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Perceptions of domestic solar systems

- a study on non-adopter views of a new technology

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The idea to this thesis, which is a part of a larger project around domestic solar systems, came from the Swedish energy company GodEl (www.godel.se). They wanted to contribute to a faster adoption of solar panel-systems in Sweden, as a way to conduce a transition towards a lower carbon society, and had an idea about running a project that could make people feel more familiar to such technologies. The project became what was called The Solar panel ambassadors (Solcellsambassadörerna). It consisted of events that were arranged at the homes of solar panel owners, where neighbors and other interested persons could get the chance to see how a solar panel system worked. The events propitiously became a huge success with a very high and responsive attendance. After contacts with local newspapers there were also several articles published about the project participants which provided a spreading of the message to an as well broader audience. As a measure of success it can be mentioned that the project even made it to the Swedish TV4 Stockholm news program with a feature clip of over 1 minute.

First of all I would like to give a huge thanks to my boss, and the project initiator, Peter Roland (GodEl) for a great cooperation, for open-heartedly opening the doors for me at GodEl and for giving me the opportunity to run this project. I'm really impressed with his ability to see the need, timing and opportunity for such a project, which is the fundamental reason for why it could ever have become so successful.

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Abstract

The world is currently facing a huge severe challenge in handling the issue of climate change. One of the ways to lower the green house gas emissions, which is seen as one of the main contributor to the climate crisis, is to use renewable technologies such as for example photovoltaic (PV) systems. PV-systems are also suitable for so called micro production, small scale energy production facilities, since it can be placed on practically any rooftop with the right solar conditions. In Sweden the usage of PV-systems has not yet gotten any wider spreading, even though the solar radiation conditions are very similar to countries that produce a lot of solar energy, as for example Germany.

The aim of this paper is to describe non-adopter perceptions of PV-systems. The study holds a qualitative approach using deep interviews for data collection. Theoretical framework used is Rogers (2003) *diffusion of innovations*, and the innovation characteristics of relative advantage, complexity, compatibility, observability and trailability. The main findings is that the relative advantage is perceived as negative in terms of finances, but that some of the respondents overestimates the payback times as well as stated payback times that are well within the price levels of today when getting the questions of what levels that would make them seriously interested in getting a PV-system. Further, PV-systems are generally seen as an environmental friendly technology, which is positive for the relative advantage attribute, but with some of the respondents raising doubts about the actual environmental benefits by a life cycle approach. A finding in this study is also that PV-systems are seen as being very easy to use, which indicates a positive view of the characteristic of complexity.

Sammanfattning

Världen står inför en stor utmaning i att hantera de just nu pågående klimatförändringarna. Den största bidragande faktorn för det förändrande klimatet, och följande klimatkris, ses som de höga halterna av växthusgaser i atmosfären. Ett sätt att sänka dessa är att avhända större andel förnyelsebara produktionskällor för energi, såsom exempelvis solceller. Solceller är även användbara för så kallad mikroproduktion då de kan placeras på i princip alla hustak som har rätt solläge. I vissa länder har användandet av solceller spridigt sig rejält, och i exempelvis Tyskland står redan idag solcellerna för 2% av landets totala energikonsumtion. I Sverige har dock solceller inte fått någon bredare spridning ännu, trots att solinstrålningsnivåerna här är likvärdiga dem i Tyskland.

Syftet med den här uppsatsen är att beskriva vilka attityder och föreställningar det finns om solcellssystem bland icke-adoptanter. Studien har en kvalitativ ansats och använder djupintervjuer som empirisk datainsamlingsmetod. Som teoretiskt ramverk används Rogers (2003) teori *diffusion of innovations*, och innovationsattributen relativ fördel, komplexitet, kompabilitet, synlighet och prövbarhet. De främsta fynden är att solcellssystem ses som en icke gynnsam ekonomisk investering vilket påverkar attributet relativ fördel negativt. Samtidigt så överskattar vissa respondenter återbetalningstiden, samt anger återbetalningstider som ligger väl inom ramen för hur prisläget faktiskt ser ut idag som svar på frågan om vilken återbetalningstid som skulle göra dem själv seriöst intresserade av att skaffa ett solcellssystem. Ett annat fynd är att solcellssystem generellt sett ses som en miljövänlig teknik, vilket är positivt för aspekten av relativ fördel samt kompabilitet med värderingar. Vissa av respondenterna hade dock tvivel på hur miljövänliga solcellssystem är sett till ett livscykelperspektiv. Ett ytterligare fynd är att solcellssystem sågs som en mycket användarvänlig teknologi, vilket innebär en positiv syn på attributet komplexitet.

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1 Introduction

This introduction chapter provides the problem background, problem formulation and thesis aim. It also presents the delimitations with the purpose of making the core content of the thesis as clear as possible.

1.1 Problem background

The world is facing a huge challenge in handling the issue of climate change (IPCC, 2007). A substantial decrease in green house gases (GHG) is needed in order to reduce the green house effect that is making the earth´s temperature rapidly rise. One of the major contributors to GHG emissions, both currently and historically, is the vast consumption of fossil fuel (IPCC, 2012). Of the world's total energy consumption over 80% is currently covered by fossil sources such as oil, coal, peal or natural gas, and of which stands for 99,6% of the energy GHG emissions (internet, IEA 1, 2011, p. 6).

There are several ways and suggestions of how to lower the GHG emissions generated by the energy sector while still meeting the global energy demand (IPCC, 2011). Some of these options are carbon capture storage, energy conservation and efficiency, nuclear, fossil fuel switching, and renewable energy (RE) technologies. One of the RE technologies that are available is the use of solar energy which can be used to generate electricity, where the technology is called photovoltaic (PV), heat or warm water (internet, Svensk solenergi 1, 2007).

PV-systems can be installed both as large scale centralized power stations and as domestic smaller scale power systems (IEA, 2010), and are seen as one of the cleanest energy sources as they produce so called zero-emission electricity (Sauter and Watson, 2007; IPCC, 2012). Even though solar only represents a small part of the total energy production in the world (internet, IEA 1, 2011) PV energy has grown with over 820%, from 4243 MW to 34953 MW installed power, in the five years between 2005-2010 (IEA, 2010, p. 4). The country that has the largest installation of PV power, as for 2010, is Germany (17370 MW), followed by Spain, USA and Japan. Sweden has an installed capacity of 11,4 MW. A comparison of the installed capacity per capita is 212,5 W for Germany and 1,2 W for Sweden.

One common misconception is that Sweden has much lower sun radiation levels than countries as for example Germany, and that the levels in Sweden are not high enough to produce energy from PV-panels (Widén, 2009). But in fact, Germany and Sweden have very similar radiation levels (Zimmerman, 2011). The difference is that Sweden has larger variations during the year, where more electricity from the PV-system can be produced in the summer and less in the winter. In total it sums up to practically the same levels as in northern Germany and similar places in central Europe. Further, a study by Kjellson (2000) shows that there are around 400 km2 roof areas that could be used to produce PV-electricity Sweden. As a calculation example it can be counted for that if only 25% of this area, 100 km2, was used this would produce between 10-15 TWh per year[1], and as comparison it can be mentioned that the Swedish nuclear power plant of Barsebäck produces around 4,7 TWh per year (Barsebäck, 2012). In other words, there is potential to produce a lot more PV-electricity of substantial quantities in Sweden, and this is without exploiting any new grounds or land.

[1] Assumtions made for this calculation is a solar electricity production of 100-150kWh/m2.

An important part of in the transition towards a sustainable development is seen to be the whole society's responsibility for the energy that we produce and consume (UN 1987; internet, UN 1, 2005). An aspect that is interconnected to this discussion is the field of microgeneration technologies (MT´s), also called micro production. MT´s is referred to as systems that can be domestically installed in households such as solar PV and small wind turbines (Sauter and Watson, 2007). PV-systems are by its nature very suitable for micro production, since they are discreetly installed on rooftops and can be used in practically any house that has the right solar conditions (internet, Energimyndigheten 1, 2009). MT´s holds benefits, besides zero emissions, such as making energy use more visible which can trigger a change towards lower levels of consumption (Sauter and Watson, 2007; Nye and Hargreaves, 2010). A study done by Keirstead (2007) showed that households which have installed PV-systems reduced their overall electricity consumption with approximately 6%, as well as shifted their usage to when the PV-system produced the most. Further, MT´s can also help create a more competitive electricity market as well as contribute to the spreading of other energy efficient technologies (DTI, 2005).

1.2 Problem

The concept of MT´s has not yet gotten any wider spreading on the Swedish market but the interest around it is increasing (Palm and Tengvard, 2009). In the recent years in Sweden there has been an increase both in the political economical support measures (IEA, 2010) as well as initiatives from companies within the electric trade market to promote micro generation of electricity (e.g. internet, TV4 1, 2012; internet, Bengt Stridh 1, 2011; internet, Bengt Stridh 2, 2012).

There have been several studies that describes barriers for adoption of PV-systems (e.g., Zhang *et al.*, 2011; Menz, 2005; Sozer and Elnimeiri, 2003; Faiers and Neame, 2006; Solar Electric Power Association, 2002; Willey and Hester, 2001; Jacobsson and Johnson, 2000; Dymond, 2002; Palm and Tengvard, 2009). A barrier that is frequently found to be the most significant and important is the financial aspects as for example long-payback time and high initial cost (e.g. Zhang *et al.*, 2011; Faiers and Neame, 2006; Menz, 2005; Dymond, 2002; Willey and Hester, 2001; Jacobsson and Johnsson, 2000; Solar Electric Power association, 2002, Goldman *et al.*, 2005; Palm and Tengvard, 2009). Other barriers that is identified is lack of governmental policy support (e.g. Dymond, 2002; Jacobsson and Johnson, 2000; Solar Electric Power association, 2002; Willey and Hester, 2001), inadequate workforce skills (e.g. Dymond, 2002; Foxon *et al.*, 2005), difficult installation and too much maintenance (e.g. Faiers and Neame, 2006), lack of information dissemination (e.g. Dymond, 2002) and difficulties overcoming established energy systems (e.g. Fuchs and Arentsen 2002). In the discussion of barriers a major aspect besides such actual features of a product is the individual's *perceptions* of such actual features (Rogers, 2003). In addition, one of the barriers that are commonly identified towards adoption of PV-systems is also a low level of awareness and knowledge among general citizens (e.g. Dymond, 2002; Jacobsson and Johnsson, 2000; Menz, 2005; Solar Electric Power association, 2002; Willey and Hester, 2001).

One of the most well-established theories around how new innovations, such as PV-panels and PV-systems for domestic use, is spread throughout a market is *diffusion of innovations* by Everett Rogers (2003). According to Rogers one of the most important factors to determine the rate of which the innovation is spread is the attitudes, perceptions, which individuals have towards the innovations characteristics. Such perceptions have empirically been found to explain 49-87% of the variation in rates of adoption. It should however in this context be noted, as Rogers (2003) points out, that these attitudes is only one of the factors that influence the spreading of an innovation, other than aspects such as the nature of the innovation, what communication channels that can be used, the composition of the social system and the role of opinion leaders. But even so, that the attitude among private persons is an important factor for the future diffusion and adoption of microgeneration technologies is confirmed by literature that specifically addresses the area of small scale electricity production (Sauter and Watson, 2007; Elliott 2000). In addition, a review of research challenges within the green marketing field by Cronin *et al.* (2011) found that research until now primarily have been focused on understanding the already environmentally minded consumer, while understanding the reluctant consumer and the barriers is as important. Also Claudy *et al.* (2010, 2) mean that empirical evidence on consumer resistance to green innovations, such as MT´s, is scarce and that this is generally an under-researched area. Hence, it is of importance, for marketers as well as for scholars, to research what attitudes, perceptions non-adopters have towards domestic PV-systems.

1.3 Aim

The aim of this study is to describe non-adopter perceptions towards a new technology. The objective is to map out non-adopter perceptions towards PV-systems.

The study addresses the following study questions:

- What are the perceptions of domestic PV-systems among non-adopter house residentials in the Stockholm region?
- What are the perceived advantages or disadvantages?
- What are the barriers towards a possible future adoption?
- What could motivate a future adoption of a domestic PV-system?

In this study that is focused on perceptions it should be noted that awareness and beliefs in itself does not always lead to positive changes in environmental behavior, sometimes referred to as the value-action gap (Withmarsh, 2009; Barr, 2006). Sovacool (2009) noted that both psychologists and economists have found that people generally hold a strong preference for a status quo, which would mean that even a favorable attitude towards an innovation not necessarily mean that adoption will occur.

1.4 Delimitations

This thesis is describing the perceptions that people have of domestic PV-systems. It is neither aiming nor claiming to describe a full attitude since such a construct, using a well-recognized attitude definition by Fishbein and Ajzen (1975), includes more than a perception. Accordingly to this attitude model, that will be further explained under the theory chapter, an attitude towards an object consists of an individual’s knowing, feeling and intention and mean that the knowledge of an object enables an assessment which leads to a feeling which in its turn determines the intention of a behavior. The focus in this paper is thus describing something that resembles the first part of the attitude concept; belief. It is highly recognized that consumer attitudes are not determined by only identifying beliefs around a product (Solomon, 2006). But since the basis for attitude information is the beliefs (Fishbein and Ajzen, 1975) it seems of relevance to know of such even though, as defined by literature, there are no full attitude construct yet. Further, this thesis focus is not a concept investigation of attitudes, nor is the analyze focused on distinguishing the difference or relationship between belief, feeling and intention, since such a construct contribution is not the aim of this thesis.

The study is delimited towards a pre-set theoretical framework, namely *diffusion of innovations* (Rogers, 2003) and also delimited to primarily using its aspects of innovation characteristics. Choosing a pre-set framework for a qualitative study have a substantial effect on the findings and direction of answers given by the respondent, as described by Kvale (1997). The direction of discussion in the interviews has most likely been influenced by the pre-set theoretical framework even though very open and broad questions were used. The choice of theory as well as method is further explained in chapter 2.

An important delimitation in this paper is the strict focus on the attitude aspect of innovation spreading. As mentioned earlier the perceptions towards an innovation are only one of the factors that will affect its diffusion. This paper is thus not anywhere near a full analyze of the current situation, the possibilities and barriers, but is quite narrowly focused on the aspect of perceptions. Further, the empirical study in this paper is geographically delimited to the Stockholm region. It should be noted that perceptions and attitudes that people hold can differ between different parts of Sweden.

