Adopters' perceptions of solar PV business models

Master's thesis in Management and Economics of Innovation

Jacob Dahm

Leonardo Johansson

DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS
DIVISION OF INNOVATION AND R&D MANAGEMENT

CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2022
www.chalmers.se
Report No. E2022:114

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JACOB DAHM
LEONARDO JOHANSSON

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Supervisor and Examiner: Ingrid Mignon, Chalmers University of Technology

Report NO. E2022:114
Department of Technology Management and Economics
Division of Innovation and R&D Management.
Chalmers University of Technology
SE-412 96 Gothenburg
Sweden
Telephone +46 (0)31-772 1000

Gothenburg, Sweden 2022

Acknowledgements

The master's thesis was carried out during the spring of 2022, at the Department of Technology Management and Economics at Chalmers University of Technology. The area of investigation for the thesis was developed and suggested by the members of a research project within the Division of Innovation and R&D Management.

First of all, we would like to express our gratitude and thanks to our supervisor and examiner, Ingrid Johansson Mignon. Thank you for the opportunity of taking on this assignment, for welcoming us as part of the research project and for the guidance and dedication you have given us. This thesis would not have been the same without your contribution and shared experience.

Secondly, we would like to thank the other members of the research project for providing valuable research leads. We would also like to thank our fellow master's thesis students for joining the research project during this spring - your peer-reviews have given us an appreciation for how to improve our thesis, and your work on intermediaries for solar PV has contributed to deepening our understanding of the sustainable transition.

Lastly, we would like to express our gratitude to all the interviewees who participated in this thesis. Your time and effort have made this an enjoyable process, and the thesis would not have been possible without your cooperation.

Jacob Dahm and Leonardo Johansson, Gothenburg, June 2022

Abstract

The increasingly severe effects of climate change puts pressure on society to decarbonize the economy, of which the energy sector constitutes an integral sector to transform. In facilitating the introduction of renewable energy technologies (RETs), innovative business models (BMs) have been highlighted as playing an important role - in particular for solar photovoltaics (PV). However, diffusion of solar PV is still dependent on individual adopters deciding to invest in these BMs, and there is a lack of research regarding how adopters perceive the available BMs. In order to accelerate the sustainable transition, we need to acquire a qualitative understanding of how adopters make sense of the solar PV BMs. To this end, the thesis sets out to answer how adopters' perceive the different BMs for solar PV. Sweden provides a suitable context in which to conduct the study, as a large, heterogeneous group of solar PV adopters have developed since the liberalisation of the energy market.

Through semi-structured interviews with residential and commercial adopters, data was collected on the adopters' perceptions of the different BMs for solar PV. More specifically, the thesis identifies the perceived value and perceived missing value of the respective BMs. The findings show that adopters generally prefer host-owned (HO) BMs compared to third-party-ownership (TPO) BMs - they are perceived as more economical, ensuring control and stability and reducing the complexity of the adoption process of solar PV. Furthermore, the adopters' perception can be considered to be influenced by a combination of system-level components, the characteristics of the innovation and the characteristics of the adopters - based on these factors, the adopters develop their own internal reasoning for their preference of the BMs. A model is proposed, synthesising the main influencing factors and providing a springboard for further research in this area.

The findings of the thesis have significant implications for policy makers. To facilitate wide-spread diffusion of solar PV, policy makers should strive to generate heterogeneity in the solar PV BMs that are being adopted. This can be achieved by acknowledging the derived perceptions of the adopters, and addressing the perceived missing value of the BMs. Moreover, policy makers should take the factors that influence perception into account when designing new policy instruments.

