that the SOIS model is financially viable for investors for medium-sized solar installations in Switzerland yielding a Modified Internal Rate of Return (MIRR) of 2.67% compared to the return of currently 0.11% on bank saving accounts, see section 4.3.1 for more detail. Installing the panels in large projects in Portugal yields a MIRR of 4.27% and is much more financially attractive than all Swiss scenarios. However, a number of conditions apply. For instance, legal challenges in regard to ownership and guarantee of continued operation in case of an insolvency of the Solar Service Company (SSC) need to be resolved. Additionally, roof-owners willing to engage in a long-term contract need to be found. Also, the study has demonstrated that the financial viability of the SOIS business model for the SSC is questionable and relies on relatively big project sizes, on the capability to scale-up fast and on very efficient management procedures to bring down investment costs per panel and to generate the necessary revenues.

In regard to the second research question it is found that the SOIS business model meets several of the interviewed potential small-scale investors' criteria.

- It offers a small investment opportunity in a concrete and tangible solar panel;
- It relieves investors from administrative burden usually associated with investment activity other than bank saving accounts;
- It enables them to contribute to an innovative business idea with environmental benefits;
- It provides them with a better financial return than a bank-savings account.

By far the most important doubt of the interviewees was the fact that the SSC is a new and small company and that it is unsure if it would be successful in the long run. They feared that even with ownership of the panels, it may be difficult requiring additional time and financial investment to continue operating them if the SSC would become insolvent. Such potentially significant transaction costs constitute a risk inherent to the SOIS business model. Because of this risk, they stressed the need to establish a high level of trust and provide transparent information about the projects. It became also apparent that a number of outdated perceptions and opinions for example regarding long energy payback times of solar panels persist among the target customer group. Careful information is important to manage and update such perceptions.

Interviewees highlighted that they wish to be able to sell their panels prematurely and it was suggested that the SSC guarantee to buy them back. Given that possibility, the expected revenue, payback times, etc. were not a major worry for most interviewees. The study suggests that the target group prioritises little time investment, innovativeness and environmental benefits over return when evaluating the SOIS business model. The low priority of financial return may be related to the fact that interviewees evaluated it from the perspective of investing only a small share of their savings.

6.2 Relevancy of Results

While some alternative investment models for small-scale investors are available, they usually involve giving loans, buying shares of a project or becoming a member in a solar association, se. All these approaches pool money from many small investors and cede various degrees of control and accordingly involve different amounts of risks for them. Based on discussions with experts, the author concludes that the SOIS business model is innovative and introduces a new element in the solar financing landscape in Switzerland: the idea that investors buy and own panels off-site. Consequently, preferences and attitudes of potential buyers regarding the ownership element as well as the legal and financial viability of the SOIS business model have not yet been examined and the study addresses a relevant knowledge-gap. Additionally, comparing the Swiss solar market conditions with the Portuguese market, the study provides an additional value and demonstrates that with the new bill in Portugal, installing panels there is more financially profitable than operating them in Switzerland.

6.3 Future Research

The study leaves several important issues regarding the SOIS business model for future research:

First, the legal model needs to be developed. In particular, it needs to be clarified to what extent the panel owners are protected in the case of an insolvency of the SSC. The author recommends to look further into the possibility to set up project-based Special Purpose Entities. This may simultaneously protect the panel owners against problems related to a bankruptcy of the SSC and insulate the SSC against project related problems. For the examined business model, it is important that this research extends to Portugal and other off-site locations attractive to solar energy.

Second, further research should deal with the scalability of the SOIS model to larger demographic buyer groups than the one targeted in this study. In order to scale up, the SSC eventually also needs to go beyond the small Swiss market and more countries need to be included in future research.

Third, future research may include the potential of emerging energy storage and management technologies to increase the rate of self-consumption of roof-owners, which may substantially increase the overall profitability of projects.

Fourth, in chapter 2.2 six typical components of business models have been identified however not all have been studied in the same detail. The *internal capabilities* as well as *growth* of the SSC and the *competition* component have not been given priority in this study and deserve more attention in future research.

Fifth, more research is needed to learn more about the preferences of the roof-owners. In the study is has been found that companies may be motivated to be a partner in the SOIS business model if the SSC can guarantee stable electricity prices at moderate discounts. However, more insight regarding additional motivations such as CSR considerations would benefit the understanding of the overall viability of the SOIS business model.

Sixth, it may be worthwhile to look into how energy policies can facilitate the emergence of business models in solar energy for tenants and generally for small-scale investors. Such policies may be attractive for policy makers because involving more people as stakeholder in the necessary energy transition may increase its acceptability and political feasibility.

Finally, the SSC needs to answer the question what happens after the end of the contract after 25 years. Most panels may continue to work when the contract expires and they are still owned by the investors. Research could look into the new contractual arrangements needed at that point in the future. Also, it needs to be clarified who has responsibilities for the end-of-life treatment of the panels.

The study has provided interesting insights in the financial and legal viability, customer preferences and in the overall feasibility of implementing the SOIS business model in Switzerland and in Portugal. However, only real life experience may tell whether the findings of this thesis are valid, whether the SSC is be able to attract enough customers, overcome the legal challenges, find suitable roofs and handle the administration of customers, projects and panels with the available income.