In relation to the theory used it should be mentioned that this paper examines and describes the beliefs and feelings of non-adopters that don’t have any connection to PV-systems, who can best be described to be at a knowledge phase (Rogers, 2003), but is using the innovation characteristics normally connected to the following attitude forming persuasion stage. Such use of the innovation characteristics as a framework on unknowledgeable non-adopters have been done before in for example a well cited study by Labay and Kinear (1981), and with a clear awareness of the concept of attitudes and what part of the construct this paper actually researches, this is not seen as creating any sort of conceptual issues for this paper. Further, since PV-systems generally is not a technology that one can adopt on a trial basis (Faiers and Neame, 2006) this characteristic is excluded from this study but still briefly explained in the theory chapter.

This paper is delimited towards PV-systems, even though there are other MT´s available such as micro wind turbines, solar heating systems or micro combined heat and power production (Sauter and Watson, 2007). It should however be noted that since many of the few studies that are conducted in this area have looked at attitudes towards for example both PV-systems as well as micro wind turbines, jointed as looking at perceptions of MT´s, such studies have been included in this papers analyze. Also, this study is delimited towards the aspect of PV small scale microgeneration even though it is recognized that PV-panels and other renewable technologies also can be used for larger production facilities (IEA, 2010).

1.5 The expected contribution and stakeholders of the study

Since this study have a lot of similarities with what can be described as market research (Kvale, 1997), describing consumer attitudes and beliefs, this study could be of benefit for the Swedish solar energy market. This study can be used for the actors in the solar market as a way of getting knowledge around what beliefs there can be around PV-systems.

The contribution of this thesis also lies in the research of a quite new and immature field, especially seen on a Swedish level. This thesis can help raise questions for further research, as well as presenting findings, within the quite new field of research in attitudes towards PV-systems. As mentioned in the introduction there is also a general research need to investigate the attitudes of not only the already environmentally minded customer, but also the reluctant, something that this thesis addresses.

2 Method

This chapter will describe the method used in this thesis and the basis for the method choices. There are many different ways to conduct research within the social science field (Robson, 2003). In science research there are numerous choices to be made, all of which will affect the results and how the findings should and can be interpreted. The chapter starts with an explanation of the fundamental methodological starting points, after which the literature review and the method used in the empirical study is accounted for. The chapter is finally rounded up by a discussion of ethical aspects connected to the thesis.

2.1 Methodological starting points

This thesis holds an inductive qualitative approach which is, according to Robson (2003), suitable since the aim and research questions is empirically driven and concerned with a relatively immature research field; consumer attitudes around domestic solar energy. A qualitative method gives room for a broader range of answers which will contribute to fulfilling the aim of this thesis by an in-depth understanding (Kvale, 1997; Robson, 2003). A qualitative method is further suitable since the research aim is to understand a social reality as the respondents *themselves* perceives it, as where a quantitative method would have been better if the aim was to create an *explanation* for such a human behavior. The type of qualitative method chosen is in depth-interviews, of which will be further explained in the second part of this chapter. Further, this thesis is of a descriptive nature and thus not for example focused on hypothesis testing.

Since this thesis is presenting qualitative empirical observations in relation to other similar studies as well as theories it is suitable to briefly mention the relation between knowledge and science, *epistemology*, and phenomenon-understanding as scientific contribution. *Science* can be described as a result of systematic and comparable research that enables generalized conclusions to be drawn (Robson, 2003), which in this paper is represented as the theory used. These scientific theories can then be used to analyze empirical findings, as in for example many of the scientific articles presented in this thesis literature review, which can create *new knowledge*. Knowledge is not the same as theory, but can be used as door-openers towards scientifically exploring the areas. In order to create knowledge the study has to have certain facets such as for example a randomized empirical sample. Since this study is based on a qualitative method without a randomized sample it will not be possible to do any kind of generalization from the results. The contribution in this thesis lies instead in a deep understanding of a phenomenon in a certain context.

2.2 Choosing the theoretical framework

The first step in the procedure of choosing what angel and what theoretical framework that would be suitable to address the research aim with was to conduct literature searches to find out how this research field had been addressed previously. Since this is quite a new field of research the number of studies was limited but not totally unexplored. There were a few different approaches found of which attitudes towards domestic solar systems, as well as solar power in general, have been investigated (this is further presented under section 4.1 in the literature review chapter). A framework that was discovered to have been used several times when investigating attitudes towards domestic solar systems was Rogers (2003) *diffusion of innovations* and its classification of innovation characteristics (e.g. in Kaplan, 1999; Labay and Kinnear, 1981; Velayudhan, 2003; Faiers and Neame, 2006). This theory and its innovation classifications were seen as useful in order to fulfill the aim of this study. Therefore, and by the fact that it is a well established theory within innovation research, it was chosen as a theoretical framework for this thesis.

A consequence from using a pre-set theory is that it can have a limiting affect on the interviews and the answers that the respondents give (Kvale, 1997). In qualitative interviews around a relatively new topic it could also have been suitable to have an even more open starting point in the empirical investigation that allowed for different kinds of approaches before deciding on the theoretical framework. But even so, it is argued that the benefits of having defined the theoretical approach from start gives huge benefits when designing the study and analyzing the material (Kvale, 1997; Patton, 1990). In order to antagonize the possible limiting effect that a pre-set theoretical framework could have, there has been a careful consideration and use of wide open ended questions in the interview guide that encourage and allow broad encompassing thoughts.

2.3 Choosing the units of analysis

The choice of unit of analysis should primarily be guided by the research aim (Kvale, 1997). Many of the previous studies regarding attitudes towards domestic solar energy have revolved around the differences between the different adopter groups (e.g. adopters and non-adopters). This study however is not investigating such differences but rather seeks to understand the attitudes of a certain group; the non-adopters of solar energy. Therefore the first criteria for choosing the units of analysis was that the respondents don't already own or have recently planned to install domestic solar power. A criterion for choosing the units of analysis was also that the interview person hadn't installed either a solar heating facility since this holds a lot of similarities to a PV-system. It could be assumed that a person who has already adopted solar heating could be more knowledgeable and familiar about similar technologies such as PV-panels than a person who has not adopted either.

This thesis tries to capture the attitudes of *non-adopter consumers* which are meant to be interpreted as *potential consumers of domestic solar energy*. Since the most common use of solar panels for domestic use is on detached villas, as oppose to apartment residents, a criteria for choosing the respondents was that the person lived in a detached villa. Further, since previous studies have found that demographic factors such as age, gender and income have an impact on how a person views PV-systems (Faiers and Neame, 2006), a criterion for choosing the respondents was that different age groups, gender, education level and income levels where represented. Additional criterions used was that the person is living in Sweden and speaks Swedish (since this thesis is conducted on a Swedish market), is a main income source in the household, is in a fit for work age and post high school graduate (19-65 years) and that he or she lives in the area of greater Stockholm. A criterion was also that there should be a more or less equal division between female and men respondents in the study.

All of the respondents were randomly chosen in a villa suburb, called Rönninge, located in the Stockholm region. The respondents were chosen from different parts of the area, covering the criterions stated in the section above, and was initially called up by telephone and asked if they wanted to participate (see appendix 1 for calling template and info given). One problem in all scientific research involving human respondents is that the ones who are most prone to participation might not be the ones who are the most representative (Robson, 2003; Lohr, 2010; Kvale, 1997). The ones most willing to talk might for example have a special interest in the subject of matter, or might be more involved in the general debates than the average. To minimize the risk of getting respondents that where for example already extremely pro-green or especially interested in green technologies the possible participants were told that they would get two cinema vouchers as compensation (with a value of SEK 200). The cinema vouchers meant that the possible participants got an incentive to participate in the study no matter what interest he or she had in the subject of PV-systems. Further, because of the risk of bias no direct or indirect acquaintances of the author, or ones who are familiar with the parallel PV-project that has been running during the time of this thesis, was used as respondents.

The number of respondents in a qualitative study should be guided by the research aim (Kvale, 1997) and to meet the research aim of this study it was suitable to cover as many different sides of demographic factors as possible. The five respondents chosen in this study cover many different demographic factors in terms of occupation, education, income and gender (as presented in part 5.1). It was however hard to find respondents to cover all types of categories, as for example to find respondents in the age category of 18-35, household sizes of + 6, people with income levels of SEK 0-250 000 as well as people with a different nationality than Swedish.

2.4 Conducting the background and literature review

To gather background information and to get a hold of previous studies within the field searches was made in the databases Business source premiere, EconLit, ScienceDirect and Emerald. Further, information from materials, links and publications on the websites of the branch organizations IEA-PVPS, EPIA, Svensk solenergi and SolElprogrammet, as well as the Swedish energy agency, was collected.

The literature review was conducted with these below listed search words in all types of combinations by the words from the first column with the ones from the second. The words marked with a * was also used on searches only using this word. In the case of searches with the words *attitudes* or *perceptions* along with the words *solar* or *energy*, the first mentioned two was put to be included in the abstract. This is since these combinations gave a very large number of hits, and that the literature relevant for this study would have such a focus on an attitudinal aspect that these would be included in the abstract.

Table 1) The search terms that was used in the literature review.

TX All Text		TX All Text		Abstract
Attitude(s)	AND	Solar	OR	Attitude(s)
Perception(s)		Energy		Perception(s)
Consumer attitude(s)*		Domestic		
Consumer perception(s)*		Solar power*		
Public attitude(s)*		Microgeneration*		
Innovation adoption*		Photovoltaic		
Diffusion of innovations*		Solar Panel(s)		

After the database searches a further screening was applied in order to sort out the relevant articles. The relevant articles for this thesis was selected on the basis that they either contained an alternate way and framework to measure peoples mental relationship to PV-systems or microgeneration technologies, or that they could present actual findings of such.

2.5 The empirical interviews

To conduct interviews is a handcraft that is more connected to art than to standardized social science methods (Kvale, 1997). But even so, there are plenty of methodological choices to be made for all the different stages in the interview process that need careful consideration. The methodological choices around the empirical survey, the actual procedure that took place conducting the interviews as well as the scientific status of the in-depth interviews will be further explained in this section.

2.5.1 In-depth interviews

This thesis is based on qualitative research with in-depth interviews as the source of empirical collection. In-depth interviews is based on the idea of human dialogue as a source of knowledge and is unique in a way that it can capture the world, situation and opinions as the respondents themselves perceives it (Kvale, 1997). Qualitative interviews also have the ability to create a deep and sensitive understanding for people's deepest feelings, with the aim of fully understanding their motives and behaviors. Because of this particular feature, qualitative interviews are frequently used in the area of market and consumer behavior research. Since this thesis intends to understand consumer attitudes, beyond the surface and as the respondents themselves perceives it, qualitative in-depth interview is seen as a suitable tool. This also approach allows for more flexibility and the exploration of factors that a quantitative method would not cover.

However, the scientific position of qualitative methods, and especially in-depth interviews, has been of debate (Kvale, 1997). One of the critiques raised is that these methods lack *objectivity*. It is argued that the human interaction that qualitative methods require, especially in the interview situation, cannot be without subjectivity. But Kvale (1997) on the other hand also mean that there are several notions of implications of why qualitative research can and should be seen as objective. For example in the aspect of a research conduct free of bias created through a skillful handcraft by the researcher, or in the aspect of that qualitative interviews can be reproduced, at least arithmetically, with corresponding data even by different observers (see more discussion of adjacent topics under part 2.3 Quality assessments).

2.5.2 Designing the interview guide

The interview conduct and interview questions (appendix 2 and English translation in appendix 3) in this thesis is built upon two steps. In the first step the respondent is asked to fill out a reflection-sheet (appendix 4), which is a long list of bipolar descriptor pairs which can describe facets of PV-systems, after which the semi-structured deep interview is held. A flexible semi-structured approach was taken where both the self reflection sheet was used during the interview as a basis for discussion alongside broad open ended deep interview questions. For example, the interviewer could ask the interviewee to explain how he or she reasoned when filling out a certain trait. In order to make sure that all subjects of interest have been covered and discussed the quantitative questionnaire as well as the questions in the interview guide served as checklists during the interview. It should be noted that the aim of the reflection survey solely was to provide a tool for reflection and not to gather any quantitative data.

The reflection sheet and the interview guide used in this thesis are inspired by a quantitative questionnaire developed by Faiers and Neame (2006). Their questionnaire was used as inspiration for the guide since their study has a similar, but yet notably different in some aspects, aim and theoretical framework as this thesis. One major difference is that their study was of quantitative nature while in this thesis has a qualitative approach. Another difference is also that their study was comparing different segments, different adopter groups, while this thesis is focused on a deeper understanding of one group (the non-adopters of solar energy). The study by Faiers and Neame (2006) was published as an article in the peer-reviewed journal *Energy Policy* in 2006, which in relation to a well explained and scientifically valid method is interpreted as a measure of high scientific quality.

The questionnaire used by Faiers and Neame (2006) was developed by using Kelly´s repertory grid method. In the first step, interviews around the characteristics of solar energy were held with 10 previous adopters of domestic solar energy. These interviews generated bi-polar descriptor pairs that could describe solar energy, with a vocabulary that would be understandable for private persons. The survey was then tested on 10 other randomly selected adopters of solar energy to establish its ease of use, after which eight descriptor pairs where deleted. The final survey was used to study 100 adopters of solar power (classified as "early adopters"), and 1000 former adopters of some type of energy efficient measures (classified as "early majority"). The basis of the survey is that all descriptor pairs can be classified into one of five innovation characteristics as described by Rogers (2003) as a way to map out consumer attitudes. The descriptor pairs are mainly related to the attribute *relative advantage,* 18 pairs, eleven pairs to compatibility and four pairs relating to observability and complexity. There are no pairs relating to *trailability*, since domestic PV-systems are generally not considered to be trail-able.

One aspect that need consideration is that the Faiers and Neame (2006) study was developed to survey the attitudes of adopters of solar energy or of other energy savings measures (e.g. early majority), while this thesis is focused on capturing the attitudes of non-adopters. The fact that the 10 people involved in the repertory grid exercise that generated the characteristics of solar energy was previous adopters of solar energy could mean that there are other views that non-adopters would have stated that are not reported. However, since the purpose of creating the survey was to produce a questionnaire that included all sorts of aspects and facets of solar energy the ones most suitable to map this out is presumably the ones that themselves have used the technology.

The questionnaire by Faiers and Neame (2006) was used for research in the United Kingdom but is seen as assumed to be feasible for use in Swedish conditions as well. Even though it was developed for a use in a different country the United Kingdom holds many similarities to Sweden, as it is an industrial country within the European Union that as well holds comparable solar conditions.