Keywords: solar PV, diffusion of innovation, adopter, business models, sustainable transition, perception

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1. Introduction

The fossil fuel-based economy that has dominated society since the industrial revolution is causing severe problems for humans and wildlife alike. In a "business as usual"-scenario, global mean temperature is projected to increase by 5 degrees at the end of the 21st century (IPCC, 2021). Policymakers have recognized the impending challenges and at the heart of Europe's efforts is the objective to produce net-zero emissions of greenhouse gases by 2050 (EC, 2020). As fossil fuels make up around 80 % of the world's energy supply, the energy sector arguably constitutes the most important sector to transform (World In Data, 2020). In achieving a transformation, facilitating the introduction and use of renewable energy technologies (from here RET) lies at the core (UN, 2021). RETs include wind, solar, tidal, geothermal and biofuel technology (Tidwell & Weir, 2015). However, despite the maturity of RETs, large-scale diffusion is currently not taking place at a desirable pace (Mignon, 2016). In order to reach the set climate targets, a rapid scale-up in deployment is needed. Biothermal and biofuel technologies have been considered as established and wide-spread technologies, while wind, solar and tidal technologies are "new" options, exhibiting a major increase in diffusion over the last decades (Jacobsson & Johnson, 2000). Here, solar photovoltaic (from here solar PV) is in many cases the least-cost option, and it is currently the fastest growing alternative for electricity generation (IEA, 2021).

1.1 Background and thesis aim

Drawing on the core concepts introduced in innovation system (from here IS) literature, it is by modelling a sector or technological system as a dynamic, complex network of diverse, interacting actors shaped by institutions that we can fully understand how to induce change (Malerba, 2002; Carlsson & Stankewiecz, 1991). As the technological system matures, it encompasses both production, diffusion and the use of the technology, and engages actors across both local and national boundaries. The IS can be considered as taking the form of a socio-technical system, incorporating the people, infrastructure, processes and culture revolving around the new technology (Geels, 2004). The creation of a new, sustainable socio-technical system - i.e. a sustainable transition - is especially challenging as the existing systems and infrastructures have co-evolved over years, characterised by lock-in mechanisms where sunk investments, scale economies, social networks and belief systems act as barriers (Verbong & Geels, 2010; Geels, 2011). Much of the focus of policy-oriented energy and climate research is committed to single pieces of the puzzle, and seem to miss some crucial elements of the multidimensionality which the decarbonization challenge entails. To understand how to facilitate a transition to a sustainable supply of energy, we should devote attention to a more socio-technical approach (Geels et al., 2017).

In light of this, there is a need to expand the current research to those parts of the sustainable transition which are relatively unexplored. Previous research regarding solar PV has identified the significance of institutions and policies in influencing supply-side development and diffusion (Balaguer & Marinova, 2009; Vasseur et al., 2013; Strupeit, 2017). However, governmental investments need to be complemented by investments of other market actors in order for the diffusion of RETs to be successful (Wüstenhagen & Menichetti, 2012). The scope of analysis for support instruments should be extended beyond the perspective of policy makers (Dinica, 2006; Masini & Menichetti, 2012); in particular as the liberalisation of the energy market has shifted the influence of the innovation process towards the consumers (Markard et al., 2004). While firms used to operate in a highly regulated context, we are now witnessing a change where the emerging opportunities attract a variety of new entrants experimenting with novel business models (from here BMs) (Bohnsack et al., 2021; Bergek et al., 2013; Karneyeva & Wüstenhagen, 2017) - creating a possibility for the development of a self-sustaining market.

Against this background, scholars have started exploring BMs and their role in accelerating the sustainable transition. There is no commonly accepted framework for the definition of a BM, but it is in wide terms understood as the activities and elements pertaining to the value proposition, value creation and delivery, and value capture of firms (Richardson, 2008; Zott et al., 2011; Teece, 2010). It is by making a technology available and understandable through suitable BMs that leads to objective value being created for the customer. Different BMs might fit a certain technology unequally and therefore yield different results - as such, the choice of BMs has a direct influence on the success of commercialization (Chesbrough, 2010). For RETs, BMs can work as tools for bringing initially niche applications to the market, hence driving a socio-technical transition (Bidmon & Knab, 2018; Würstenberger et al., 2011). Specifically, in the absence of subsidies, the trend of increasing additions in solar PV capacity can largely be attributed to grassroot-level actors, facilitated by growing affordability and innovative BMs (Ford et al, 2017; Huijben & Verbong, 2013).