7 Bibliography

Al-Debei, M. M., & Avison, D. (2010). Developing a unified framework of the business model concept. *European Journal of Information Systems*, *19*(3), 359-376. doi:10.1057/ejis.2010.21

Associação Portuguesa de Empresas do Sector Fotovoltaico. (2015). O autoconsumo e a sua envolvente. Retrieved from http://apesf.pt/images/anexos/see_apresentao%20apesf.pdf

Associação Portuguesa de Empresas do Sector Fotovoltaico. (2015). Regime juridico autoconsumo. Retrieved from http://media.wix.com/ugd/a925b0_1a96bbf258cd4fd8a893b7062b0deb61.pdf

Balkissoon, D. (n.d.). *Semi-Structured interviews*. Retrieved on 2015-09-13 from http://designresearchtechniques.com/casestudies/semi-structured-interviews/

Barasinska, N., Schäfer, D., & Stephan, A. (2008). Hohe risikoaversion privater haushalte bei geldanlagen. *Deutsches Institut Für Wirtschaftsforschung*, *75*(45), 704-710. Retrieved from http://www.diw.de/documents/publikationen/73/diw_01.c.90133.de/08-45-1.pdf

BBC News. (2013). UK nuclear power plant gets go-ahead. Retrieved from http://www.bbc.com/news/business-24604218

Bernische Kraftwerke. (2015). Energie produzieren. Retrieved from www.bkw.ch: http://www.bkw.ch/privatkunden/energie-produzieren/#c1230

Bollinger, B., & Gillingham, K. (2012). Peer effects in the diffusion of solar photovoltaic panels. *Marketing Science*, *31*(6), 900-912. doi:10.1287/mksc.1120.0727

Brandhoff. (2015). Sekundärmarkt für solaranlagen. *Pv Magazine*, (Juni 2015).

Brekke, K. A., & Johansson-Stenman, O. (2008). *The behavioural economics of climate change*. Göteborg: Department of Economics, School of Business, Economics and Law, University of Gothenburg.

Bundesamt für Energie. (2014). KEV: Zuschlag steigt 2015 auf 1.1 rappen pro kilowattstunde. Retrieved from http://www.ee-news.ch/de/article/28982/kev-zuschlag-steigt-2015-auf-1-1-rappen-pro-kilowattstund

Bundesamt für Statistik. (2015a). Statistik schweiz - haushaltseinkommen und -ausgaben 2013. Retrieved from http://www.bfs.admin.ch/bfs/portal/de/index/themen/20/02/blank/key/einkommen0/niveau.html

Bundesamt für Statistik. (2015b). Statistik schweiz - staatsangehörigkeit. Retrieved from www.bfs.admin.ch: http://www.bfs.admin.ch/bfs/portal/de/index/themen/01/07/blank/key/01/01.html

Cloudsolar. (2015). Cloudsolar. Retrieved from http://www.gocloudsolar.com/

Coady, D., Parry, I., Sears, L., & Shang, B. (2015). *How large are global energy subsidies?*. Retrieved from http://www.imf.org/external/pubs/cat/longres.aspx?sk=42940.0

Cohn, M. J. (1997). Asset securitization: How remote is bankruptcy remote. *Hofstra L. Rev.*, *26*, 929. Retrieved from Google Scholar: http://scholarlycommons.law.hofstra.edu/cgi/viewcontent.cgi?article=2020&context=hlr

Colman, A. (2013). *Project finance made easy. Sort of.* Retrieved from https://joinmosaic.com/blog/project-finance-made-easy-sort/

Coughlin, J., & Cory, K. S. (2009). *Solar photovoltaic financing residential sector deployment*. Golden, Colo.: National Renewable Energy Laboratory. Retrieved from http://purl.access.gpo.gov/GPO/LPS112153

Couture, T., & Gagnon, Y. (2010). An analysis of feed-in tariff remuneration models: Implications for renewable energy investment. *Energy Policy*, *38*(2), 955-965. doi:10.1016/j.enpol.2009.10.047

Debor, S. (2014). *The socio-economic power of renewable energy production cooperatives in germany*. Wuppertal: Wuppertal Institut für Klima, Umwelt, Energie GmbH. Retrieved from http://nbn-resolving.de/urn:nbn:de:bsz:wup4-opus-53644

Diaz-Rainey, I., & Ashton, J. K. (2011). Profiling potential green electricity tariff adopters: Green consumerism as an environmental policy tool? *Business Strategy and the Environment*, *20*(7), 456-470. doi:10.1002/bse.699

Drury, E., Miller, M., Macal, C. M., Graziano, D. J., Heimiller, D., Ozik, J., & Perry IV, T. D. (2012). The transformation of southern california's residential photovoltaics market through third-party ownership. *Energy Policy*, *42*, 681-690. doi:10.1016/j.enpol.2011.12.047

Eidgenössische Elektrizitätskommission. (2015). Die kantonalen strompreise im vergleich. Retrieved from https://www.strompreis.elcom.admin.ch/Map/ShowSwissMap.aspx

Ek, K., & Söderholm, P. (2008). Norms and economic motivation in the swedish green electricity market. *Ecological Economics*, *68*(1), 169-182. doi:10.1016/j.ecolecon.2008.02.013

Elektrizitätswerk Zürich. (2015). Solarstrom aus der nachbarschaft. Retrieved from mein.ewz.ch: https://mein.ewz.ch/irj/portal/anonymous?NavigationTarget=navurl://fea0e2b11d4490fb3e2fda7f811df098

Energieverordnung. (2015). Swiss Federal Government. Retrieved from https://www.admin.ch/opc/de/classified-compilation/19983391/201506010000/730.01.pdf

Europa: Publication Office. (2015a). Rules for expressing monetary units. Retrieved from http://publications.europa.eu/code/en/en-370303.htm

Europa: Publication Office. (2015b). Punctuation in figures. Retrieved from http://publications.europa.eu/code/en/en-360500.htm

European Central Bank. (2015). Monetary policy. Retrieved from www.ecb.europa.eu: https://www.ecb.europa.eu/mopo/html/index.en.html

European Photovoltaic Industry Association. (2014). Global market outlook for photovoltaics 2014-2018. Retrieved from http://www.cleanenergybusinesscouncil.com/site/resources/files/reports/EPIA_Global_Market_Outlook_for_Photovoltaics_2014-2018_-_Medium_Res.pdf

Eurostat. (2015a). Housing statistics. *Housing statistics - statistics explained*. Retrieved from ec.europa.eu: http://ec.europa.eu/eurostat/statistics-explained/index.php/Housing_statistics

Eurostat. (2015b). Socioeconomic development. Retrieved from ec.europa.eu: http://ec.europa.eu/eurostat/web/sdi/indicators/socioeconomic-development

Fessler, P., & Schürz, M. (2008). Aktienbesitz in österreich. Retrieved from https://www.econbiz.de/Record/aktienbesitz-in-österreich-fessler-pirmin/10009871990

Flick, U. (2009a). *An introduction to qualitative research*. Los Angeles: Sage Publications.