The translation of the quantitative reflection-questionnaire from English to Swedish was made by the author, after which one peer and one older acquaintance, who holds a degree of higher education, was asked to review the translation. After their feedback some changes in the wording was made and one descriptor pair was eliminated since it was agreed upon that this trait was not relevant for Swedish conditions. It should be noted that one of the contributions in this thesis is the interviewees feedback on the questions, the understandability and relevance, since it is highly recognized that the questionnaire and interview questions needs careful reviewing in order to become as useful as possible for future use.

An important part of this study, even though it starts with a quantitative reflection-sheet, is the openness and flexibility since the aim is to gather qualitative data and to deeply understand how the interviewee reasons. A risk when using the qualitative-reflection sheet is that the interviewee in the continuous interview limit herself to the areas covered in this questionnaire. But on the other hand it brings vast benefits as a tool for reflection on a subject that most people are not particularly familiar with, and thus might not by themselves see all the aspects of, which is seen as overruling the downsides. Further, as explained the questionnaire is designed to be as all-inclusive as possible, mapping out all different kinds of aspects around the traits of domestic solar energy, as it includes 26 descriptor pairs of which cover a wide range of angles.

2.5.3 Procedure at the interviews and analysis of data

Before the interviews the respondents was given a brief introduction to the research project and the aim of the thesis according to a standardized presentation (see appendix 2). The respondents were also told, in according to the principles of research ethics by the Swedish Research council (2011), how the data from the interviews where to be analyzed and presented in the thesis. They were for example informed about that they are completely anonymous and would not be mentioned by names, addresses or similar information, and would only be given a number (respondent 1,2,3 and 4). The supposed timescale for the interview, also as told to the respondent, was approximately but not strictly limited to one hour. The interviews were, with the permission of the respondents, audio recorded and then transcribed into text. During the interviews the interviewer also wrote memos and summaries of the interpretations of what was being said. This is important in deep interviews since the importance lies not only in what is actually being said but rather the underlying meaning (Kvale, 1997). The recorded and transcribed interviews in combination with memos written during the time of the interview are seen as a propitious documentation for a forthcoming analyze.

The analyze method that is used in this study is *thematic coding analysis*. This method is flexible and suitable for many types of qualitative data and is a scientifically accepted approach by researchers and journal editors (Robson, 2003). The coding analyze was both containing the codes that where pre-set by the design of the interview guide but also new categories that was found in the answers. Basic word program functions were used as tools for analyzing and the amount of data was well manageable in such a way. Before the coding analyze the whole full interviews was word-for-word transcribed into text.

2.5.4 Feedback on the quantitative reflection survey

As a side contribution for this thesis there was a moment of feedback and discussion around how the respondent interpreted the qualitative questionnaire with the purpose of improving the survey for future potential use. From the feedback some of the wordings where altered, as well as some layout matters clarifying how to fill in the second page (demographics). The questionnaire is attached both in its original form as well as with the alterations from the feedback (appendix 5). Even though further and more systematical testing would be needed before the qualitative questionnaire could be properly used (Lohr, 2010), this contribution might be of use for future researchers who wish to conduct similar studies.

2.6 Quality assessments

One very important question to handle when conducting scientific research in flexible design settings, such as qualitative methods that involves a human observer and interpretation, is the different aspects of *validity* (Robson, 2003). This means that the research should be conducted in such a way that the findings and processing of data is accurate as possible. One of the factors that increase the validity of this thesis, in terms of description and interpretation as described in Robson (2003), is that all the interviews was audio-taped followed by a careful transcription into text. During the process, and particularly during and after the interviews, memos were also constantly written in order to directly recap and capture the essence as well as the interpretation of what was said “in between the lines”. This careful documentation entailed for going back and review the interviews, both in recordings, transcripts and memos, whenever needed to create a full understanding or rethinking the analyze.

One way of creating validity in a study is to use multiple sources to enhance the cogency of the research, which is called *triangulation* (Robson, 2003). This can be done by for example using more than one method of data collection, to combine both quantitative and qualitative approaches or to use multiple perspectives or theories. A critique towards this thesis is that it is focused on deep interviews as the only source of empirical data sampling. A great deal of effort have however been taken into interpreting the respondents answers as deeply and accurately as possible, for example by using both the reflection sheet in combination with interview questions as well as constantly recapping how I interpreted the thoughts of the respondent for instant confirmation, which is positive for the validity of the data. The combination of using both the reflection survey and interview questions was for example a good way of finding inconsistencies in the answers and to clarify thoughts. Further, since the aim of this thesis is to capture attitudes of people it would also have been complicated, if not impossible, to for example use any kind of secondary data in this matter to supplement the empirical interview findings.

An important aspect when conducting research is *reliability*, which mean that the study should be designed and explained in such a way which enables someone else to re-construct it (Robson, 2003; Bryman, 2004). This means that the tool or instrument, which in this thesis is the method described in this chapter and the interview guide, should be able to produce consistent results when replicated. This thesis and the instrument created should be seen as reliable since the process is as standardized as possible by the terms of qualitative deep interviews and is carefully explained for in this chapter. Even though all of the conversations and interviews following the method used in this thesis are unique, because of the very nature of semi-structured deep interviews, an interviewer can be sure to cover all the same themes if using the checklist, reflection survey and interview guide. Further, the criterions for the sample used as well as the choice of analyze-method are thoroughly explained which allows for a replication of the study.

Another issue for trustworthiness in qualitative design research is author bias (Robson, 2003). In an attempt to minimize bias and such effects in the research, I have throughout the process actively taken an attentive and critical approach to myself as a researcher. This was also perceived as extra important since I parallel to this thesis have been working in a project within the same area, close to many actors within the solar industry, with the pronounced aim of influencing general attitudes around solar energy. But the other side of this coin is also that such abiding involvement can enhance the researcher´s knowledge about the context and situation of operation in a way that is beneficial (Lohr, 2010). It is argued for that this type of involvement gives a researcher a deep understanding and firsthand insight into the field as well as the different jargons and terms that are frequently used. Even though the sample used in this study is non-experts, and the interview questions is consciously designed as to be targeting such an ungrounded population, my involvement in the matter could have been beneficial since it enhances the understanding of the field.

2.7 Ethical aspects

When conducting research there are several research-ethical aspects to take into consideration (The Swedish Research Council, 2011). A very important part of research-ethics revolves around how the people involved in the study, the respondents, are treated. In research that involves people, such as this study, Kvale (1997) presents three aspects that should be specially regarded; informed consent, confidentiality and consequences. Informed consent mean that the respondents are informed about the aim, design and eventual participation risks surrounding the study before making the voluntary decision to participate. One aspect for the researcher to handle regarding this is how much information the respondents should be given on beforehand since giving to much information can have a tainting effect on the respondent. The respondents in this study have, before their decision to participate, been given a clear but comprising explanation on the purpose of the study and general set-up, and are all taking part on a voluntary basis. Further, the respondents in the study are promised confidentiality and are thus only entitled in the thesis with 1,2,3 and so on. Since the respondents in this study are random private persons not named or likewise keyed it is seen as impossible for a third part to identify them. Because of this, and the fact that this study is not targeting either private or especially sensitive subjects, it is seen as participation could endure no negative consequences for the respondents.

Another important aspect in research ethics is the responsibility towards the society and the research community (The Swedish Research Council, 2011). Fundamental guidelines involves points such as telling the truth, not steal or copy the results of others and openly account for the method used. In this thesis such aspects have been regarded as axiomatic starting points in the whole research conduct. Generating a truthful and accurate research handcraft is seen as the primarily purpose in creating this thesis and such an approach have been seen as a fundamental foundation for the whole process.

3. Theoretical review

This chapter presents a theoretical review and the conceptual framework that are used in this thesis. It starts with a discussion and definition around the concept construct of attitude, followed by a presentation of the rational choice paradigm and of Rogers (2003) *diffusion of innovations*. Even though mainly a specific part of this last mentioned theory is used as the practical conceptual framework for this thesis, namely the characteristics of an innovation (presented in the parts 3.3.4-3.3.8), the theory need to be briefly explained as a whole in order to create a comprehensible context.

3.1 The concept of attitude

One of the most generally accepted definitions of an attitude is the Fisbein and Ajzen (1975) ABC-model of attitudes (Solomon *et al.*, 2006). This model describes that an attitude contains three components: affect, behavior and cognition, which together creates the attitude concept (Fishbein and Ajzen, 1975). The model illustrated the complexity around the concept of attitude since it emphasizes that an attitude is built up by several components, and the interrelationships between knowing, feeling and doing. It means for example that a consumer attitude towards a certain object cannot simply be determined by the individual's belief of its attributes.

The most common order of which to describe attitude formation within the ABC-model is called the standard learning hierarchy and mean that an individual starts with a cognition of something, that leads to an affect, which in its turn creates a intention of a behavior (to either adopt or reject the object) (Salomon *et al.*, 2006). It should be noted that wheatear or not cognition, affect and behavior follows this specific order has been of much debate in the marketing literature (Barry, 2002). There has been alternative hierarchies presented that is assumed to be of more relevance in certain contexts than the standard one, for example in the context of low involvement purchases or when consumers act on basis of emotional reactions (Salomon, 2006). Even Rogers (2003) holds some critique towards the standard learning hierarchy, of which diffusion of innovations is built on, but mean the standard hierarchy it is still the norm that in exceptional cases can alter.

Fishbein and Ajzen (1975) mean, with the ABC model and the standard learning hierarchy, that the knowledge of an object forms the basis if the attitude towards that object. This means that before a consumer can form an attitude towards an innovation they have to be exposed to its existence in order to create some sort of knowing or awareness. This knowledge or awareness is formed by earlier experiences and either consciously or unconsciously received information. The knowing of an object is created where certain specific attributes is connected to the object, as for example the attribute easy to install with PV-panels. Both actively researched information and one that is exposed on an involuntarily passively basis can form the knowledge of an object (Drury and Farhoomand, 1999). What Fishbein and Ajzen (1975) mean with cognition have a lot of similarities to what Rogers (2003) mean is the knowledge phase in the innovation-decision process (described in part 3.3.2).

After gaining knowledge, belief, about an object the individual can start to create a feeling, affect, towards it (Fishbein and Ajzen, 1975). In contrast with the first step that only involves knowledge of an object, the affect refers to the evaluation and feeling towards an object. There is a widespread agreement that the affect, feeling, is seen as the most essential part of the attitude concept (ibid.). Within the literature there are some confusion around the two terms feeling and attitude, where the feeling towards an object can be taken for being the attitude towards it. For example Rogers (2003) is using the terms feeling and attitude somewhat synonymously. What is essential in the ABC-model and standard hierarchy by Fishbein and Ajzen (1975) is that the individual can start forming a feeling towards an object only after gaining initial knowledge about it. Affect, as defined by Fishbein and Azjen (1975), holds a lot of similarities with what Rogers (2003) mean is the persuasion phase in the innovation-decision process (described in part 3.3.2), where an individual´s perception of innovation characteristics are formed. Further, after the individual have gained knowledge and a feeling towards an object, as described by Fishbein and Ajzen (1975), he or she creates an intention to either adopt or reject it. This is referred to as intention for behavior. It should be noted that this is not the same as actual behavior, but rather an intention to do something. This stage holds a lot of similarities with what Rogers (2003) describes as the decision-phase in the innovation-decision process.

3.2 Rational choice

There are several different kinds of approaches and theoretical directions within the field of consumer behavior (Faiers, 2009). One of them is *rational choice* which is an economic paradigm where customers are seen as rational profit maximizers (Koppl and Whitman 2004). Rational choice assumes that the preferred choice is the one of lowest cost in relation to highest gain (Lovett, 2006). The theory of rational choice is central to many customer and adoption behavior, as compiled by Faiers (2009); as for example *the theory of planned behavior* (1986), *theory of reasoned action* (1975) and *diffusion of innovations* (2003). However, there are criticism against the rational choice approach which for example says that there can be non-economic features incorporated in the decision making process (Vatn, 2005; Rios, 2006; Yang and Lester 2008), something that the rational choice would fail to fully attend to. But even so, the rational choice is a well used and accepted theoretical foundation within the field of consumer behavior (Faiers, 2009).

3.3 Diffusion of innovations

The theory on *diffusion of innovations*, developed by Rogers (2003), explains how and why an innovation is spread, diffused, among citizens within a society. The theory was first developed in the 1960´s, when the first edition of the book "*Diffusion of Innovations*" by Rogers was released, initially from researching how innovations in the rural and agricultural areas spread. The theory has since then been widely accepted and applied on different kinds of innovations and innovative ideas in various sectors, ranging all the way from communication technology to health campaigns. One of the many areas that the diffusion theory have been applied to is the adoption domestic solar systems, for example by Kaplan (1999), Labay and Kinnear (1981), Velayudhan (2003), and Faiers and Neame (2006).

The word *diffusion*, which is a central concept for the theory, is defined as "*the process by which an innovation is communicated through certain channels over time among members of a social system*" (Rogers, 2003 p. 35). The theory holds many different aspects of what influences the diffusion of an innovation, ranging all the way through the characteristics of the innovation, the characteristics and demographics of different adopter groups, the role of change agents, as well as the communication channels and networks surrounding the innovation. This thesis focuses on the perceived innovation characteristics and beliefs that individuals have of these, but in order to fully understand how and where that fit in to the bigger picture of the theory some central themes needs to be explained.

3.3.1 Adopter categories

An innovation is not adopted simultaneously by all members of a society, but follows a certain flow of adopter groups (Rogers, 2003). The different groups possess different kinds of characteristics and demographics and they are called *innovators*, *early adopters*, *early majority*, *late majority* and *laggards*. The *innovators*, consisting of 2,5% of the population, are the ones that are first to adopt an innovation and are seen as more risk taking, highly educated and connected to the world than the other categories. After the innovators follows the *early adopters*, consisting of 13,5% of the population, who often have a character of high respect and opinion leadership, and decreases uncertainty by actually trying something out by themselves. The *early majority,* consisting of 34% of the population, adopts an innovation just before the mean member of a system, and don't want to be the first nor the last to adopt something. After the early majority comes the *late majority*, consisting of 34% of the population, who adopts an innovation just after the average, and can have drivers such as economical reasons or increasing peer pressure. The late majority approach innovations with an air of skepticism and cautiousness and needs the innovation to be within the system norm in order to adopt it. They want all or most of an uncertainty connected to the innovation to have been removed before they can adopt it. At last there are the laggards, consisting of 16% of the population, who make decision on the past rather than the now and the future. They are seen as being very traditional and suspicious of newness.

Empirical findings suggest however that the adopter groups are product specific, so that for example an innovator for one product can be a laggard in another (Sultan and Winer, 1993). These findings makes it relevant to conduct research that are product specific, since it seems like general conclusions on the demographics for different adopter groups can be misguiding depending on the product. And even further, it seems like there can be large differences even within the same field where research have shown for example that an individual that take green actions such as sorting the domestic garbage not necessarily engage in other environmental actions such as energy preserving measures (Ottman, 2011).