BMs are not sufficiently successful on their own - there is an interdependency between innovative BMs, policy framework and existing infrastructure that enables a departure from the incumbent energy scheme (Bolton & Hannon, 2016). For solar PV, the regulatory framework might prohibit the implementation of certain BMs (Horváth & Szabó, 2018); some BMs are affected by changes in policy more than others (Karneyeva & Wüstenhagen, 2017); and accordingly, entrepreneurs are shown to structure their BM around the regulatory regime (Huijben et al., 2016). In order to design policies that both attract private and public investments, decision-makers need to develop an understanding of the available BMs and how the policy instruments at their disposal affect these models. On this note, Bankel & Mignon (2022) surveyed the solar PV BM landscape in Sweden from a firm's perspective and identified a mismatch between how policy makers and existing literature perceive BMs for solar PV, as compared to the firms involved in offering these BMs themselves. This implies that policy makers and scholars do not completely grasp how the market and its actors interact, which might lead to policy shortcomings.

To further complement these findings, it is of importance to study the demand-side of solar PV diffusion in relation to the BM perspective. If a self-sustaining market for RETs is to be developed, scholars and policy makers also need to be aware of the main drivers and obstacles from an investor-perspective. The diffusion of a technology is dependent on micro-decision processes taken by individual adopters that lead them to adopt (Rogers, 1983); however, there is a lack of empirical research about how these adopters - referred to as an individual or an organisation who invests in a solar PV BM to use the solar PV technology to produce electricity for self-consumption or selling - perceive the different BMs for solar PV. For instance, there is no account for why adopters prefer one solar PV BM over another. While previously considered to mainly consist of profit-maximising electric utilities, adopters of RETs have been shown to comprise a large, diverse group whose background, resources, characteristics and preferences vary (Bergek & Mignon, 2017; Bergek et al., 2013). Accordingly, in the case of the implementation process for residential solar PV systems, adopters' heterogeneous motives and driving forces influence the choice of installation intermediaries and their perception of the service provided (Aspeteg & Mignon, 2019). Ultimately, this suggests that adopters might have differing perceptions about the existing BMs for solar PV.

By understanding how adopters make sense of solar PV BMs - and if there is a resulting mismatch - policy makers will have an easier time designing policies focused on stimulating demand. The risk might otherwise be that policymakers misjudge the importance of a market segment or certain BM components, and misinterpret the impact of policies. Firms can also benefit from such insights; the diversity of adopters articulates a need for a broad customer offering (Bankel & Mignon, 2022), and a BM that does not meet customer needs might lead to commercial failure (Teece, 2010). To bridge the existing research gap, this thesis thus aims to examine adopters' perceptions of different BMs for solar PV in Sweden, and to explore if there are any specific factors that determine their perceptions. As such, the work has strong roots in existing literature, but also strives to complement and add new insights to the current agenda. The research questions (from here RQ) are structured as follows:

1) How do adopters perceive different BMs for solar PV?
2) What are the main factors that influence adopters' perceptions of BMs for solar PV?
3) What are the implications of the empirical findings for policy makers, firms and adopters?

1.2 Scope & Limitations

The thesis is being carried out as part of an on-going research project on innovative BMs for solar PV within the department of Innovation and R&D Management at Chalmers University of Technology - the scope of the thesis is therefore confined to the boundaries of the project and the focus of the thesis is dictated by the work undertaken within the research project so far.

Previous research in the project has identified multiple BMs for solar PV in Sweden, which will be used as baseline when surveying the adopters' perception. As the study will be conducted on adopters in Sweden, the results are therefore not necessarily applicable to other contexts. Regulations, norms and additional factors that might influence the available categories of BMs and demand-side perception could be different in other countries.

Lastly, due to the difficulty of reaching customers who are planning to adopt, our analysis will be restricted to customers who have already decided to adopt and implement the BM - thus, we do not get the perspective of those who are yet to invest.

2. Frame of reference

This chapter presents an in-depth review of literature containing key concepts for understanding adopters' perceptions of solar PV BMs. First, literature on diffusion of innovation is reviewed (from here DOI), outlining the main theoretical components needed to understand how and why innovations diffuse. Thereafter, literature on BMs is presented, covering the BM concept at large and accounting for the role of BMs in relation to the market, firms and adopters respectively. Concludingly, literature on adoption of solar PV is discussed, complemented by a delineation of the BM landscape for solar PV in Sweden.