Fraunhofer Institute. (2014). Photovoltaics report. Retrieved from http://www.ise.fraunhofer.de/de/downloads/pdf-files/aktuelles/photovoltaics-report-in-englischer-sprache.pdf

Frijns, B., Koellen, E., & Lehnert, T. (2008). On the determinants of portfolio choice. *Journal of Economic Behavior & Organization*, *66*(2), 373-386. doi:10.1016/j.jebo.2006.04.004

Fuhs, M. (2015). Crowdfunding-Plattformen: Fragen und antworten. *PV-Magazin Deutschland*, (02/15).

German Wind Energy Association. (2012). *Community wind power. Local energy for local people*. Retrieved from https://www.wind-energie.de/sites/default/files/download/publication/community-wind-power/bwe_broschuere_buergerwindparks_engl_2012_l06_final.pdf

Gerpott, T. J., & Mahmudova, I. (2010). Determinants of green electricity adoption among residential customers in germany. *International Journal of Consumer Studies*, *34*(4), 464-473. doi:10.1111/j.1470-6431.2010.00896.x

Glaser, B. G., Strauss, A. L., & Strutzel, E. (1968). The discovery of grounded theory; strategies for qualitative research. *Nursing Research*, *17*(4), 364. doi:10.1097/00006199-196807000-00014

Gloor, I. (2014). Photovoltaik. Retrieved from http://www.energie.ch/photovoltaik

GMT Research. (2015). PV balance of systems 2015: Technology trends and markets in the U.S. And abroad. Retrieved from http://www.greentechmedia.com/research/report/pv-balance-of-systems-201

Goldman Sachs Asset Management. (2014). *Investing in a low interest rate environment: Investor survey switzerland 2014*. Retrieved from http://www.goldmansachs.com/gsam/ch/advisors/en/about/survey/survey.pdf

Greenxmoney. (2015). Ihre handelsplattform für nachhaltige investments. Retrieved from https://www.greenxmoney.com/wie-funktionierts.html

Gross, J. (2013). Opportunities and risks of closed-end funds for private and corporate investors. In Munich GRIN Verlag GmbH 2014.

Handelskammer Deutschland - Schweiz. (2010). Übersicht lohnnebenkosten. Retrieved from www.arbeitsproduktivitaet.ch: http://www.arbeitsproduktivitaet.ch/uebersicht-lohnnebenkosten

Hedman, J., & Kalling, T. (2003). The business model concept: Theoretical underpinnings and empirical illustrations. *European Journal of Information Systems*, *12*(1), 49-59. Retrieved from http://www.palgrave-journals.com/ejis/journal/v12/n1/full/3000446a.html

Hochguertel, S., Alessie, R., & Van Soest, A. (1997). Saving accounts versus stocks and bonds in household portfolio allocation. *The Scandinavian Journal of Economics*, *99*(1), 81-97. doi:10.1111/1467-9442.00049

International Bureau of Weights and Measures. (2003). Symbol for the decimal marker. http://www.bipm.org/en/CGPM/db/22/10

ICF Consulting Limited. (2015). *Assessment of climate change policies as part of the european semester: Country report portugal*. Retrieved from http://ec.europa.eu/clima/policies/g-gas/progress/docs/pt_2015_en.pdf

IEA PVPS. (2015). *Snapshot of global PV*. Retrieved from http://iea-pvps.org/fileadmin/dam/public/report/technical/PVPS_report_-_A_Snapshot_of_Global_PV_-_1992-2014.pdf

International Energy Agency. (2015a). International energy statistics. Total electricity net generation. Retrieved from http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=2&pid=2&aid=12

International Energy Agency. (2015b). *The power of transformation: Wind, sun and the economics of flexible power systems*. Retrieved from http://www.iea.org/textbase/npsum/givar2014sum.pdf

Investing.com. (2015). Switzerland government bonds. Retrieved from www.investing.com: http://www.investing.com/rates-bonds/switzerland-government-bonds

IPCC. (2014). *Mitigation of climate change. Contribution of working group III to the fifth assessment report of the intergovernmental panel on climate change*. United Kingdom and New York, NY, USA: Cambridge University Press.

Jacobson, M. Z., Delucchi, M. A., Bazouin, G., Bauer, Z. A. F., Heavey, C. C., Fisher, E., . . . Yeskoo, T. W. (2015). 100% clean and renewable wind, water, and sunlight (WWS) all-sector energy roadmaps for the 50 united states. *Energy Environ. Sci.*, *8*(7), 2093-2117. doi:10.1039/c5ee01283j

Jäger-Waldau, A. (2014). *PV status report 2014*. Luxembourg: European Research Centre. Retrieved from http://dx.publications.europa.eu/10.2790/629644

Jordan, D. C., & Kurtz, S. R. (2013). Photovoltaic degradation ratesan analytical review. *Progress in photovoltaics: Research and applications* (Vol. 21, pp. 12-29). Wiley Online Library. Retrieved from http://www.nrel.gov/docs/fy12osti/51664.pdf

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica: Journal of the Econometric Society*, 263-291. doi:10.2307/1914185

Kierulff, H. (2008). MIRR: A better measure. *Business Horizons*, *51*(4), 321-329. doi:10.1016/j.bushor.2008.02.005

Kirchner, A., Bredow, D., Ess, F., Grebel, T., Hofer, P., Kemmler, A., & Struwe, J. (2012). Die energieperspektiven für die schweiz bis 2050. *Bundesamt Für Energie (BFE), Bern, Switzerland.*

Klein, A., Held, A., Ragwitz, M., Resch, G., & Faber, T. (2007). Evaluation of different feed-in tariff design options: Best practice paper for the international feed-in cooperation. *Karlsruhe, Germany and Laxenburg, Austria: Fraunhofer Institut Für Systemtechnik Und Innovationsforschung and Vienna University of Technology Energy Economics Group*. Retrieved from http://www.feed-in-cooperation.org/wDefault_7/download-files/research/Best_practice_Paper_3rd_edition.pdf

Kurz, J. (2015). Apricum's global PV's 5 year outlook - strong continued growth. Retrieved from http://www.apricum-group.com/global-pvs-five-year-outlook-going-from-strength-to-strength/

Markowitz, H. (1959). *Portfolio selection : Efficient diversification of investments*. New York: Wiley.