3.3.2 The innovation-decision process

The innovation-decision process, as presented by Rogers (2003), describes the different stages that an individual goes through from gaining initial knowledge to actual adoption of an innovation. It contains five phases; 1) *knowledge*, 2) *persuasion*, 3) *decision*, 4) *implementation* and 5) *confirmation*, that entails a series of choices and actions by which an individual evaluates and decides on wheatear or not to adopt an innovation. It has since long been recognized that an individual's decision regarding an innovation is not an instantaneous act, but rather a process occurring over time with a series of different actions and phases. An essential aspect of the innovation-decision process, compared to other decision-processes, is that the individual is dealing with a new idea or alternative to prior options.

The innovation decision-process starts at the knowledge phase which commences at the point where an individual is exposed to an innovations existence and obtain a knowledge and understanding of its functions (Rogers, 2003). The knowledge phase is mostly connected to cognition and creating a belief about something. After the knowledge phase follows the persuasion stage were the individual forms an attitude, favorable or unfavorable, towards the innovation and it´s classified characteristics; *relative advantage*, *compatibility*, *complexity*, *trailability* and *observability*. At the persuasion stage the individual also decides what messages to regard as credible. Attitude is in this context defined by Rogers (2003) as "*a relatively enduring organization of an individual´s beliefs about an object that predisposes his or her actions*" (Rogers, 2003, p. 174-175).

The decision stage occurs when an individual decides to either adopt or reject the innovation (Rogers, 2003). The stage takes place when the individual pursues actions that will lead to a decision on either adopting or rejecting the innovation. Even though an individual have a positive attitude towards an innovation it doesn't mean that he or she necessarily will adopt it and discrepancy between indulgent attitudes and adoption has been frequently found (ibid.). Finally, the implementation stage occurs when the new idea or innovation actually is put into practice. As oppose to the previous three steps that where only about mental exercise (knowledge-persuasion-decision) the implementation stage means that action is taken. At last there is the confirmation stage, where the adopter seeks information that confirms and reinforces the decision to adopt.

3.3.3 Innovation attributes and rate of adoption

The rate of adoption is the speed of which an innovation is adopted by individuals in a social system, in other words how fast it is diffused in society (Rogers, 2003). Rogers (2003) mean that the attributes of an innovation, *relative advantage*, *compatibility*, *complexity*, *trailability* and *observability*, as they are perceived by individuals, is an important explanation for the rate of adoption. The more positive perceptions individuals have of these attributes the faster rate of adoption and thus faster diffusion-process will occur. One important aspect is that it is not the innovations actual attributes that is of importance but the subjective perceptions of these attributes as seen by individuals.

The innovation attributes, as perceived by individuals, is said by Rogers (2003) to be the most important determinant for the rate of adoption and to explain 49-87% of the variance. But it should be noted that other variables such as the nature of communication channels, the type of innovation, the nature of the social system and the amount of efforts by change agents also has an affect the rate of adoption.

3.3.4 Relative advantage

Rogers (2003) define the relative advantage as whether or not an innovation is seen to be better than the product, item or idea it replaces. It can for example be expressed in monetary terms or as in conveying social prestige, and includes factors such as economic profitability, initial cost, the impact on comfort, social prestige, time and effort savings, as well as the level of immediacy on reward. Regarding relative advantage the following generalization is made: "*The relative advantage of an innovation, as perceived by members of a social system, is positively related to its rate of adoption*" (Rogers, 2003, p. 233).This means that if an innovation is seen as having a relative advantage towards the competing alternatives this is positive for the adoption (Rogers, 2003). It can also be noted that the aspect and characteristic of relative advantage have been found to be one of the strongest predictors of the innovations future rate of adoption (ibid).

The innovation itself and its nature determines what relative advantages it has (economic, social or other), but the characteristic of the adopter will also determine which relative advantages that will be of importance (Rogers, 2003). Even though relative advantage often is connected to economic aspects, being that the innovation brings cost savings or cost effectiveness, this is not always the main driver. Studies have found that for example social approval can be a more important driver than financial return.

3.3.5 Compatibility

Compatibility describes to what degree an innovation is consistent with past experiences, existing values, and needs of potential adopters (Rogers, 2003). Compatibility makes the innovation fit with an individual's situation, makes it feel familiar and serves as the mental tool and standard from which individuals assess the new innovation. Regarding compatibility Roger (2003) makes the following generalization: "*The compatibility of an innovation, as perceived by members of a social system, is positively related to its rate of adoption*" (Rogers 2003, p. 249). This means that the more compatible the innovation is with societal values, infrastructures and social structures, the more adoption will occur. Innovations can also be compatible with previously introduced ideas and old innovations, which is generally positive for the rate of adoption.

3.3.6 Complexity

Complexity is the degree of which an innovation is perceived as being relatively difficult to use and understand (Rogers, 2003). Regarding complexity Roger (2003) suggests the following generalization: "*The complexity of an innovation, as perceived by members of a social system, is negatively related to its rate of adoption*" (Rogers 2003, p. 257). This means that if an innovation is seen as easy to understand and use this is positive for the rate of adoption. For some innovations complexity can serve as a significant barrier, as for example in high-tech domestic products (Rogers, 2003). One example of this is the early home computers, launched in the 1980´s, which required a lot of engagement from the owner in order to install all the programs and connect the different components.

3.3.7 Observability

Observability is described as the degree of which an innovation is visible to others (Rogers, 2003). Some innovations and ideas are more easily communicated, whereas others can be harder to describe and observe. The observability of an innovation is often connected to the very nature of the innovation, and whether or not the innovation is mostly a software or hardware product, where the hardware product has higher observability. For observability Roger (2003) makes the following generalization: "*The observability of an innovation, as perceived by members of a social system, is positively related to its rate of adoption*" (Rogers 2003, p. 258). This means that if a technology can be seen by others this will be positive for the innovation adoption.

3.3.8 Trailability

Regarding trailability Roger (2003) makes the following generalization: "*The trailability of an innovation, as perceived by the members of a social system, is positively related to its rate of adoption*" (Rogers 2003, p. 258). Trailability is wheatear or not the innovation can be tried out on a trial basis before purchase or definite adoption decision is taken (Rogers, 2003). New ideas and innovations that can be tried out are generally adopted more rapidly. Some innovations can however by its nature not be tried out before the decision of adoption has to be made. The trial and demonstration by peers, "trail by others", can to a certain extent substitute this. This can be connected to that trailability is seen as more important for the relatively early adopters than the later adopters. The early adopters have no precedent available when they adopt, which makes the trailability of more significance than for the followers.

4 Empirical background

This chapter provides a background and context for this study. It presents the current research situation, a practical outlook into the market of solar power as well as discusses alternative angles that could have been used to address this thesis research aim with.

The literature review part starts with presenting how attitudes towards PV-systems, and microgeneration technologies, have been measured and researched previously. The chapter part also presents the actual findings of studies that are of similar nature as this one, that will be later in the analyze put in relation to the findings of this study.

4.1 Literature review

Firstly it should be mentioned that there are different kinds of barriers towards and factors that affect adoption of PV-systems, perceptions of the innovation attributes being one. These different kinds of barriers have been investigated with different approaches, for example using energy policy analysis (e.g., Menz, 2005; Jacobsson and Johnson, 2000), architectural design analysis (e.g., Sozer and Elnimeiri, 2003), PV utility focus (e.g., Willey and Hester, 2001; Solar Electric Power Association; 2002), financial analysis (e.g., Goldman *et al.*, 2005), quantitative customer attitude survey (e.g., Faiers and Neame, 2006), qualitative interview market and customer surveys (e.g., Palm and Tengvard, 2011) and expert focus groups (e.g., Dymond, 2002).

Secondly, it should generally be noted that many studies conducted within the area of consumer attitudes towards domestic PV-systems have included several types of microgeneration technologies, for example including both micro-wind turbines and PV-systems (e.g. Palm and Tengvard, 2009; Sauter and Watson, 2007; Scarpa and Willis, 2010; William and Millis, 1986). This literature review is covering attitudinal research that focuses on the microgeneration aspect if this includes PV-systems besides the other technologies as well as studies focused only on PV-systems.

Some studies have looked at attitudes described as acceptance towards micro-production technologies from a *social acceptance* point of view (e.g. Sauter and Watson, 2007; Wüstenhagen *et al.*, 2007). The term social acceptance holds the two terms social, which can be described as the society and its different groups, and acceptance, which can be both a passive acceptance as in a general value or active acceptance as in active involvement and decision (Sauter and Watson, 2007). Further, there are three dimensions of social acceptance; socio-political, community and market acceptance where the last mentioned is equal to customer’s acceptance. The social acceptance framework used within the field of energy has often been connected to perceived risk within new technologies, and holds for example aspects such as the “Not-In-My-Back-Yard”-syndrome often found towards large wind energy parks (Sauter and Watson, 2007).

Attitudes can also be measured in Willingness-To-Pay (WTP) for different microgeneration technologies. Scarpa and Willis (2010) investigated WTP for microgeneration technologies (including micro wind, PV-systems, solar thermal heating, heat pumps, biomass-boilers and pellets stoves) for households in the UK using a choice experiment. The study measured six attributes, including for example size of the current energy bill, maintenance cost, inconvenience level of the system and capital cost of the technology, in relation to the WTP. The overall findings of the study were that the WTP was not high enough to cover the capital cost of the investments in all the various microgeneration technologies, including PV-systems. The respondents accepted payback time for wind power, solar thermal as well as PV-systems where 3-5 years. A study done by Claudy *et al.* (2011) also measured the WTP for various microgeneration technologies, and did so in relation to factors such as their perception of the innovation characteristics as defined by Rogers (2003); relative advantage, compatibility, trailability, observability and complexity. The study measured the WTP among what can be called knowledgeable non-adopters; people who had heard about the different microgeneration technologies and where somewhat familiar with them. The findings of Claudy *et al.* (2011) support Scarpa and Willis (2010) in their conclusion of that the WTP is lower than the actual prices for the various microgeneration technologies, and regarding PV-systems Claudy *et al.* (2011) found that the average accepted payback period where approximately 9 years. Futher, an additional finding by Claudy *et al.* (2011) was that the aspect of energy independence, classified as a relative advantage characteristic, had a positive impact on the respondent's WTP. In addition, the respondents who thought that investing in microgeneration technologies make them energy independent had also an especially high WTP for PV-panels, which can be interpreted as that they connect PV-systems to the characteristic of energy independence.

As studies on WTP are presented it can be mentioned that a hands on survey regarding WTP for solar energy recently was conducted in Sweden by the company TNS-SIFO (2011), who specializes in conducting market research such as quantitative data on preferences of individuals. The question that was asked was how much the respondent would be WTP per month in order to get electricity from PV´s into their normal energy mix, in other words not owning a PV-system but to buy energy generated by solar. The findings where that 39% said that they where WTP at least SEK 20, and of which 28% answered to be WTP SEK 50 or more (ibid).

Another way to measure people's mental relation to microgeneration technologies is to look at consumer awareness. Claudy *et al.* (2010, 1) did a study on awareness of various microgeneration technologies in Ireland, including micro wind, PV-panels, solar thermal, heat pumps, micro CHP and pellets stoves. A finding was that the level of awareness varied significantly between the different technologies and overall also between the customer segments. PV´s where the technology that had the highest level of awareness, with a number of 80%, which can be put in relation to for example micro wind turbines with an awareness of 58% (Claudy *et al.*, 2010, 1, p. 2157). For PV-panels, with the high levels of awareness, the authors could not find any of the socio-demographic or household characteristics, other than internet access, to have an impact. One finding was also that men generally had a higher level of awareness of the microgeneration technologies than women. Some research around green consumption have shown however that women often are more aware and concerned with environmental issues (e.g. Straughan and Roberts 1999), which according to Claudy *et al.* (2010, 1) could indicate that it could be of interest to reach more women with messages around the existence microgeneration technologies.

One way of researching attitudes is to look at consumer attitudes by a qualitative approach. Palm and Tengvard (2011) did a report followed by an article on microgeneration of energy, mainly PV-panels and micro wind, which included the opinions and attitudes of people who had already adopted or have considered adopting such a technology. The study was conducted by a qualitative method with 20 respondents, of which nine already has purchased the product, eight on their way to or are actively considering buying, and three that had considered but chosen not to buy. Most of the respondents had a relatively high educational level as well as income, and a common trait was also that they had stated that they had an interest in environmental issues. The authors described it as the respondents in their study had a lot of similarities with Rogers (2003) innovators and early majority groups, and the study did not include any attitudinal comparison with unknowledgeable non-adopters. Findings in the study show that all groups of respondents generally viewed the investment in the microgeneration technology not from strictly an economical point of view but also from a moral standpoint. A common trait for the adopters was that the microgeneration investment gave these households a “better conscience” and that is was seen as a good way to present their ecological lifestyle towards neighbors and relatives. A finding was that the decision to adopt, for the ones who had adopted a system, thus seemed to have nothing to do with economic rationality.

One aspect that seemed of importance in the study by Palm and Tengvard (2011), that many respondents stressed the benefits of, was the self-sufficiency aspect. Many said that a benefit from the microgeneration facility was that they became more independent as well as less vulnerable if a temporary power failure would occur. Further, when asking the respondents that had either rejected to buy a microgeneration plant, or at least postponed the decision, argument such as a too high investment cost as well as uncertainty in buying what was perceived as a relatively new untested product. One argument against buying a system was also the fear of that they would need a lot of maintenance. One hindrance that was found was also the lack of routines around the set of regulation by local authorities and grid companies.

Faiers and Neame (2006) did a quantitative study in the UK that measured attitudes towards domestic solar energy systems, where Rogers (2003) five innovation characteristics were used as a framework. The focus of the study by Faiers and Neame (2006) was to compare the attitudes between *early adopters* and *early majority*, as well as map out demographic influences, and did thus not include the other adopter groups as defined by Rogers (2003) nor a sample of a general public. Some of the demographic findings by Faiers and Neame (2006) was that female respondents were less likely to have the attitude of that solar panels negatively affect the visual landscape, people with an age over 50 where more likely to think that the payback period is longer compared to people aged under 50, and people that had a lower household income than £50,000 per year where more likely to think that solar power revenues more value than what the higher earners thought.