2.1 Diffusion of innovations

Diffusion is the process in which an innovation - a new and useful idea, practice or object - spreads throughout a specific market or social group. Research on the diffusion and use of new ideas can be traced back to the late 19th century and the sociological studies conducted by Gabriel Tarde (Srivastava & Moreland, 2012), but diffusion theory as an explicit literary body of science that incorporates both ideas and technological artefacts was initially synthesised by Rogers in 1962. This spawned an extensive range of studies within multiple disciplines, such as sociology, anthropology, geography, economics and technological change, aiming to discern what factors that lead to the successful adoption of new technology (Das, 2022).

Rogers (1962) theorised that technological innovations diffuse through a specific population or market via the individual decisions of various adopters - as such, this stream of research mainly regards adoption from the individual perspective. The adopters - in this case, defined as individuals who decide to implement a new product or idea that differs from their current use-process or behaviour - are characterised by innate differences in their timing of adoption. The process of adoption does not constitute single point events; rather, individuals adopt at different instances over time. In line with this, Rogers (1962) popularised the now widely used S-shaped curve, which describes the number of adopters plotted cumulatively over time. In general, the distribution of adopters can be considered to grow slowly at first with few adopting individuals; when a critical mass is reached, the adoption rate speeds up until half of the population of individuals have adopted, after which it begins to level off as fewer and fewer potential adopters remain.

According to this field of theory, the influence of peers is considered to be a crucial aspect for the diffusion of an innovation. The communication within the population of adopters determines the flow of information about the innovation, thereby reducing the inherent uncertainty regarding the performance of new technologies. Face-to-face exchanges between individuals are principally the most influential for the ultimate decision to adopt - the importance of adopting neighbours in facilitating diffusion has been shown empirically on multiple occasions (Rogers, 2003). Consequently, the DOIs has been likened to an epidemic model, where users transfer the knowledge of a technology's existence via interpersonal interaction with non-users (Stoneman, 2002).

While the first adopters largely take independent adoption decisions, the remaining groups are affected by their social network to a higher degree; the probability of adoption taking place is dependent on the number of previous buyers (Bass, 1969). The extent of diffusion is closely tied to the norms and boundaries of the surrounding social system - the information and beliefs about the innovation that are being perpetuated in the network might impede the distribution; conversely, a change in perception resulting from a growing amount of adopters also has the possibility of creating a so-called bandwagon effect (Abrahamson & Rosenkopf, 1997). In fact, the strength of the social pressure to adopt can sometimes lead to the diffusion of inferiorly performing products (Tingling & Parent, 2002).

Some innovations are very successful in the sense that they diffuse quickly and completely replace the incumbent products, as illustrated by the substitution of horses for motor cars in the early 20th century (Grübler, 1996). Other innovations, such as the Dvorak Simplified Keyboard, get completely rejected despite having a superior performance (David, 1986). It appears that for an innovation to diffuse successfully, it is not enough to only consider the technical excellence of the innovation; in understanding the dynamics behind why some technologies diffuse successfully while other technologies fail, the scholarly scope has been broadened to include a variety of factors. For one, the innovation needs to be compatible with the existing political, social and economic systems and infrastructures (Katz & Shapiro, 1994; Edquist, 1997). Furthermore, attention has been drawn to how the specific attributes of the innovation being adopted affect diffusion and implementation (Tornatzky & Klein, 1982; Aiman-Smith & Green, 2002). Lastly, elaborating on the individual perspective of diffusion theory as discussed above, the importance of considering the characteristics of the individual adopters has been highlighted; the timing in adoption varies because individuals are different and thus will react in different ways to the introduction of new technologies (Rogers, 2003). As such, technology diffusion can be regarded as a multidimensional interplay between factors at the micro, meso and macro level (MacVaugh & Schiavone, 2010). In the following sections, these main observed themes - the system, the characteristics of the innovation and the characteristics of the adopters - and their role in the diffusion of innovations will be explained in more detail.