Masini, A., & Menichetti, E. (2012). The impact of behavioural factors in the renewable energy investment decision making process: Conceptual framework and empirical findings. *Energy Policy*, *40*, 28-38. doi:10.1016/j.enpol.2010.06.062

Masini, A., & Menichetti, E. (2013). Investment decisions in the renewable energy sector: An analysis of non-financial drivers. *Technological Forecasting and Social Change*, *80*(3), 510-524. doi:10.1016/j.techfore.2012.08.003

Massachusetts Institute of Technology. (2015). *The future of solar energy: An interdisciplinary MIT study*. Retrieved from https://mitei.mit.edu/system/files/MIT%20Future%20of%20Solar%20Energy%20Study_compressed.pdf

Mäkinen, S., & Seppänen, M. (2007). Assessing business model concepts with taxonomical research criteria. *Management Research News*, *30*(10), 735-748. doi:10.1108/01409170710823458

Mendonca, M., Jacobs, D., & Sovacool, B. K. (2009). *Powering the green economy: The feed-in tariff handbook*. Earthscan. Retrieved from http://www.tandfebooks.com/isbn/9781849774550

Migros. (2014). *Die migros erhöht die löhne um 0.7 bis 1.2 prozent*. Retrieved from http://www.migros.ch/de/medien/medienmitteilungen/aktuelle-meldungen-2014/migros-erhoeht-die-loehne.html

Ministerio do Ambiente, Ordenamento Do Território E Energia. (2014). *Decreto-Lei n. 153/2014*. Retrieved from http://info.portaldasfinancas.gov.pt/NR/rdonlyres/7C8B4709-4E30-4ABF-B58B-97616A0E33B1/0/Decreto_Lei_153_2014.pdf

Morgan Stanley. (2014). *Solar power and energy storage: Policy factors versus improving economics*. Retrieved from http://forms.greentechmedia.com/Extranet/95679/Morgan%20Stanley%20Solar%20Power%20&%20Energy%20Storage%20Blue%20Paper%20July%2029%202014.pdf

Morris, M., Schindehutte, M., & Allen, J. (2005). The entrepreneur's business model: Toward a unified perspective. *JBR Journal of Business Research*, *58*(6), 726-735. doi:10.1016/j.jbusres.2003.11.001

Neue Zürcher Zeitung. (2014, February 25). *Eigenheim: Wohneigentum wächst langsam, aber stetig*. Retrieved from www.nzz.ch: http://www.nzz.ch/schweiz/wohneigentum-schweiz-1.18251039

Newton, N. (2010). The use of semi-structured interviews in qualitative research: Strengths and weaknesses. *Exploring Qualitative Methods*, *1*(1), 1-11. Retrieved from http://www.academia.edu/1561689/The_use_of_semi-structured_interviews_in_qualitative_research_strengths_and_weaknesses

North, D. C. (1990). *Institutions, Institutional Change and Economic Performance*. doi:10.1017/cbo9780511808678

Lamba, R. S. (2010). NPV vs IRR vs MIRR: Pitfalls in the real world. Retrieved from http://finaticsonline.com/blog/2010/11/npv_vs_irr_vs_mirr

OECD. (2015). Average annual wage. Retrieved from http://stats.oecd.org/Index.aspx?DatasetCode=AV_AN_WAGE

OMIP. (2015). The iberian energy derivates exchange. Retrieved from www.omip.pt: http://www.omip.pt/

Overholm, H. (2015). Spreading the rooftop revolution: What policies enable solar-as-a-service? *Energy Policy*, *84*, 69-79. doi:10.1016/j.enpol.2015.04.021

Parkinson, S. (2014). Renewables surge to 74% of german demand on sunday : Renew economy. Retrieved from http://reneweconomy.com.au/2014/renewables-surge-to-74-of-german-demand-on-sunday-62168

Patel, S. (2014). Europe moves to phase out renewable subsidies. *Power Magazine*. Retrieved from www.powermag.com: http://www.powermag.com/europe-moves-to-phase-out-renewable-subsidies/

Patton, M. (2002). *Qualitative research and evaluation methods* (3rd ed.). London: Sage.

Phalippou, L. (2008). The hazards of using IRR to measure performance: The case of private equity. *Journal of Performance Measurement*, *12*(4), 55-67. doi:10.2139/ssrn.1111796

Pollitt, M. G., & Shaorshadze, I. (2011). *The role of behavioural economics in energy and climate policy*. Cambridge: University of Cambridge, Faculty of Economics.

Price Waterhouse Coopers. (2015). *Global economy watch projections | economic outlook*. Retrieved from www.pwc.com: http://www.pwc.com/gx/en/issues/economy/global-economy-watch/projections.jhtml

PVCalc. (2015). What is kilowatt-peak? Retrieved from http://pvcalc.org/what-is-kilowatt-peak

PV magazine Deutschland. (2012). Vergütung? Nein, danke! Retrieved from http://www.pv-magazine.de/archiv/artikel/beitrag/vergtung-nein--danke-_100008906/

PV Parity Project. (2012). *Electricidty prices scenarios until at least the year 2020 in selected EU countries*. Retrieved from http://www.pvparity.eu/fileadmin/PVPARITY_docs/documents/D.2.2_Electricity_prices_scenarios.pdf

Raphael, A., & Zott, C. (2001). Value creation in e-business. *Strategic Management Journal*, *22*(6/7), 493. doi:10.1002/smj.187

Ratchford, B. T. (1987). New insights about the FCB grid. *Journal of Advertising Research*. Retrieved from Google Scholar: http://www.researchgate.net/publication/232488924_New_insights_about_the_FCB_grid

Ringel, M. (2006). Fostering the use of renewable energies in the european union: The race between feed-in tariffs and green certificates. *Renewable Energy*, *31*(1), 1-17. doi:10.1016/j.renene.2005.03.015

Roe. (2012). *Compare solar efficiency losses over time*. Retrieved from sroeco.com: http://sroeco.com/solar/solar-efficiency-losses-over-time

Romero-Rubio, C., & de Andrés Díaz, J. R. (2015). Sustainable energy communities: A study contrasting spain and germany. *Energy Policy*, *85*, 397-409. doi:10.1016/j.enpol.2015.06.012

Roselund. (2015). Better than grid parity. *PV-Magazine*, (07/2015).