One of the findings in the study by Faiers and Neame (2006) was that the only characteristics that the adopter group answered to be negative was the financial aspect of payback time. This implies that their decision for adopting a PV-system is not strictly an economical decision which is in line with the findings of Palm and Tengvard (2011). Further, while the adopter group was positive to almost all of the characteristics, the respondents in the early majority group (non-adopters) was positive to 13 of 23 (Fairs and Neame, 2006, p. 1802). The 13 positive responses were mainly about environmental benefits and the early majority group answered negative towards for example the payback time, the visual attractiveness and the amount of grants available. Besides these positive and negative responses there were also ones that was seen as “do not know”-answers from the early majority, for example in the area of maintenance and installation. As a conclusion Faiers and Neame (2006) mean that the results in the study indicate that the early majority group doesn’t have a sufficiently positive view on PV-systems attributes in order to adopt it. They also argue for that the single most limiting factor overall is the economical aspect of payback time. A note that the authors make regarding this is that besides lowering the investment cost with things such as grants, the respondents also want to see improved productivity of the system and a decrease in retail price as the technology improves.

Another study that looked at consumer perceptions, and that support the cost-related findings of Palm and Tengvard (2011) and Faiers and Neame (2006), was conducted by Zhai and Williams (2012). The purpose was to measure differences in perceptions among non-adopters and adopters, and to use these findings to develop a fuzzy logic inference model that relates perception variables to purchasing probability. In the first part of the survey a question were asked that measured the respondents own perception of what would affect a decision to buy solar panels. From these answers three perception variables could be distinguished; perceived cost, perceived maintenance and environmental concern. The survey showed that adopters see the environmental benefit as most important for their decision making, and for the non-adopters the most important factor was the cost. The fuzzy model that was later developed from the findings can be used to measure purchasing probability, with the three variables that was distinguished from the first part of the survey.

Labay and Kinear (1981) did a well cited study on attitudes towards domestic solar energy systems using Rogers (2003) innovation attributes framework. The study by Labay and Kinear (1981) measured differences between three adopter groups, clustered as adopters (people who had already adopted solar energy systems), knowledgeable non-adopters (for example unsuccessful applicants for tax grants within solar hot water and non adopting members of solar energy associations) and unknowledgeable non-adopters (people in the remaining population who were not a part of the previous two groups) in their view on the five innovation attributes in domestic PV-systems. One of the hypotheses tested was if the perceptions of the innovation attributes were a more effective predictor for adoption than the demographic factors. The findings showed some support for this on an overall basis, where perceptions of attributes could be a more successful factor than demographics in classifying people into adopters or non-adopters. This would mean that studies that also measure people's opinions and perceptions around innovation attributes has significance, for both marketers, researchers or anyone interested in predicting future adoption, rather than simply looking at demographic or classical adopter-categories traits. It should however be noted it could be so that the ones has already adopted had a more positive view on the attributes since they were more familiar with them. Further findings was that demographics of the two groups adopters and knowledgeable non-adopters was very similar, but differed significantly from the unknowledgeable non-adopters, as the two first mentioned where younger, had higher education, income level and occupational status.

4.2 PV-systems

PV-systems and PV-panels convert solar radiation into electricity (internet, Energimyndigheten 1, 2009). There are primarily four types of PV-systems; they can either be domestic or for commercial use, and either connected to the electricity grid or used off-grid. An off grid domestic system could for example installed used in a summer cottage where there are no electricity grid connection, as oppose to a larger grid-connected system that would be used as an electricity production facility for commercial use. A domestic grid-connected system, as is the focus of this thesis, is a plant that is installed into a private household property and is connected with the electricity grid. The electricity that is produced by the PV-system is directly connected to the house and is directly consumed as household-electricity. When the PV-system doesn't produce enough energy to cover the usage of the house it automatically utilizes electricity from the ordinary grid to fill up the gap. When the PV-system produces more than the usage of the house the electricity surplus is automatically instead fed into the grid. There are different rules and regulations around micro production in different countries (see more under 4.2.2 International outlook), but generally, and as in Sweden, the surplus can be sold to an electric trade company (IEA, 2010). The typical domestic PV-system is installed on the roof of a house, and optimal conditions for placement is a shadow free area that is located towards somewhere between south east and south west (internet, Energimyndigheten 1, 2009). Further, grid connected PV-systems stop producing electricity if there is a general power blackout on the grid. This is by safety reasons so that no surplus energy can be sent out into the grid in case of man-made reparations are going on.

Prices on PV-panels have decreased with around 50%, as for 2012, in the last three years (internet, BSW 1, 2012). The prices on PV-panels follow an international market and the price fall is due to both cheaper production as well as a production overcapacity (IEA, 2010). There are many factors that influence the economic outturn, such as interest rate, estimated and actual lifespan, electricity price in the region, rules and regulations, initial investment cost, eventual subsidies and surplus selling price (internet, Energimyndigheten 1, 2009). But generally, as in Sweden, a guideline for PV-systems is a payback time of 7-8 years including the governmental subsidy of 45% of the investment cost, and around 15 years without (personal com., Hedström, 2012). The retail price, including all materials, contracting and installation, is in between SEK 19 000-25 000 per installed kW (incl. sales tax) (ibid). PV-systems are economically characterized with a big initial investment but then being rather maintenance and cost-free (internet, Energimyndigheten 1, 2009). Systems for domestic use can either be bought or installed by a full contractor, taking care of the whole process, or by partly doing installation work by oneself (ibid.).

Above: Examples of how domestic PV-systems can look like from the outside of a house.

The technology in the PV-panel products on the today market is seen as mature and extensive research and development activities have been going on for decades (IEA, 2010). There has been a usage of PV-panels since the 50´s, where it was first used to supply electricity for satellites, and has since then evolved and gradually become cheaper and more effective (internet, Energimyndigheten 1, 2009). But even though the PV-products on today’s market are highly evolved there is still a lot of research going on around various ways of improving the use (IEA, 2010). There are continuous research going on in for example building integration, new visual designs, increasing the energy output percentage, alternative materials and new application areas.

4.2.1 Current situation for PV-systems in Sweden

The market for solar power in Sweden can be described as immature and the use of the technology has not yet reached a wider spreading (Palm and Tengvard, 2009). Compared to for example Germany, which has similar solar conditions, Sweden has a very low amount of installed solar power capacity (Widen, 2009). In numbers, as for 2010, Sweden have 11,4 installed MW solar power while Germany have 17370 (IEA, 2010, p. 4). But even so, the Swedish market for solar power has grown in the past years due to successful governmental direct subsidy schemes, directed towards grid-connected solar power systems, which covered in between 45-60% of the total investment cost (ibid.). The first subsidy was introduced in 2005 and was targeted at public buildings, followed by the second subsidy that was started in 2009 and targeted to all types of installation including domestic use. A consequence of the second subsidy scheme was an increase in not only the total amount of installed PV-power, but also the amount of installed private domestic solar systems. The interest in the second subsidy scheme, both by companies as well as private persons, was so high that in many districts there were more applications than the amount of money allocated (internet, SVT 1, 2012).

When it comes to politics and policymaking the Swedish government, as for 2012, has clearly stated that they have a positive standing towards microgeneration technologies and to support such production of electricity (internet, Regeringen 1, 2010; internet, Expressen 1, 2012). The government is, as for 2012, investigating the possibilities around imposing a new law that would allow for micro producers, for example owners of domestic solar systems, to net debit their production towards their consumption (internet, Regeringen 2, 2012). Such a law would mean that the electricity produced by the solar panels increases in value, which makes an investment in a domestic solar system even more economically beneficial (Söder, 2008), and has already been in place in for example Denmark since 1998 (internet, NyTeknik 1, 2011). The topic of net debit has been of heavy debate for several years with a unified industry standing heavily at its favor (internet, NyTeknik 1, 2011; internet, Svensk Energi 1, 2012).

4.2.2 International outlook

The usage of PV-systems, both in terms of off- and on-grid domestic systems, systems installed by small scale businesses as well as commercial larger production facilities, is increasing worldwide (IEA, 2010). The international outlook is characterized by a general high percentage growth (ibid.). In between 2009-2010 the estimated cumulative installed PV-capacity, counted within the IEA PVPS countries,[2] increased with 68%, from 20 758 MW to 34 953 MW (ibid., p. 5). The country that by far has the largest installed PV-power, both in terms of per capita and in actual numbers, is Germany with a total of 17370 MW installed capacity (ibid.). In Germany, as for 2011, 2% of the total energy use is covered by PV (internet, BSW 2, 2012, p. 1). Other countries that has a large amount of installed PV-power is Spain (3915 MW), Japan (3618 MW), Italy (3502 MW), USA (2534) and France (1054) (IEA, 2010, p. 4). There are different rules, regulations and subsidy systems around PV-systems and MT´s in different countries, which is affecting the market and interest in varied ways (ibid.). Germany have had support systems for MT´s since 1991, and the current system consists of a feed-in tariff that gives all micro producers of renewable energy a pre-set guaranteed price for the electricity that they deliver into the grid for 20 years forward (ibid.). Some countries instead have net debiting scheme, such as for example Denmark (internet,

[2] IEA PVPS is the global organ for PV-systems, and their calculations from their member nations are the most accurate global estimation of PV-power there is as for today. Note that this is not a number that is claiming to be a world total, since only the member nations capacity can be measured. To see what member nations IEA PVPS have please visit www.iea-pvps.org.

IEA 2, 2012). It can be mentioned that during 2011 the PV-installations in Denmark suddenly rose significantly, due to the net debit rule in combination with falling prices on PV-systems and an increase in electricity price (ibid.). The financial payback time for PV-systems in Denmark is, as for 2011, 6-9 years (ibid.).

5 The empirical study

This chapter presents the findings in the empirical study. The chapter starts with a table presentation of the respondents. The empirical findings is then divided into main themes of which came from both the pre-set interview material as well as themes that arose during the actual interviews.

5.1 Presentation of the respondents

In the table below the respondents and their demographic factors are presented.

Table 2) The respondents and their demographic information.

Respondent no.	Male/ female	Age category (years)	Houshold size (no. of persons)	Education and occupation	Income level (SEK)	Environmental aspects in consumption
1	Male	51-65	1-2	Civil engineer, works as a consultant in microelectronics.	+ 1 000 000	Not usually
2	Female	36-50	3-5	University degree midwife, works as a midwife at a delivery ward.	500 000- 1 000 000	Not usually
3	Female	36-50	3-5	Education within childcare, works with network marketing online trading.	250 000 – 500 000	Tries to be environmentally aware in buying decisions.
4	Female	36-50	3-5	Economic program at upper high school, works with contracts at a cable operator firm.	500 000 – 1 000 000	Tries to be environmentally aware in buying decisions.
5	Male	36-50	3-5	Two year university degree in production technology, works with projecting service repair shops.	500 000 – 1 000 000	Not usually

5.2 Empirical findings

This part presents the findings of the empirical deep interview. The findings are presented sorted into the categories 5.2.1 Economy and energy production, 5.2.2 Property value, 5.2.3 Environmental aspects, 5.2.4 Self sustainability, 5.2.5 Visual aspects, 5.2.6 Visual statements, 5.2.7 Installation, 5.2.8 Usage and technology, 5.2.9 Rules and regulations, and 5.2.10 Motives for adopters and future diffusion. In the description of the empirical findings the term "many" is used when the viewpoint is shared by 4 of the respondents, the term "some" is used when it is shared by 2-3 of the respondents, and the term "all" is used when it is shared by all of the respondents.

5.2.1 Economy and energy production

The general view by all respondents is that PV-systems do not pay off economically and that they are expensive to install. Some of the respondents (1, 2, 4) has the image of that PV-panels probably don't produce enough energy under the Swedish weather conditions, which is seen as a major problem towards PV-systems. The weather aspect is by these respondents linked to seeing PV-systems as an insecure energy source. One respondent (3) thinks that the Swedish solar conditions might not be the most beneficial ones, but that you could still produce energy from PV-systems on a sufficient level. One of the respondents (5) links the production more towards the solar conditions on the actual rooftops, and think that PV-panels in Sweden is economically beneficial already today, but that for example his own roof do not have the right conditions. Respondent number 5 is the only one who explicitly expresses that he has heard that the prices have gone down in a way where PV-systems can be economically beneficial already today in Sweden. Another respondent (1) highlights that he think that there are very different solar conditions in different geographical places in Sweden, and think that PV-systems is much more appropriate to use in southern Sweden than in the north. Even though the economical aspect is primarily seen as a disadvantage, all of the respondents mentions that PV-systems might be or probably is economically propitious in the long run, which is also then seen to be one of the possible benefits.

One reoccurring answer when speaking of the economical aspects is that PV-systems needs to be able to be competitive to other energy and heating sources (2, 3, 5). Something that is mentioned in this discussion is that PV-systems are seen as a much more insecure investment than for example other more well-tried technologies such as air heat pump. Further, all of the respondent standpoints are that the only thing that could make them get PV-systems is a really good and competitive economic calculation.

The view on how long time the PV-system produces energy as well as the economical payback time differs between the respondents. Generally for all respondents it can be said that they underestimate the lifespan, as well as see it as an uncertain attribute, and that some of them underestimate (2,5) and some overestimate the payback time (1,4). The life span, which is underestimated and seen as uncertain, is seen as a major disadvantage by some of the respondents (1, 3).

After getting information (same for everyone) about that PV-panels have an effect warranty of at least 80% for 25 years, the respondents answer to the question of what would be a payback time that would make themselves interested in investing with this presumption. The answers given are 10 years (1), 5-10 years (2), 8-10 years (4), and 5 years (5).

Three of the respondents think that there are not that extensive financial support systems available (2,3,5) and one person think that there is (1). In the discussions the respondents say that they have little knowledge about what governmental financial support systems there are, apart from one person (4) who says to have read about that there are some funding to apply for.

Some respondents says that a downside to PV-systems is that you probably would have to complement with electricity from the normal grid (2,4,5). As an example, one respondent says that it feels unnecessary to install PV-panels if they do not provide that much energy which meant that you have to buy the majority from your normal electric company anyhow (4). The same person says that an adequate level of production, which would make it feel like the PV-panels produced enough energy to make the effort worth, would be to be self sufficient on solar energy around 6 months of the year.

PV-panels are by all of the respondents seen as having seasonal production, which is also generally seen as a disadvantage. It seems like there is a general confusion, and the respondents themselves says that they are very unsure, about what happens when the PV-panels produce a surplus (1,3,4,5), for example if you store it in a battery, and if so what the energy losses would be, or if you can put the surplus back into the grid. Many of the respondents seems to be leaning towards thinking that you save the electricity as in a battery (1,3,5). By one respondent (4) the aspect of seasonal production is seen as a disadvantage at first glance, but when thinking about that you could probably sell the surplus this view changes. This respondent also says that if you could sell the surplus and get paid for it this would mean a big value, and that it would mean that the green electricity from the PV-panels not only benefitted ones house but that the electricity also could be used by the neighbors. It seems like there is a wish to feel like you are saving the electricity produced in the summer for later use (1,3,4,5) and the link to that selling the surplus means the same thing is not totally clear as just one person mentions it so.