2.1.2 Innovation systems

IS scholars propose that the emergence and growth of an IS depend on system-level components (Carlsson & Stankiewicz, 1991; Grübler, 1991). Although IS literature does not inherently focus on the diffusion of technologies, the system level perspective is important due to the fact that the more established an IS gets, the more easily the diffusion can take place (Mignon, 2016). Scholars have highlighted the importance of various system-level components, and in this paper the following components are considered as vital for the DOIs: market structures, networks and communication channels, institutions, and infrastructures (Negro et al., 2012).

The definition of market structure in the IS context is the organisation of the current market and the criteria for selecting innovations (Negro et al., 2012). Existing markets often constitute harsh selection environments embodied in incumbent socio-technical regimes (Smith & Raven, 2012). New technologies suffer due to incumbents obtaining advantages of economies of scale, extensive periods of technological learning and socio-institutional embedding. These advantages allow them to offer lower prices, become more efficient, produce at larger scale and optimise alignment between system actors. If the advantages become too great, novel technologies might never stand a chance to begin with (Negro et al, 2012). It is therefore important for innovators to be aware of the current market structure in order to apply fitting strategies and overcome such obstacles, which will directly and indirectly impact the diffusion (Mignon, 2016).

As discussed in the previous section, the processes of interaction and communication are key for innovations to successfully enter the market. The IS-perspective regard this element as a systemic factor; if communication channels - such as mass media - or networks of peers do not exist, the potential adopter will struggle to receive necessary information about the innovation, including how to use and implement it (Wejnert, 2002). These interactions and market relationships involve cooperation between both inter-firm and firm to non-firm organisations, and impacts diffusion through preventing or enabling coalitions, limiting or promoting development of a shared vision of future technology and providing knowledge transfer and knowledge diffusion (Carlsson & Jacobsson, 1997).

IS studies also promote the component of infrastructure as crucial. The infrastructure provides the physical and organisational structures which enable the necessary operations for an enterprise's daily and long-term activities and developments (Negro et al., 2012). If infrastructure is missing or is incompatible with the innovation, adoption is near impossible (MacVaugh & Schiavone, 2010). Literature distinguishes between different types of infrastructure: physical infrastructures refer to technical structures such as electricity grids, highway systems and high-speed ICT - which are key in the transformation of large technical systems as they are associated with large investment costs and coordination problems; knowledge infrastructure meanwhile includes both physical assets - laboratories, universities and research facilities - as well as non-physical assets such as scientific knowledge and skills (Negro et al., 2012). As mentioned with regard to communication channels and networks, the diffusion of knowledge is essential for the diffusion of a technology and the build up of an IS. For diffusion of knowledge to take place, knowledge infrastructure is key. For instance, there needs to be an alignment between the knowledge produced at universities, and the knowledge needed in practice (ibid).

The institutional component is essential for facilitating development and diffusion of an innovation (Carlsson & Stankiewicz, 1991; Bergek et al., 2008a). Hard institutions are formal and intentionally created instruments used by governments and policy makers in order to solve system failures, create new industries or induce the DOI (Negro et al., 2012). These include various types of legislation, regulation, policy schemes and governmental programmes (Bergek et al., 2014). In contrast, soft institutions consist of informal structures often evolved spontaneously and created by the social system. These include behavioural frameworks such as culture, norms and values which impact the DOIs either positively through supporting the innovation, or negatively through opposing the technology (van Lenete, 1993).

When it comes to system-level strategies in order to stimulate adoption or mitigate system obstacles, hard institutions in terms of policies are worth emphasising. Policies can support needed infrastructure such as financial institutions which could increase the share of private investments (Jacobsson & Karltorp, 2012), and funding provided for research institutes and universities can strengthen knowledge infrastructure and lower obstacles in knowledge diffusion (Bergek et al., 2010). Policies are also essential when influencing market structure - they can shield the developers and early adopters through creating protective market spaces. Such spaces can work as nursing and bridging markets, sheltering innovation from the selection pressure of an otherwise hostile environment (Smith & Raven, 2012). Additionally, policies are often influential on soft institutions. Due to the social nature of long-term political visions, political networks and advocacy coalitions can contribute to increased legitimacy and social acceptance (Bergek et al., 2008b).