Rowlands, I. H., Scott, D., & Parker, P. (2003). Consumers and green electricity: Profiling potential purchasers. *Business Strategy and the Environment*, *12*(1), 36-48. doi:10.1002/bse.346

Sachse, K. (2008). *Risiken der kapitalanlage aus sicht der privatanleger*. Thesis. Retrieved from https://opus4.kobv.de/opus4-tuberlin/files/1811/sachse_katharina.pdf

Schäfer, H., & Kuhnle, O. (2006). *Die bilanzielle behandlung von zweckgesellschaften und ihre bedeutung im rahmen der corporate governance* (Vol. 177). Hans-Böckler-Stiftung. Retrieved from http://www.boeckler.de/pdf/p_edition_hbs_177.pdf

Schmidt, M. (2015). *Internal rate of return, modified IRR calculated and explaine*. Retrieved from www.business-case-analysis.com: https://www.business-case-analysis.com/internal-rate-of-return.html

Schweizer Banken.info. (2015). Sparkonto: Zinsvergleich. Retrieved from http://www.schweizer-banken.info/de/vergleich/sparkonto.htm

Schweizerische Eidgenossenschaft: KMU Portal. (n.d.). Wie findet man für sein KMU die ideale rechtsform? Retrieved on 2015-09-13 from http://www.kmu.admin.ch/kmu-gruenden/03476/03513/index.html?lang=de

Schweizerische Eidgenossenschaft: KMU-Portal. (2012). Ziele und budget sauber definieren. Retrieved from www.kmu.admin.ch: http://www.kmu.admin.ch/kmu-betreiben/03642/03655/03656/03657/index.html?lang=de

Seibel, K. (2012). Sparkonten: Inflation vernichtet jährlich 13 milliarden euro. Retrieved from http://www.welt.de/finanzen/article106211135/Inflation-vernichtet-jaehrlich-13-Milliarden-Euro.html

Sherwood, L. (2007). US solar market trends. In *Proceedings of the solar conference* (Vol. 2, p. 909). Retrieved from http://www.irecusa.org/2014/08/the-what-why-of-solar-trends/

Solarcontact. (2015). *Dachvermietung für photovoltaik: Geld verdienen ohne eigeninvestition*. Retrieved from de.solarcontact.com: http://de.solarcontact.com/photovoltaik/dach/dachvermietung

Solar Energy Industries Association. (2012). US solar market insight report | Q1 2012 | executive summary. Retrieved from http://www.seia.org/sites/default/files/resources/gbF1R8KqY92012Q1SMIES.pdf

Solar Facts and Advice. (2013). How to find the kwp and efficiency rating for any solar panel. Retrieved from http://www.solar-facts-and-advice.com/kWp.html

Solargis. (2015). *Global horizontal irradiation (portugal)* [Map]. Retrieved from http://solargis.info/doc/_pics/freemaps/1000px/ghi/SolarGIS-Solar-map-Portugal-en.png

Solomon, M., Russell-Bennett, R., & Previte, J. (2012). *Consumer behaviour*. Pearson Higher Education AU.

Sonnberger, M. (2014). *Der erwerb von photovoltaikanlagen in privathaushalten: Eine empirische untersuchung der handlungsmotive, treiber und hemmnisse*. Springer-Verlag.

Sonnenenergie. (2011). *PV mieten!*. Retrieved from http://www.sonnenenergie.de/index.php?id=30&no_cache=1&tx_ttnews%5Btt_news%5D=105

Spertino, F., Di Leo, P., & Cocina, V. (2013). Economic analysis of investment in the rooftop photovoltaic systems: A long-term research in the two main markets. *Renewable and Sustainable Energy Reviews*, *28*, 531-540. doi:10.1016/j.rser.2013.08.024

Spiezsolar. (2015). *Solarenergie, photovoltaik und solarthermie*. Retrieved from http://www.spiezsolar.ch/app/download/9908914595/Handbuch_V8.pdf?t=1431503451

Strupeit, L., & Palm, A. (2015). Overcoming barriers to renewable energy diffusion: Business models for customer-sited solar photovoltaics in japan, germany and the united states. *Journal of Cleaner Production*. doi:10.1016/j.jclepro.2015.06.120

Swiss Federal Office of Energy. (2014). One-off investment grants. Retrieved from www.bfe.admin.ch: http://www.bfe.admin.ch/themen/00612/05410/06149/index.html?lang=en

Swissgrid. (2015). Herkunft der fördergelder. Retrieved from https://www.swissgrid.ch/swissgrid/de/home/experts/topics/renewable_energies/remuneration_re/crf/facts_crf/origin_of_grants.html

Swiss National Bank. (2015). *Bedingte inflationsprognose der SNB*. Retrieved from http://www.snb.ch/ext/stats/statmon/pdf/deen/A4_1_Bedingte_Inflationsprognose_der_SNB.pdf

Tabi, A., Hille, S. L., & Wüstenhagen, R. (2014). What makes people seal the green power deal? — Customer segmentation based on choice experiment in germany. *Ecological Economics*, *107*, 206-215. doi:10.1016/j.ecolecon.2014.09.004