5.2.2 Property value

Some of the respondents thinks that the PV-systems could help increase the value of a house (1,2,4) and two see it as more indifferent (3,5). One of these respondents (2) reasons around that if the person who wants to buy the house has green values it can be a clear benefit, but that it could also be of no importance if the future speculators have no such values. Respondent 3, who are very uncertain on whether or not they add value, also says that it’s dependent on the environmental concerns of the potential buyer. Two of the respondents (1,4) are more focused on the economical sales argument and respondent 4 for example says that if you can prove that the PV-panels help lowering the total energy cost of the house it can be beneficial, since costs are always interesting. But the same respondent also states that some people might think that the PV-panels are ugly, so that it might not be totally positive. Respondent 5 sees PV-systems as an additional plus for a house but does not think it matters so much.

5.2.3 Environmental aspects

The environmental aspect is mentioned to be the primary benefit of PV-panels by most of the respondents (1,2,3,4) and by one respondent (5) as a possible benefit but not primary. Most of the respondents who think that the environment is the primary benefit (2,3,4) trusts the technology to be more or less truly environmentally beneficial but also states that they do not know for sure. Further, there are some skepticism among some respondents (1,5) about how environmentally friendly they really are considering things such as the production and materials. One respondent (1) think that the dismantlement of the PV-panels after the lifetime use probably is an environmental issue. Also respondent 4, even though positive towards the environmental aspects, mentions that if you had to replace the panels often it would maybe lead to a lot of waste material that had to be taken care of. Regarding the life cycle skepticism, respondent 5 states:

> *“I’m drawing parallels here to the popular environmental car Toyota Prius. Rumors say when looked upon from a total environmental life cycle point of view, including production, it is more polluting than a normal car.”* (Freely translated from Swedish)

One respondent (3) is, when speaking of environmental aspects, into a reasoning on whether or not the PV-panels needs some sort of electronically run device in order to produce the energy. The respondent believes that so is not the case, but that if so it would be a potential hidden environmental downside.

Another both economical and environmental benefit that is mentioned by one of the respondents (5) around PV-systems is that he thinks that his total consumption would decrease if the installed solar panels. The respondent makes a parallel to that he recently have gotten an environmental diesel car and that he now sees it as a sport to use as little gas as possible when driving. He thinks that the same thing would happen with PV-panels and that he would waste less, where as he today is not that careful of turning off the TV and other devices.

5.2.4 Self sustainability
One aspect that is connected to PV-systems by some of the respondents (4,5) is the aspect of self sustainability, both in terms of increasing ones resilience in case of a power blackout (4, 5) and as a way of knowing that one is using truly green electricity (4). The self sustaining aspect is seen as a major benefit overall for PV-systems by these two respondents. Three of the respondents (1, 2, 3) does not by themselves directly connect PV-systems to such a value, and even when presented with the term self production two of them (1,2) does not connect it to any benefits or being of any kind of positive value. But respondent 3 thinks that it would be a benefit, even though she is not reflecting about the self sustaining aspect before confronted with it, as a way of being un-dependent of the electric companies pricing.

5.2.5 Visual aspects
There are different opinions regarding if the PV-panels affects the visual landscape. Some mean that they would affect it in a somewhat negative way (1,3,4), one person thinks that they were not at all visually intrusive (2), and one person think that they would negatively affected the landscape in certain contexts as for example in rural summerhouse areas (5). The ones (1,3,4) who thinks that PV-systems could affect the visual landscape in a negative way says that they believe that the PV-panels would take up most of the roof and be very visible. One of the respondents (3) also thinks that PV-systems are placed several meters up from the rooftop as a large building extension and that this would be visually disturbing. The same person says that a wish would be to have the PV-panels looking as much as the normal roof as possible, maybe the same color, so that it blends in with the house as much as possible. One of the respondents (1) thinks that you might place the PV-panels on a separate station in the garden, and that this would be really visually disturbing, but if you place it discreetly on the house it is visually ok.

It is also said though (4), that the visual aspect is not a deal breaker, and that if the economical benefits is high enough the negative visual factor could be accepted. It is also interpreted between the line as this viewpoint is shared by the three others who were negative against the visual aspect (1,3,5), if even still being a negative attribute. Further, at the same time as many of the respondents has visual objections against PV-systems the aspect of visually disturbing neighbors or likewise is clearly stated to be not a concern for any of the respondents.

5.2.6 Visual statements
One respondent (2) states that PV-panels provides a visual statement of beliefs, as towards neighbors and friends, other respondents says that this aspect is not so important (3,4,5), and one of the respondents says that he could not care less about the visual aspect in terms of transmitting green values (5). For respondent 2, even though providing a visual statement, this is not said to be any major driver towards adopting a PV-system. Further, respondent 2 also connects this to the attractiveness of a house, in terms of possible future sales, where a PV-system would indicate that there had been modern and environmentally minded people living there.

Generally, the aspect of how much the PV-system visualizes values, and if so how much this aspect contributes in terms of added value for the owner, seems hard to answer by a direct question. Further, two of the respondents (3,4) also mentions that people generally don't like to stand out from the crowd, indicating that the visual statement aspect also could be viewed as negative in that sense.

5.2.7 Installation

All of the respondents have the view of that when you get a PV-system you hire someone, a firm, to do the whole actual job for you and that this is quite easy to arrange. All of the respondents believe that you do not need to have any special kind of technical competence to get a PV-system. One respondent (2) expresses it as you probably would get all the user info you need when the installation is made.

Two respondents, even though agreeing with the above mentioned, thinks that it might be complicated and problematic to install since you might have to rebuild a lot (1, 4). The thought by respondent 4 is that the technology and infrastructure in the house might not be directly compatible with the PV-system and that you might not be able to just plug it in. The view of respondent 1 is more connected to the actual placing of the panels, as where he thinks that a major part of the roof needed to be raveled.

5.2.8 Usage and technology

All of the respondents think that PV-systems are a very user friendly technology that is easy to use for one self. All of the respondents see PV-systems as being maintenance free, as when you have installed the panels they don't require a large amount of care or reparations. But all of the respondents also think that you might need to wipe them off sometimes. This is seen though as being just on a normal maintenance level as when you own a house, and the maintenance levels seem to be nothing that would scare any of the respondents off from installing solar panels but rather the contrary.

The usage of the PV-systems is also seen as being rather cost free in terms of maintenance by all of the respondents, as there is seen as to be no or little running costs after you had made the initial investment. Some of the respondents (1, 4), though mentions that you might have to replace some parts, like one of the PV-panels, and that this could be a cost. But generally the running costs is seen as low which is looked upon as a benefit. Further, it is by most of the respondents seen as a user safe technology (1,3,4,5) that does not mean any safety risk to have installed upon the rooftop. One of the respondents has some doubts about the safety and says that it feels a bit unsafe because she does not know that much about it (2).

Some of the respondents has fears about that that the PV-products on the market might not be as well developed as they could be in a near future (1,4) and some believes it is a quite well developed technology but that the message might not have reached the broader public (2,3). One respondent (3) who thinks that it is a quite well developed technology says that since PV-systems are in use and have started to retail in Sweden she trusts that the technology are working here. The view of the skeptics is that there is a lot of research going on, and that there could be a big improvement in both the performance and quality (1,4).

> *"You don't wanna put up a bunch of stuff now if you in 5 years could get something that is 10 times better."* (4) (Freely translated from Swedish)

These respondents (1,4) is also doubtful about if the lifespan is as much as guaranteed (25 years). Another respondent (5) has a similar reasoning and thinks that the utilization factor probably will decrease with time.

The two respondents (2,3) who thinks that the technology is well developed also at the same time says that PV-systems might be immature and untested from a private use point of view since not so many people have it. This reasoning is by one respondent (2) put in relation to air heat pumps that has become very popular for private use and thus, in combination with that they don't have any unsure parameters such as solar conditions, is seen as a much more secure investment.

Even though there is doubt about the quality the actual materials and panels is seen as being a robust and resilient material by most respondents (2,3,4,5), and even so by one of the respondents that where skeptical to the technology development as mentioned earlier (4). Further, one of the respondents (5) raises the issue of whether or not the rest of the material and devices used in the PV-system, assuming there are such parts, has a sufficiently long life span and quality.

5.2.9 Rules and regulation

Some of the respondents says that they had not thought so much about the aspect of rules and regulations (2,3,4), but that it is not seen as being any particular hinder (2,3,4,5). One of the respondents (5) thinks that you would need a normal building permit, but that this is not an issue. One of the respondents (1) does not think that there are any proper rules around production of energy with PV-systems, and thinks that this is a downside and a possible hinder.

5.2.10 Motivation for adopters and future diffusion

When the respondents get the question of what they think motivates people who install PV-systems the answers is generally either a strict environmental aspect (1,3,4,5) or a combination of environment and long term economic benefits (2,4). One of the respondents (1) also mentions that he thinks that besides the environmentally friendly adopters there is a group of especially technically interested people among adopters of PV-systems. All of the respondents think that PV-systems are modern and compatible with modern living.

On the question of what would be needed in order for themselves to become seriously interested in installing a PV-system all of the respondents talks about the economical aspect firstly in that it needs to be economically beneficial. One respondent (2) explicitly says that recommendations from people, friends or acquaintance, would play an essential part, and especially if they lived in the same area so that one would know that the PV-system worked with the current solar conditions. This is connected to the aspect of lack of knowledge that all respondents mention as a downside as well as eventual hidden effects, as one respondent states it:

> *"I <u>think</u> that PV-systems are pretty maintenance free, but I don't know they are, I think that PV-systems are environmentally friendly, but I don't <u>know</u> they are."* (5) (Freely translated from Swedish)

All of the respondents think that PV-systems will spread a lot more in the future, which is first of all connected to that they think that the prices on the systems will go down even more. The environmental aspect as a motivator is also a part of the discussion of a future spreading but is not seen as the general main driver for individuals. One aspect that is discussed by some respondents is that there needs to be more discussions in the media on for example PV-systems in order to increase the awareness (3,4). Some respondents (2,3) discusses the fact that when more people get something others tend to follow and that the same thing can happen to PV-systems if they become economically beneficial.

6 Analysis and discussion

This chapter addresses the research questions in this thesis. The chapter starts with an overview chart of the similarities and differences in relation to findings of other studies, followed by analyze and discussion divided into thematic areas. The research questions are, as stated in chapter 1:

- What perceptions does non-adopter house residential in the Stockholm region have of the attributes of domestic PV-systems?
- What are the perceived advantages or disadvantages?
- What are the perceived barriers towards a possible future adoption?
- What could motivate a future adoption of a domestic PV-system?

The respondents in this study fits into the knowledge stage of the innovation-decision process, as well as the belief-stage of the ABC-model of attitudes, since they don't have so much previous contact or connections to PV-panels. What is presented and analyzed is thus not a full attitude as earlier defined by Rogers, since this would mean a relatively enduring organization of beliefs, but rather a cognitive stage and a snapshot of the beliefs as the respondents perceives it in this exact moment.

Table 3) Similarities and differences in findings compared to other studies.

Study:	**Similarity to my study:**	**Difference to my study:**
Palm & Tengvard (2011)	Economical aspect most important for non-adopters. Skeptical view among non-adopters of how well developed the technology. Non-adopters show economic rationality. Adopters of microgeneration technologies are primarily guided by environmental reasons, and not by economical. High value on the self-sustainable aspect. Belief of that PV-systems make one less vulnerable to power black outs.	Negative view among non-adopters of technical hindrance, rules and regulations, while this study found positive views. Installing a PV-system is a good way of demonstrating green values, while this study did not found this to be of such importance.
Zhai & Williams (2012)	Economical aspect most important for non-adopters. Adopters of microgeneration technologies are primarily guided by environmental reasons, and not by economical.	
Claudy *et. al* (2012)	WTP payback times (9 years). High value on the self-sustainable aspect.	Lower WTP payback time than the actual cost for PV-systems.
Scarpa & Willis (2010)		WTP payback times was lower (3-5 years) than in this study. Lower WTP payback time than the actual cost for PV-systems
Faiers & Neame (2006)		Clearly positive view among non-adopters on the environmental aspects of PV-systems, while this study found some skepticism.
Widén (2009)	Misconception of solar radiation levels being too low for production of solar energy in Sweden.	

6.1 Economy and energy production

The economical aspect of PV-systems is connected to the innovation characteristic of relative advantage in a way where it gets compared to other competing energy and heating sources. The perception by all of the respondents in this study is that PV-systems has the attribute of being quite expensive as compared to other sources and is not an investment that would pay off in a reasonable timeframe, which is also said to be the main reason for not adopting. This would mean that the view of a PV-systems relative advantage, in terms of financial aspects, is negative. It should be noted what makes this view of the economical relative advantage negative is not solely that the respondents see it as an expensive technology, but also that they view this trait as being of significant importance. In other words, and according to the theory of the innovation characteristics, it is not the actual price of PV-systems that creates the negative relative advantage, but rather the view as well as the preferences of the respondents. For another group, for example innovators as described by Rogers (2003), these economical preferences could look totally different and thus the effect of the relative advantage attribute.

The finding in this study in that the financial aspect of buying a PV-system is the most important one, and would be the main determinant in a possible future adoption, is in line with previous research of non-adopters. For example both Palm and Tengvard (2011) as well as Zhai and Williams (2012) found that the ones who had not adopted a system gave financial reasons for not doing so. But one interesting thing that can be mentioned is that some of the respondents in this study actually are mentioning WTP payback-times that are well in line with what a PV-system, if including the governmental subsidy, would have. These respondents stated WTP payback times that are in line with the findings in Claudy *et al.* (2011) that found that the WTP payback time for PV-systems where 9 years. Further, both Claudy *et al.* (2011) and Scarpa and Willis (2010) said that their findings where that the WTP was lower than the actual cost for the various MT´s, but since the prices on PV-systems have gone down very rapidly the last years this parameter change very fast. One finding in this study is also that all of the respondents stated that they think that PV-systems might be economically beneficial in the long run, which indicates a not solely negative view on the financial aspects already as today. But even so, the view is that the all of the respondents generally see the economic aspect as something negative and as a major barrier for the adoption of a PV-system. The findings around the WTP payback times can however indicate that the economic barrier, however perceived as large by the respondents, might not be that huge in real numbers after all.