2.1.3 Characteristics of the innovation

For a technology to achieve lasting diffusion, adoption needs to be followed by continuous use. This puts a requirement on individuals to understand how to properly operate the new technology (Grübler, 1996). In line with this, differing rates of diffusion can partly be explained by the degree of innovation complexity (Rogers, 2003). Some technologies are more complex than others, in the sense that they are intertwined with existing infrastructure and systems and interact with other technologies to a high degree (Grübler, 1991). The system-embeddedness of these innovations calls for substantial operating skills and changes in user practices that need to be developed over long time frames (Lyytinen & Damsgaard, 2001). Complexity is also related to how easy the innovation is to understand - certain technologies are more advanced than others in terms of the efforts required by the user to understand it (Aiman-Smith & Green, 2002). Furthermore, even after the decision to adopt has been made, the final step of diffusion still hinges on whether the actual implementation is successful. Obstacles in the implementation process can cause the adopter to not reach the desired benefits and lead to discontinued use (Klein & Sorra, 1996). Adopters experiencing troubles to make sense of an innovation and implement it due to its complex character correlate negatively to its rate of diffusion (Rogers, 2003), while innovations that are easy to understand are more quickly adopted (Sahin, 2006; Premkumar, Ramamurthy & Nilakanta, 1994).

Another noted driver of diffusion with regard to the characteristics of an innovation is the potential utility to be gained from adoption (MacVaugh & Schiavone, 2010; Tornatzky & Klein, 1982). Also known as relative advantage, this refers to whether the adoption of the new technology will yield benefits for the adopter that supersede the status quo, e.g. what is currently achieved with existing products or practices (Rogers, 2003). The importance of relative advantage in facilitating diffusion has been shown in various empirical studies (Plouffe et al., 2001; Osorio-Gallego et al., 2016; Flight et al., 2011; Tambago & Espinosa, 2017). In theory, the relative advantage of an innovation can represent an edge in both the economic, social and environmental dimension, but it is mostly expressed and viewed in the light of economic profitability (Rogers, 2003; Knowler & Bradshar, 2007). The argument for adoption often boils down to a consideration of costs versus benefits (Greeve, 1998) - if the adopter believes the cost or price of the innovation to be too high in relation to the received benefits, this can significantly impede the adoption rate (Wejnert, 2002).

A much visited characteristic of innovations in research is the compatibility (Osorio-Gallego et al., 2016, Moore & Benbasat, 1991). This describes the degree to which the innovation is compatible with the adopter's socio-cultural beliefs and ideas, past experiences and needs - as well as the innovation's compatibility with the adopters' other technical tools and infrastructure (Smerecnik & Andersen, 2011). The rate of diffusion of a new technology can be hindered if the properties of the innovation do not gel well with the cultural values of the adopters, as illustrated by the reluctance of indigenous South American farmers to implement soil conservation innovations (Rogers, 2003). Innovation compatibility also represents the extent to which the technology is conforming to the existing practices of the adopter (Tornatzky & Klein, 1982). In the case of adopting web technology for educational purposes, the compatibility with traditionally used teaching methods have been shown as a primary diffusion driver (Jebeile & Reeve, 2003); similarly, in the acceptance of a smart-card payment option, consumer adoption is positively influenced by their previous behaviour and affinity with the feature (Plouffe et al, 2001).

As we touched upon in the beginning of this chapter, newness - e.g. an attribute of novelty - is an inherent characteristic of innovations (Rogers, 1962). The newness of a technology is arguably directly related to both the complexity and the relative advantage (Wells et al., 2010). For some, the novelty of an innovation can create feelings of uncertainty and fear (Swanson & Ramiller, 1997); for others, it represents a new, exciting opportunity waiting to be seized (Cox & Locander, 1987;