Tsagas. (2014). Portugal adds 33 MW of PV for 330 MW cumulative solar capacity. Retrieved from http://www.pv-magazine.com/news/details/beitrag/portugal-adds-33-mw-of-pv-for-330-mw-cumulative-solar-capacity_100016340/#axzz3igbhgaEe

Veolis. (2015). *Crowdfunding cleantech sustainability switzerland*. Retrieved from veolis.ch: http://veolis.ch/

von Lüde, R. (2013). Anlageverhalten auf finanzmärkten. *Wirtschaftsdienst*, *93*(5), 328-336. doi:10.1007/s10273-013-1529-x

Welsch, H., & Kühling, J. (2009). Determinants of pro-environmental consumption: The role of reference groups and routine behavior. *Ecological Economics*, *69*(1), 166-176. doi:10.1016/j.ecolecon.2009.08.009

Wirth, H., & Schneider, K. (2015). Aktuelle fakten zur photovoltaik in deutschland. Fraunhofer ISE. Retrieved from https://www.ise.fraunhofer.de/de/veroeffentlichungen/veroeffentlichungen-pdf-dateien/studien-und-konzeptpapiere/aktuelle-fakten-zur-photovoltaik-in-deutschland.pdf

Wirtz, B. W. (2010). *Business model management: Design-Instrumente--Sucess factors.* Retrieved from http://berndwirtz.com/downloads/bmm_lm_extract.pdf

Wüstenhagen, R., & Teppo, T. (2006). Do venture capitalists really invest in good industries? Risk-return perceptions and path dependence in the emerging european energy VC market. *International Journal of Technology Management*, *34*(1/2), 63. doi:10.1504/ijtm.2006.009448

Wüstenhagen, R., & Menichetti, E. (2012). Strategic choices for renewable energy investment: Conceptual framework and opportunities for further research. *Energy Policy*, *40*, 1-10. doi:10.1016/j.enpol.2011.06.050

Yildiz, Ö. (2014). Financing renewable energy infrastructures via financial citizen participation – the case of germany. *Renewable Energy*, *68*, 677-685. doi:10.1016/j.renene.2014.02.038

Zott, C., & Amit, R. (2010). Business model design: An activity system perspective. *Long Range Planning*, *43*(2-3), 216-226. doi:10.1016/j.lrp.2009.07.004

Annex 1: Interview Lists With Experts in Switzerland and in Portugal

	Name	**Organisation / Company**	**Date**
		Switzerland	
1	Christian Moll	Swissolar	2015-06-16
2	Peter Toggweiler	Basler & Hofmann AG	2015-06-22
3	Thomas Grädel	Alternative Bank Schweiz	2015-07-03
4	David Galeuchet	Solarmarkt Schweiz	2015-07-09
5	Christian Kilchhofer	Ecoptima AG	2015-07-28
6	Christoph Oliver Schmid	Stierlin Law	2015-07-30
		Portugal	
1	Karl Moosdorf	Associação Portuguesa de Empresas do Sector Fotovoltaic	2015-07-14
2	Nuno Brito Jorge	Boa Energia	2015-07-15
3	Joana Fernandes	Portuguese National Energy Agency	2015-07-17

Annex 2: Interview Questions for Potential Investors

#	Introduction
1	What do you think about climate change?
2	What would you be ready to do in order to help stopping climate change?
	Pay higher energy costs
	Eat less meat
	Fly less
	Drive a smaller car / don't own a car
	Invest in renewable energy production
3	What do you know about solar energy?
4	How do you view solar energy, what is your attitude?
#	**General Investment Questions**
5	Are you personally able to save money?
6	Are you satisfied with the return on your savings?
7	Have you looked into alternative investment possibilities?
8	How important are the following criteria to decide how to invest money?
	Little risk
	High financial return
	Little additional work
	Social benefit. Status, demonstrate values
	Environmental benefit
	Other
9	Do you consider investing in renewable / solar energy?
10	Regarding investing in renewable energy, what are additional motivations?
	Self-consumption, independence from utility / the grid
	Reduce dependency from global energy markets
	Knowing people that have done it
	Other
#	**Explanation of the SOIS business model**
11	How do you assess alternative options?
	Investing in stocks

	Member in a foundation
12	What do you think about the SOIS model?
	What advantages do you see?
	What disadvantages / barriers do you see?
13	How would owning a solar panel make you feel?
14	Do you think owning a panel influences the risk of an investment?
15	How does the reliance on subsidies of a business model influence your investment decision?
16	How important is the feeling to be part of a community?
17	If you were to invest in solar energy, how important would the possibility to self-consume the electricity be?
18	Would the place where the solar panel is installed matter to you? (private or commercial roof, public building, social institution or NGO)
19	If you would buy panels, would you be ready to have them installed in another country?
	If yes, under what conditions?
20	Do you any preferences in regard to countries? What about Portugal?
#	**Socio-demographic questions**
21	Gender
22	Age
	20 - 30
	30 - 40
	40 - 50
	50 - 60
	60 - 70
	70 - 80
23	What is your education?
	University or equivalent
	Professional degree
24	Do you own your house / flat?

Annex 3: Interviews Questions for Experts in Switzerland

#	Financial Questions
1	What are the latest system prices per Wp for 5 kWp, 30 kWp and 400 kWp systems?
2	How much is maintenance and insurance?
3	How are the FIT reference prices determined? How should they be interpreted?
4	What installations sizes are the most viable currently in Switzerland?
5	The literature indicates that 1 kWh can be produced per Wp installed capacity per year. Is this realistic? What is the performance ratio?
6	What is your assessment of the future development of investment costs in Switzerland?
7	How does the EU price limit / trade dispute with China influence the solar market and prices in Switzerland?
8	What is your analysis in regard to the development of the feed-in price for electricity that is not self-consumed?
9	Is there a limit to self-consumption?
10	What is your assessment in regard to the development of electricity prices? How will deregulation affect them?
11	What is the current trend in regard to panel efficiencies?
12	What is the standard guarantee?
13	Does the guarantee cover other installation items such as cables, inverters, etc.?
#	**Explanation of SOIS business model**
14	What do you think about the model?
15	What advantages do you see?
16	What disadvantage do you see?
17	Do you think the fact of owning gives a sense of security and is something buyers value?
18	Do you know of similar models in Switzerland?
#	**Subsidy Related Questions**
19	Is the FIT available for new installations?
20	Can the SSC claim the One-Off Investment Grant on behalf of the owners?
21	How much money is left in the One-Off Investment Grant scheme? Will the CHF 135 million be replenished? How long is it going to last, what happens afterwards?
22	Do you see any consequences of the 3 party (Panel owner, roof owner and service company) setting in regard to the One-Off Investment Grant?