One view that many of the respondents shares is that the Swedish solar conditions are not beneficial for the usage of PV-systems and that these to low solar radiation levels is an issue. This aspect is connected to the compatibility with infrastructure as well as relative advantage in terms of a safe supply of energy. The PV-systems is not seen as fitting in with the current weather conditions which has a negative effect on the compatibility characteristic. The solar conditions also contributes to a production-wise insecure as well as seasonal view of PV-systems, which becomes a relative advantage downsides compared to buying the electricity from the normal grid. The solar conditions is also connected to the economical aspect by many of the respondents, were these two factors are interconnected as the economic side is seen as negative since the solar conditions is seen as insufficient and unreliable. The view of the respondents regarding the insufficient solar conditions is in line with previous research such as Widén (2009), where this is found to be a common misconception in Sweden.

Another aspect that is related to compatibility with infrastructure is what happens to the surplus electricity that is produced by the PV-system, and many of the respondents state that they are unsure of this aspect. It seems like there is a firm wish by most of the respondents to feel like they can use their surplus energy in a way similar to storing it to the winter. The fact that the respondents are unsure about if you could use the surplus energy in a good way would contribute to a negative, or at least a hesitant, view of the innovation characteristic of compatibility.

Most of the respondents are clearly skeptical towards if the PV-products on today's market are fully developed, either in terms of technology or in terms of private usage. This is in line with the findings of Palm and Tengvard (2011) where non-adopters gave such reasons for not buying a system. This aspect of newness is contributing to a negative view of the innovation characteristic of relative advantage in terms of economical aspects of an undeveloped technology, as well as compatibility in terms of a lack of knowledge of previous private usage. But it should also be noted that most of the respondents in this study at the same time thinks that the materials used in the PV-system are resilient and robust, which is a positive parallel parameter.

The respondents in this study shows what can be described as economic rationality, which fits under the paradigm of rational choice, while the adopters in the study by Palm and Tengvard (2011) seemed to not guide their choice in such a way but rather include other factors such as green values. This is also in line with what others studies have found namely that the adopters of microgeneration technologies are not primarily guided by economical reasons (Zhai and Williams, 2012). Since this study is a small qualitative study the findings can not in any way be generalized, but this thought anyhow emphasizes the fundamental difference between what motivates adopters and what would motivate what can be describes as the more general public.

6.2 Environmental aspects

Most of the respondents perceive the primary benefit of PV-panels to be environmental and three of the respondents in this study seem to view the PV-systems as being truly environmentally beneficial. There are some doubts raised however by two of the respondents, about how environmentally friendly the technology actually is if seen in a life cycle approach.

The environmental aspect is both connected to the attributes of compatibility in terms of value conformation as well as relative advantage. In terms of environmentally friendliness as an actual relative advantage of PV-systems there is a divided view of whether or not they are seen as truly environmental. There is however no doubts about that the environmental aspect is of huge importance as a relative advantage as it is seen as the (possible) primary benefit of PV-systems. This would mean that the environmental aspect of PV-systems is highly valued as a relative advantage, but that the view of the actual environmental relative advantage differs between the respondents.

Even though some, three, of the respondents states that they don't particularly consider the environment when usually buying something, all of the respondents perceived the environmental friendliness attribute of PV-systems as something fundamentally positive. This means that even the respondents that don't normally consider environment when they buy something actually do value green aspects and that PV-systems are compatible with these values. This is connected to the aspect of compatibility with values, in this case green values, and means that this aspect is seen as positive. PV-systems can for example be seen as being compatible with the societal idea of green energy and environmental measures. The finding in that even the ones who normally don't consider the environment when buying something does value the green aspects that PV-systems bring could be an example of the value-action gap that is presented by for example Withmarsh (2009).

The skeptic view of the environmental friendliness by some of the respondents in this study is not completely in line with the findings of for example Faiers and Neame (2006), who found the non-adopters to have a clearly positive view on the environmental aspects. But since these two studies are different in style and also respondent-wise such disparities cannot be simply compared. Further, the environmental aspect are seen by most of the respondents in this study as the main driver for those who had installed a PV-system, which is in line with the actual findings by both Palm and Tengvard (2011) as well as Zhai and Williams (2012) of what motivates adopters.

6.3 Self sustainability

Some of the respondents in this survey raised the discussion, and put a high value, on a self-sufficiency aspect of PV-systems. This trait is connected to a relative advantage, where PV-systems are seen as bringing the facet of self sustainability as oppose to buying the electricity from the normal grid. The view of that self sufficiency is important, or even a connected facet of PV-systems, is however not a common trait for all of the respondents in this study. But for the ones who did connect such an attribute and did raise the discussion it seems as being of major importance as a relative advantage. Further, the self sufficiency aspect can also be connected to the compatibility aspect where it is compatible with the need of, or at least the need of feeling, self sufficient.

The view of putting a high value on the self sufficiency aspect that some respondents raises in this study is in line with the findings in Palm & Tengvard (2011) where such an aspect was seen important. One belief that the respondents in this study shared with the views in Palm and Tengvard (2011) on the topic was that they thought that having a PV-system make you less vulnerable to power blackouts. This is however not accurate in real terms, at least in terms of grid-connected PV-systems, since they stop producing electricity of there is a grid power blackout. PV-systems can still mean that one can be self-sufficient in terms of accumulative production, but grid-connected systems do not retrieve from power blackouts. The aspect of self-sufficiency is as discussed earlier connected to both relative advantage as well as value compatibility, where it in this study, at least by some of the respondents, seems to be perceived as even more positive than what it actually is. Further, in line with the positive findings around the self sufficiency aspect Claudy *et al.* (2011) also found that the attribute of self sufficiency seemed to have a high value as it generated a higher WTP. It should however again be noted that not all of the respondents in this study cares so much of this attribute, but for the ones who do so it seems like it is of major importance.

6.4 Usage and installation

All of the respondents seems to have the view of that PV-systems are user friendly, have a low maintenance levels, and don't require any kind of special technical competence. This indicates a positive view of the innovation characteristic of complexity which is according to the theory positive for the adoption. There seems to be no such perceived complexity barriers as for example existed around the domestic computer exemplified by Rogers (2003). Further, if PV-systems are seen as user friendly as towards other competing microgeneration facilities and heating options, depending on how high this trait is valued by the individual, it also enhances the characteristic of relative advantage.

Regarding the maintenance level, that is seen as low by all of the respondents, a frequent concrete example stated by the respondents is the view of that you might have to wipe them off every once in a while. But PV-systems in real terms actually requires even less maintenance than this, you don't even need to wipe them off, and they are classified as being totally maintenance free. This means that even though complexity is seen as a positive innovation attribute by the respondents, the actual attribute is even better.

Most of the respondents view PV-systems as being a very user safe technology and most of them also seems to have a positive view, or at least a view of that there would be no hindrance, on the rules and regulations surrounding a PV-system. These positive views of rules and regulations are however not in line with the empirical findings in Palm and Tengvard (2011) where non-adopters seemed to think that there could be such hindrance, where the thoughts for example were that the technologies could need more maintenance than stated by the supplier and that there was a lack of regulatory routines. This difference to the very positive views of the respondents in this study could very well be from that the non-adopter respondents in the study by Palm and Tengvard actually had been in the process of getting a microgeneration facility, of why they might have started to reflect more of such hindrance while the respondents in this study have not. It should also be noted that the non-adopter respondents in Palm and Tengvard is represented by privies for both PV-systems as well as micro-wind turbines, which could have had an impact on their responses in this matter. Moving on, in the study by Faiers and Neame (2006) the non-adopter respondent group gave "do not know"-answers in many of the questions within the area of maintenance and installation in particular, indicating that this would be an area where there is a knowledge gap. Even though the respondents in this study are positive when getting the question in a qualitative manner, they might also have responded "do not know" too the same questions regarding PV-systems in a quantitative survey.

Even though PV-system is seen as easy to use there is a division on the view of the actual installation, where some of the respondents think that it could be troublesome while others does not. The aspect of installation is connected to compatibility with infrastructure as the respondents that are negative thinks that you might have to rebuild a lot and that the infrastructure of the house might not be directly compatible with the PV-system. But the rest of the respondents, three of them, does not think there where such installation hindrance, so the views differs. All of the respondents answered though that if you want to install a PV-system you hire a firm that takes care of everything for you, and that this is seen as quite easy to arrange, which can be seen as to have a smoothing impact on the compatibility characteristic even for those who are negative.

6.5 Visual aspects

PV-systems are perceived by the respondents as a visible technology, which means that the respondents think that PV-systems have a high level of observability. According to the theory this is positive for its rate of adoption and is seen as a positive innovation characteristic. But even so, most of the respondents states that the aspect of added value from the PV-panels by transmitting ones green values does not matter. This is a major difference from the adopter group in Palm and Tengvard (2011) who stated that installing a PV-system was a good way of demonstrating green values towards neighbors and relatives. This difference could for example be connected to the aspect of what motives people to install a PV-system and how high the environmental aspect ranks in this matter. But the visual aspect also holds the dimension of whether or not PV-systems are visually intrusive, which is connected not so much to observability but rather to the innovation characteristic relative advantage. Many of the respondents in this study seems to think that PV-systems where somewhat visually intrusive which has a negative effect on the characteristic relative advantage. If PV-systems are seen as visually intrusive they have a relative downside towards the option of not at all adopting, since this last mentioned simply would mean no visual changes at all on the house. In the matter of visual intrusiveness it should be noted that there seems to be some confusion among the respondents what a PV-system and PV-panels actually looks like. Some of the respondents for example overestimate the size and construction. Further, in the discussion of visual aspects as a relative disadvantage one of the respondents clearly states, and what could also very well be a shared underlying opinion, that the visual downside would not be a deal breaker if the economic gains would be vast enough.

One interesting finding in the discussion of visual aspects is that even though most of the respondents find PV-systems to be somewhat visually intrusive the aspect of disturbing the neighbors seems to be of no concern. This means that the relative disadvantage in terms of intrusiveness at least not holds the dimension of being afraid of disturbing the neighbors by installing a PV-system. Instead the visual aspect in this sense actually have a positive effect on the relative advantage if compared to other even more visually intrusive micro generation technologies.

Regarding that the respondents in this study, other than one, does not report on the green aspect being of such a big importance, the theory still means that an observable attribute of an innovation is positively linked to the spreading. One aspect is that the observability for PV-systems could have a positive impact as an attribute transmitting green values even though the respondents does not by themselves fraise it or think of it that way. Another aspect is that it helps the actual diffusion since an observable technology becomes more familiar to the ones who can view it.

7 Conclusions

This chapter presents the conclusions of this study as well as provides suggestions for future research. The chapter summarizes the main findings by the stated aim of this thesis: *The aim of this study is to describe non-adopter perceptions towards a new technology.*

7.1 Main findings

This study has shown that the relative advantage of PV-systems is seen as negative in terms of finances. PV-systems are seen as an investment that is as for today not financially beneficial, which is also stated to be the most important aspect when considering adoption. Some of the respondents however overestimate the actual payback-time, as well as stated payback times that are well within the price levels of today when getting the questions of what levels that would make them seriously interested in getting a PV-system.

The findings in this study indicate that value compatibility for PV-systems in terms of environmental friendliness is positive. Environmental friendliness in terms of relative advantage is also seen as rather positive, but with some of the respondents raising doubts about the actual environmental benefits by a life cycle approach.

A finding in this study is that PV-systems are seen as being very easy to use, which indicates a positive view of the characteristic of complexity. Some of the respondents however, but notably not all, thought that the actual installation could be complicated, which for these respondents would have a negative impact on both the complexity as well as compatibility with infrastructure aspect.

PV-systems are perceived as being a very visible technology, but the environmental aspect as transmitting green values to neighbours and relatives did not seem to matter so much. Further, the visual aspect of the PV-systems were by most of the respondents seen as, however not a deal breaker, somewhat visually intrusive. But the visual aspect of possibly disturbing neighbours did not at all seem to be an issue though. The visual aspect in terms of relative advantage is all in all interpreted to be seen as somewhat, but not overruling, negative. Further, it could be noted that there were some confusion of that a PV-system actually looks like, where the notion generally was that they were more protruding than they actually are.

The respondents in this study showed what can be described as economic rationality, while other studies have shown that actual adopters of PV-systems not is guided by such a view.

7. 2 Suggestions for future research

One especially interesting finding in this study is that some respondents actually gave payback times, as an answer to the question of what payback time that would make them seriously interested in investing a PV-system, that were well in line with the actual payback times as today. This means that what was said to be the major hindrance towards adopting a PV-system, the financial aspect, might not at all be a hindrance if the payback times are well in line with that is considered to be a good investment. It would be interesting to look further at the WTP for PV-systems among general citizens, to see if this finding in this study was just an exception or if it actually could be a trend. If being a trend and that the WTP are actually well in line with today's retail prices, the market have a very invitingly communication challenge ahead, in addressing and changing the view of that PV-systems isn’t an economically beneficial investment, that can be extremely fruitful.

Another aspect that could be of interest to further investigate is people’s views of what PV-systems actually look like and how well this corresponds with the actual visual aspects. A side finding in this study was that the respondents didn’t really know what a PV-system looked like, with a tendency to overestimate its intrusiveness on the house. It would be of interest to find out if this view is generally shared by a larger part of the population, since such a belief of a negative visual aspect that exaggerates the actualities is negative for adoption.

It could also be of interest to find out more about if PV-systems are trusted as being a truly environmentally friendly technology and how such constructs are created. Even though most of the respondents were generally positive towards the environmental aspects as being truly green, there were some doubts raised. It is important for a future diffusion that people can trust the technology in being truly green, as it is one of the main relative advantages.

One topic that two of the respondents raised as very important and beneficial was the aspect of self sustainability. Even though this aspect was not shared by all of the respondents, it seemed to be of major significance for the ones who did talk about it. One parallel that can be drawn to this aspect of producing your own electricity is the general trend of producing your own food, which can be seen both in more rural areas and as urban farming cities. It seems like these two ideas are very closely linked together and based upon the same value of self sustainability. One though that rises is if these two aspects in combination, producing your own electricity and growing your own food, could give an added value to each other if used altogether. The value in being self sustainable might become exponentially larger if more self sustaining aspects are added, which would be an interesting aspect to research since it could reveal new potential markets. It could be so that a person who already grows her or his own food might have a closer link towards as well starting to produce own energy, or vice verca, which would be an interesting link for the market to look at in the aspect of for example joint marketing actions.

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Appendix 1) Template for initial telephone contact with the possible respondents

Hej,
Jag heter Martina, och jag håller just nu på att skriva min masteruppsats på Sveriges Lantbruksuniversitet. Den handlar om attityder och hur folk ser på solceller och egenproduktion av solel, och jag har valt ut det här området till min studie. Jag undrar om du skulle ha lust att vara med och svara på lite frågor? Det tar max en timme, och du får två biocheckar för 200.