#	**Legal Questions**
23	Are panel owners really protected in a bankruptcy of the SSC?
24	Can the company negotiate and register the right to use the roof under its name on behalf of the panel owner but the panel owner retains legal ownership independently from the company?
25	What could be the role of a Special Purpose Entity in the SOIS business model?
26	How can the Special Purpose Entity be insulated from a failure of the company?
27	Are liability questions likely a problem here? If yes, how to solve them?
28	Can the service company have a contract with the buyer of the electricity even though it does not own the panels?
29	Can a roof-owner *self-consume* electricity from panels that it does not own?
30	Open question: Do you see any other legal issues with this kind of arrangement. What are biggest challenges with such an arrangement?
#	**Taxes Related Questions**
31	Can the owner deduct the investment costs from income taxes even though he/she does not install the panels on his / her roof?
32	What tax regime applies? The panels are private property but installed on commercial property, how does it work?
#	**Investment Related Questions**
33	How big is the market segment of people interested in sustainable investments?
34	What segments of the population is particularly interested in sustainable investment? Education, age, income
35	How is the sustainable investment market developing?
36	What is the motivation to invest in renewables?
	High Environmental benefit
	Self-consumption, independence from utility / the grid
	Reduce dependency from global energy markets
	Innovation; solar is the future
	High financial return
	Knowing people that have done it
	Demonstrating green mindedness
	Other?
37	How much money do Swiss park in savings accounts?

Annex 4: Interviews Questions for Expert in Portugal

#	Financial
	What are the latest system prices per Wp for various capacities?
	How much is maintenance and insurance?
	What is the yearly output in Portugal? Average w/m2, kWh / m2.
	How much is the performance ratio?
	How high is the electricity price for consumers and for commercial users?
	What is your assessment of the future development of investment costs in Portugal?
	What is your assessment of future electricity costs in Portugal?
#	**Regulation / Subsidies**
	Are there any subsidies in Portugal or has it been completely replaced with the right to self-consume?
	How long do you expect a typical installation process to take?
	UPAC: Can you please elaborate how the dimension calculation works?
	How is self-consumption defined? Does it need to be on the same area? Would it be possible that one company builds solar panels and has a direct wire to another company for ”self-consumption”?
	What is your assessment of the compensation tax linked to the CIEG?
	UPAC: for how much can excess electricity be sold to the grid?
	What is the current level of solar?
	UPP: What is the feed-in price for electricity?
	UPP: There is a cap of 20MW per year. What happens to the excess applications? Waiting list?
	UPP: Can you please elaborated on how the dimension calculation works?
	Is there any legal modification planned at this point? Is there a risk of regulation change that could affect the SOIS business model?
	The current regulation is still quite new. Do you have first experiences? How does the market react, how is it implemented?
	Do you have any projection about the effects?
#	**Legal**
	What are the market entry conditions for foreign capital in the solar market in Portugal?
	Do you see legal or other issues with implementing the SOIS business model?
	Can a roof-owner ”self-consume” electricity from panels that it does not own?

Annex 5: Financial Scenario Switzerland Small Installation

Number of years		25	
Number of panels		20	

		All panels	**1 panel**
Production per year baseline	**kWh**	**5 200**	**260**
Solar panel area	m2	50	1.63
Solar panel efficiency		16%	
Solar panel power rating / nominal output	kWp	5.20	0.26
Solar insolation	kWh / m2	1 000	
Production yearly changes			
Decrease in capacity per year	%	0.65%	

Gross revenues per year baseline	**CHF**	**753**	**38**
Self-consumption	35%		
Utility rate for roof-owner (CHF per kWh)	0.23		
Discount for selling electricity to roof-owner	5%		
Sell price to roof-owner = revenue from self-consumption (CHF per kWh)	0.22	398	
Price for excess production (CHF per kWh)	0.11	355	
Revenues yearly changes			
Inflation + increase of electricity price per year	0.50%		

Costs of investments baseline	**CHF**	**10 920**	**546**
Investment costs (CHF / Wp)	3.00	15 600	
Subsidies on investment costs (30%)	CHF	-4 680	
Costs Yearly Changes			
Maintenance per year (of gross investment)		1%	

Profitability for panel owner(s)			
Gross revenue over 25 years (including reinvestment of receipts)	CHF	13 165	658
Net revenue over 25 years (including reinvestment of receipts)	CHF	2 244	112
Gross revenue (including reinvestment of receipts) average per year	CHF	592	39
Payback time in years		23.42	

Rate of return for owner(s)			
Interest rate for discounting		1.00%	
Discount rate for negative cashflow		1.00%	
Interest rate for reinvestment of positive cashflow from project (receipts)		1.00%	
Internal Rate of Return (IRR)		0.50%	
Modified Internal Rate of Return (MIRR)		0.75%	
Net Present Value (NPV)	CHF	-654.7	

Income for Service Company			
Income per year in CHF (average of 25 years including variable revenues)	20%	116	6
Income over 25 years	CHF	2 910	146

Average income for roof-owner per year	CHF	21	1.05

Panel price for buyer	CHF		546

Annex 6: Financial Scenario Switzerland Medium Installation

Number of years		25	
Number of panels		115	

		All panels	1 panel
Production per year baseline	**kWh**	**29 900**	**260.00**
Solar panel area	m2	290	1.63
Solar panel efficiency		16%	
Solar panel power rating / nominal output	kWp	29.9	0.26
Solar insolation	kWh / m2	1 000	
Production yearly changes			
Decrease in capacity per year	%	0.65%	

Gross revenues per year baseline		**5 854**	**51**
Self-consumption	80%		
Utility rate for roof-owner (CHF per kWh)	0.23		
Discount for roof-owner	5%		
Sell price to roof-owner = revenue from self-consumption (CHF per kWh)	0.22	5 227	
Price for excess production (CHF per kWh)	0.11	628	
Revenues yearly changes			
Inflation + increase of electricity price per year	0.50%		

Costs of investments baseline		**58,400.00**	**507.83**
Investment costs (CHF / Wp)	2.50	74 750	
Subsidies on investment costs (1400+(500/kWp))		-16 350	
Costs yearly changes			
Maintenance per year (of gross investment)		1%	

Profitability without discounting for owner(s)			
Gross revenue (including reinvestment of receipts) over 25 years	CHF	112 941	982
Net revenue (including reinvestment of receipts) over 25 years	CHF	54 541	474
Gross revenue (including reinvestment of receipts) average per year	CHF	4 517	39
Payback time in years		13.1	

Rate of return for owner(s)			
Interest rate for discounting		1.00%	
Discount rate for negative cashflow		1.00%	
Interest rate for reinvestment of positive cashflow from project (receipts)		1.00%	
Internal Rate of Return (IRR)		4.68%	
Modified Internal Rate of Return (MIRR)		2.67%	
Net Present Value (NPV)	CHF	29 667	

Income for service company			
Income per year in CHF (average of 25 years including variable revenues)	20%	999	8.7
Income over 25 years	CHF	24 971	217

Income for roof-owner per year	CHF	275.08	2.39

Panel price for buyer	CHF		508

Annex 7: Financial Scenario Switzerland Large Installation

Number of years		25	
Number of panels		1 539	

		All panels	**1 panel**
Production per year baseline	**kWh**	**400 140**	**260**
Solar panel area	m2	3 800	1.63
Solar panel efficiency		16%	
Solar panel power rating / nominal output	kWp	400	0.26
Solar insolation	kWh / m2	1 000	
Production yearly changes			
Decrease in capacity per year	%	0.65%	

Gross revenues per year baseline		**56 499**	**37**
Self-consumption	80%		
Utility rate for roof-owner (CHF per kWh)	0.17		
Discount for selling electricity to roof-owner	5%		
Sell price to roof-owner = revenue from self-consumption (CHF per kWh)	0.16	51 698	
Price for excess production (CHF per kWh)	0.06	4 802	
Revenues yearly changes			
Inflation + increase of electricity price per year	0.50%		

Costs of investments baseline		**720 252**	**468.00**
Investment costs (CHF / Wp)	1.80	720 252	
Costs yearly changes			
Maintenance per year (of gross investment)		1%	

Profitability without discounting for owner(s)			
Gross revenue (including reinvestment of receipts) over 25 years	CHF	1 090 2234	708
Net revenue (including reinvestment of receipts) over 25 years	CHF	369 972	240
Gross revenue (including reinvestment of receipts) average per year	CHF	43 609	28
Payback including reinvestment of receipts		16.6	

Rate of return for owner(s)			

Interest rate for discounting		1.00%	
Discount rate for negative cashflow		1.00%	
Interest rate for reinvestment of positive cashflow from project (receipts)		1.00%	
Internal Rate of Return (IRR)		2.40%	
Modified Internal Rate of Return (MIRR)		1.67%	
Net Present Value	CHF	129 870	

Income for service company			
Income per year in CHF (average of 25 years including variable revenues)	20%	9 642	6.2
Income over 25 years	CHF	241 043	157

Income for roof-owner per year	CHF	2 721	1.8

Panel price for buyer	CHF		468.00

Annex 8: Financial Scenario Portugal

Number of years		25	
Number of panels		1 539	

		All panels	1 panel
Production per year baseline	**kWh**	**600 210**	**390**
Solar panel area	m2	3 800	1.63
Solar panel efficiency		16%	
Solar panel power rating / nominal output	kWp	400	0.26
Solar insolation	kWh / m2	1 500	
Production yearly changes			
Decrease in capacity per year		0.65%	

Gross revenues per year baseline	**EUR**	**59 541**	**39**
Self-consumption	80%		
Utility rate for roof-owner (EUR per kWh)	0.12		
Discount for selling electricity to roof-owner	5%		
Sell price to roof-owner = revenue from self-consumption (EUR per kWh)	0.11	54 739	
Price for excess production (EUR per kWh)	0.04	4 802	
Revenues yearly changes			
Compensation (CIEG = 20%), 30% / 50% of CIEG	0%	0.00%	
Inflation + increase of electricity price per year	2%		

Costs of investments baseline	**EUR**	**520 932**	**338**
Investment costs (EUR per Wp)	1.30	520 182	
Taxes	EUR	750	
Costs yearly changes			
Maintenance and insurance per year (of gross investment)		1.00%	

Profitability for owner(s)			
Gross revenue (including reinvestment of receipts) over 25 years	EUR	1 480 351	961
Net revenue (including reinvestment of receipts) over 25 years	EUR	959 419	623
Gross revenue (including reinvestment of receipts) average per year	EUR	59 214	38
Payback time in years (including reinvestment of receipts)	EUR	10	

Rate of return for owner(s)			
Interest rate for discounting		1.00%	
Discount rate for negative cashflow		1.00%	
Interest rate for reinvestment of positive cashflow from project (receipts)		1.00%	
Internal Rate of Return (IRR)		8.26%	
Modified Internal Rate of Return (MIRR)		4.27%	
Net Present Value	EUR	633 399	
Income for service company			
Income per year (average of 25 years including variable revenues)	20%	13 202	8.6
Income over 25 years	EUR	330 050	214

Income for roof-owner per year	EUR	2 881	1.87

Panel price for buyer	EUR		338