English translation:

Hi,
My name is Martina and I´m currently doing my masters thesis on the Swedish university of agricultural science. Its about attitudes and perceptions of solar panels and self production of solar electricity, and I have chosen this area for my study. I wonder if you could consider to participate and answer some questions? It will take maximum one hour, and you will get two cinema vouchers worth SEK 200.

Appendix 2) Original interview guide (in Swedish)

A) Att förklara innan intervjun börjar:

- Upplägget är runt 15 minuter för egenreflektionsenkäten, följt av intervjun. Ingen direkt tidsgräns rådet dock från mitt håll. Jag tänkte att vi även kan ha den sen och gå tillbaka till som grund för diskussion sen om det passar.
- Intervjun är halvstrukturerad, så vi kan hoppa fram och tillbaka hur vi vill.
- Syftet med uppsatsen är att undersöka hur folk generellt sett ser på solceller och på egenproduktion av solel, det handlar alltså bara om vad du *tror*, och det finns inget rätt och fel.
- Ett sidosyfte med uppsatsen är även att få feedback på själva upplägget samt den första reflektionsenkäten, så jag kommer ställa lite frågor om hur du uppfattade den, och du får gärna under hela intervjuns gång också ge sådan feedback om det är något du tänker på.
- Jag spelar in samtalet, så att jag ska komma ihåg vad det är vi pratar om.

B) Kontrollfrågor (JA krävs på första frågan, NEJ på andra, för att fortgå):

Bor du i villa (JA/NEJ)
Äger du någon form av solceller eller solvärme (villa samt sommarstuga), eller har aktivt planerat att skaffa? (JA/NEJ)

C) Respondenten fyller i den kvantitativa enkäten som en chans för egen reflektion innan djupintervjun börjar (ca 15 min).

D) Metodanknutna frågor:

1. Hur uppfattade du enkäten? Var det något som var extra lätt- eller svårtförståeligt?
2. Vad var lättförståeligt?
3. Vad var svårtförståeligt?

E) Intervjufrågor (Växla mellan frågor och förklarande resonemang kring den ifyllda enkäten)

1. Vad är dina tankar kring solceller och egenproduktion av solel? Hur ser du på solceller och egenproduktion av solel?
2. Hur skulle du resonera kring solcellers för och nackdelar?
3. Vad skulle den största fördelen vara med solceller?
4. Vad skulle den största nackdelen med solceller vara?
5. Vilket värde skulle solceller ge? Vad är värdet i solceller?
6. Vad bidrar solceller INTE med?
7. Vad tror du motivationen är för dem som skaffar solceller?
8. Vad tror du hindrar dem som INTE skaffar solceller?
9. Hur ser du på de miljömässiga aspekterna av solel och solceller?
10. Hur ser du på de tekniska bitarna kring solceller?
11. Vilken egen teknisk kompetens skulle du tro behövas för att skaffa solceller?
12. Vad har du för tankar om regelverk och dylikt kring solceller och om man ska skaffa solceller till sin villa?

13. Hur ser du på säkerheten kring elproduktion med solceller?
14. Hur ser du på det visuella kring solceller? (Syns de mycket? Stör de miljön? Är de snygga?)
15. Är solceller moderna? Varför?
16. Tror du att solceller kommer spridas mer i framtiden? Varför?
17. Hur ser du på underhållsaspekterna av solceller?
18. Avslutande fråga: Finns det något mer du skulle vilja tillägga?

Appendix 3) Translated interview guide (in English)

A) To explain before the interview starts:

- The structure is that you first sit down and fill in the self-reflection survey, about 15 minutes, and then we have the interview. There are no direct time limits from my side though. I thought that we also could have the self-reflection survey as a tool and go back to for discussion later.
- The interview is so called semi-structured, so we can back and forth in the subjects as much as we want.
- The purpose with the thesis is to investigate what people generally think and perceives about solar panels and domestic production of solar electricity, so it's just about what you think, there are no right or wrong.
- A bi-purpose of this thesis is to get feedback on the structure and the self-reflection survey, so I will ask some questions of what you thought about it, and feel free also to during the whole interview give feedback if there is something you think about.
- I will record the conversation, so that I can go back and hear exactly what we talked about.

B) Control questions (YES is needed on first, NO on the second, to conduct the interview):

Do you live in a free standing villa? (YES/NO)
Do you own some form of solar panels or solar heating devices (in your villa or summerhouse), or have actively planned to install? (YES/NO)

C) The respondent fills in the quantitative self-reflection survey (around 15 minutes)

D) Method questions:

1. How did you interpret the survey? Was there something that was extra easy or hard to understand?
2. What was easy to understand?
3. What was hard to understand?

E) Interview questions (change between these questions and explanatory discussions around the filled in quantitative self-reflection survey)

19. What are your thoughts around solar panels and self-production of solar electricity? How do you view solar panels and self-production of solar electricity?
20. What do you think of the pros and cons of solar panels?
21. What would be the largest benefit of solar panels?
22. What would be the largest con of solar panels?
23. What value would solar panels give? What is the value in solar panels?
24. What does solar panel NOT contribute with?
25. What do you think the motivation is for those who install solar panels?
26. What do you think hinders the ones who don't install solar panels?
27. How do you see the environmental aspects of solar panels?
28. How do you see the technical aspects of solar panels?

29. What technical competence do you think a person needs in order to get solar panels?
30. What are your thoughts on the rules and regulations around solar panels as if you want to install it in your villa?
31. How do you see the safety around solar panels and electricity production with solar panels?
32. How do you see the visual aspect of solar panels?
33. Are solar panels modern? Why?
34. Do you think solar panels will diffuse more in the future? Why?
35. How do you see the maintenance aspects of solar panels?
36. Concluding question: Is there something more you want to add or have thought about or?

Appendix 4) Original self-reflection survey

Del 1. Egenproduktion av solel.

Nedan finner du en rad påståenden som kan beskriva egenproduktion av solel. Var god sätt en linjemarkering (kryss på linjen) som bäst skulle beskriva dina tankar kring de två meningarna.

Solel har lång återbetalningstid	-----+-----+-----+-----+-----+-----+-----	Solel har kort återbetalningstid
Det finns få statliga stöd	-----+-----+-----+-----+-----+-----+-----	Det finns omfattande statliga stöd
Solceller bidrar med värde	-----+-----+-----+-----+-----+-----+-----	Solceller bidrar inte med värde
Solceller är visuellt påträngande	-----+-----+-----+-----+-----+-----+-----	Solceller är visuellt diskreta
Attraktiva	-----+-----+-----+-----+-----+-----+-----	Oattraktiva
Underhållsfria	-----+-----+-----+-----+-----+-----+-----	Kräver regelbundet underhåll
Minskar koldioxidutsläpp	-----+-----+-----+-----+-----+-----+-----	Ökar koldioxidutsläpp
Minskar miljöförstöring	-----+-----+-----+-----+-----+-----+-----	Ökar miljöförstöring
Förorenande	-----+-----+-----+-----+-----+-----+-----	Rena
Minskar kostnaderna	-----+-----+-----+-----+-----+-----+-----	Minskar inte kostnaderna
Producerar hela tiden	-----+-----+-----+-----+-----+-----+-----	Säsongsbunden produktion
Naturliga	-----+-----+-----+-----+-----+-----+-----	Onaturliga
Bortkastade pengar	-----+-----+-----+-----+-----+-----+-----	God investering
Teknologi till överkomligt pris	-----+-----+-----+-----+-----+-----+-----	Teknologi till oöverkomligt pris
Kommer utvecklas mer i framtiden	-----+-----+-----+-----+-----+-----+-----	Kommer troligen inte utvecklas mer
Bidrar inte till snabbare husförsäljning	-----+-----+-----+-----+-----+-----+-----	Bidrar eventuellt till snabbare husförsäljning
Bidrar inte med mervärde till en fastighet	-----+-----+-----+-----+-----+-----+-----	Ger mervärde till en fastighet
Synliggör värderingar	-----+-----+-----+-----+-----+-----+-----	Inte särskilt synliga
Kommer spridas mer framöver	-----+-----+-----+-----+-----+-----+-----	Kommer inte bli mer populärt i framtiden
Soleller är kompatibelt med modernt leverne	-----+-----+-----+-----+-----+-----+-----	Solceller är inte kompatibelt med modernt leverne
Krångligt att installera i ett hus	-----+-----+-----+-----+-----+-----+-----	Enkelt att installera i ett hus
Användarsäker elproduktion	-----+-----+-----+-----+-----+-----+-----	Inte en användarsäker elproduktion
Solceller påverkar inte det visuella landskapet	-----+-----+-----+-----+-----+-----+-----	Solceller påverkar det visuella landskapet
Sparar bränsle	-----+-----+-----+-----+-----+-----+-----	Sparar inte bränsle
Härdat, moståndskraftigt material	-----+-----+-----+-----+-----+-----+-----	Ömtåligt material
Beprövad och mogen teknik	-----+-----+-----+-----+-----+-----+-----	Ny och obeprövad teknik

(Based on a questionnaire developed and used in the article: Faiers, A., & Neame, C., 2006. Consumer attitudes towards domestic solar power systems, *Energy policy*, 34, pp: 1797-1806. Original questionnaire retrieved by email correspondence with Adam Faiers April 2012.)

Del 2. Övrig info:

Vilken åldersgrupp tillhör du?

18 – 35	☐	51 – 65	☐
36 – 50	☐	66+	☐

Vad jobbar du med? Beskriv nedan:

Hur många är ni i hushållet?

1-2	☐	6+	☐
3-5	☐		

Vad är hushållets totala inkomstnivå (SEK):

0 – 250 000	☐	500 000 – 1 000 000	☐
250 000 – 500 000	☐	1 000 000+	☐

Vilken är er villas huvudsakliga uppvärmningskälla?

El	☐	Fjärrvärme	☐
Bergvärme	☐	Oljepanna	☐
Luftvärmepump	☐	Värmepanna biobränsle	☐

Har er villa haft något av följande energisparåtgärder installerade?

Extra väggisolering	☐	Värmeregulator	☐
Isolering av vindsytrymme	☐	Energifönster	☐
Lågenergilampor	☐	Övrigt:_____________	☐

Vilken typ av omgivning bor du i?

Urban storstadsregion	☐	Mindre stad/landsbygd	☐

Appendix 5) The reworked self-reflection survey

Del 1. Egenproduktion av solel.

Nedan finner du en rad påståenden som kan beskriva egenproduktion av solel. Var god sätt en linjemarkering (kryss på linjen) som bäst skulle beskriva dina tankar kring de två meningarna.

Solel har lång återbetalningstid	-----+-----+-----+-----+-----+-----+-----	Solel har kort återbetalningstid
Det finns få statliga stöd	-----+-----+-----+-----+-----+-----+-----	Det finns omfattande statliga stöd
Solceller bidrar med värde	-----+-----+-----+-----+-----+-----+-----	Solceller bidrar inte med värde
Solceller stör den visuella miljön	-----+-----+-----+-----+-----+-----+-----	Solceller stör inte den visuella miljön
Attraktiva	-----+-----+-----+-----+-----+-----+-----	Oattraktiva
Underhållsfria	-----+-----+-----+-----+-----+-----+-----	Kräver regelbundet underhåll
Minskar koldioxidutsläpp	-----+-----+-----+-----+-----+-----+-----	Ökar koldioxidutsläpp
Minskar miljöförstöring	-----+-----+-----+-----+-----+-----+-----	Ökar miljöförstöring
Förorenande	-----+-----+-----+-----+-----+-----+-----	Rena
Minskar kostnaderna	-----+-----+-----+-----+-----+-----+-----	Minskar inte kostnaderna
Producerar hela tiden	-----+-----+-----+-----+-----+-----+-----	Säsongsbunden produktion
Naturliga	-----+-----+-----+-----+-----+-----+-----	Onaturliga
Bortkastade pengar	-----+-----+-----+-----+-----+-----+-----	God investering
Teknologi till överkomligt pris	-----+-----+-----+-----+-----+-----+-----	Teknologi till oöverkomligt pris
Kommer utvecklas mer i framtiden	-----+-----+-----+-----+-----+-----+-----	Kommer troligen inte utvecklas mer
Bidrar inte till snabbare husförsäljning	-----+-----+-----+-----+-----+-----+-----	Kan bidra till snabbare husförsäljning
Bidrar inte med mervärde till en fastighet	-----+-----+-----+-----+-----+-----+-----	Ger mervärde till en fastighet
Synliggör gröna värderingar	-----+-----+-----+-----+-----+-----+-----	Synliggör inte gröna värderingar
Kommer spridas mer framöver	-----+-----+-----+-----+-----+-----+-----	Kommer inte bli mer populärt i framtiden
Soleller är kompatibelt med modernt leverne	-----+-----+-----+-----+-----+-----+-----	Solceller är inte kompatibelt med modernt leverne
Krångligt att installera i ett hus	-----+-----+-----+-----+-----+-----+-----	Enkelt att installera i ett hus
Säker teknologi för användaren	-----+-----+-----+-----+-----+-----+-----	Inte en säker teknologi för användaren
Solceller påverkar inte det visuella landskapet	-----+-----+-----+-----+-----+-----+-----	Solceller påverkar det visuella landskapet
Härdat, motståndskraftigt material	-----+-----+-----+-----+-----+-----+-----	Ömtåligt material
Beprövad och mogen teknik	-----+-----+-----+-----+-----+-----+-----	Ny och obeprövad teknik

(Based on a questionnaire developed and used in the article: Faiers, A., & Neame, C., 2006. Consumer attitudes towards domestic solar power systems, *Energy policy*, 34, pp: 1797-1806. Original questionnaire retrieved by email correspondence with Adam Faiers April 2012.)

Del 2. Övrig info:

1. **Vilken åldersgrupp tillhör du? (ringa in)**

18-35
36-50
51-65
66+

2. **Vad jobbar du med?**

---

3. **Vad har du för utbildning?**

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4. **Hur många är ni i hushållet? (ringa in)**

1-2
3-5
+6

5. **Vad är hushållets totala inkomstnivå? (ringa in)**

0-250 000
250 000 – 500 000
500 000 – 1 000 000
+1 000 000

6. **Vilken är er villas huvudsakliga uppvärmningskälla? (ringa in)**

El
Bergvärme
Luftvärmepump
Fjärrvärme
Oljepanna
Värmepanna biobränsle

7. **Hur resonerar du i vanliga fall kring miljö när du handlar? Beskriv nedan:**