Mukherjee & Hoyer, 2001). This speaks to the fact that an innovation's degree of novelty is not static; rather, the opinion varies between different individuals (Blythe, 1999). Likewise, with regard to the cost of adoption, what one adopter considers expensive might be a reasonable price in the mind of another (Moore & Benbasat, 1991). When assessing the same technology, there are observable differences between cultural and social groups in terms of the emphasis put on the attributes of an innovation (Flight et al., 2011; Plouffe et al, 2001). Sometimes adopters are not fully aware of all their needs, and how an innovation can fulfil them - when introduced to new technologies, the perceived usefulness and perceived ease-of-use are generally what drives wide-scale acceptance among the population of adopters (Davis, 1989). The key conclusion to draw here is that innovation characteristics - what is considered as new, complex, beneficial, costly or compatible - and their role in driving diffusion depend on the individual perception of the adopter in question (Rogers, 2003; Frambach & Schillewart, 2002; Mignon, 2016)

2.1.4 Characteristics of the adopters

In accordance with the conclusion above, it is of utmost importance to take the characteristics of adopters into account - even if all the systemic and technological conditions to support adoption are in place, it is still up to the adopter to decide whether to adopt or not (MacVaugh & Schiavone, 2010). Based on their timing of adoption, Rogers (2003) categorises adopters into 5 corresponding groups: the venturesome innovators, followed by the respectful early adopters, who help trigger the deliberate early majority, followed by the sceptical late majority, and lastly, the traditional laggards. The differing timing of adoption of the groups can be explained by calling attention to the inherent characteristics of the adopters; in general, they can be observed to diverge in terms of socio-economic status, personality values and communication behaviour. Compared to later adopters, earlier adopters are associated with - to name a few - higher social status, more formal years of education, higher intelligence, possession of wealth, more accepting towards change, higher interconnected networks, more cosmopolite, greater knowledge of innovations and more contact with change agents. This results in different degrees of innovativeness of the groups - thus, the individuals are bound to react differently when introduced to a new technology (Rogers, 2003).

The protracted character of diffusion processes can also be attributed to the fact that the adopters' decision to implement a new technology or idea is not an instantaneous procedure. Previous approaches model adoption as a linear process with decision-focus progression through various different stages - in the innovation-decision process (Rogers, 2003), the entity engaged in adoption is imagined as moving through 5 distinct stages: the knowledge stage, where the adopter becomes aware of the existence of an innovation; the persuasion stage - where the adopter forms an opinion of the innovation; the decision stage, where the adopter decides to adopt or reject the innovation; the implementation stage, where the adopter puts the innovation to actual use, and lastly; the confirmation stage, where the adopter seeks information to confirm the decision made to implement the innovation.

However, this perspective of the decision process views the adopter as somewhat of a black box - modelling the adoption-related activities rather than modelling the adopter - missing an examination of the adopters' mental processes (Seligman, 2006). Much of the previous research on DOI is subject to an innovation bias, assuming that the innovation being adopted is inherently good and will replace the incumbent products for utility maximising individuals (Davis, 1989; Venkatesh et al., 2003); if the innovation is not accepted, it is because the adopter lacks the right characteristics, such as resources, knowledge and status (Rogers, 1962). Recent DOI literature challenges this notion and highlights that adopters are not solely driven by economic rationality (Zenobia & Weber, 2011) - instead, the consideration of the adopters driving forces should be extended to incorporate their individual beliefs and norms - identity, habits, impulses and perceptions are the key determining factors (Seligman 2006; Selwyn, 2003). For instance, some might adopt because they believe it gives them legitimacy in the social network (Zimmerman & Zeits, 2002), and, as mentioned earlier, others might be pressured by their social network to adopt (Teo et al, 2003).

For the reasons described above, although the idea should not be completely disregarded, it is questionable to try to understand reasons for adoption solely based on characteristics such as demographics and economic status. Adopters are a heterogeneous group that develop an internal reasoning for what motivates their decision to adopt or not adopt (Mignon, 2016). On this note, there is a lack of in-depth understanding of the underlying mental processes behind the decision to adopt (Seligman, 2006). The majority of empirical studies on adoption have used quantitative methods (Meade and Islam, 2006); and have thus focused on testing and modelling the deterministic factors of adoption (Lee et al., 2005; Marcati et al., 2008). The adoption process however is complex, affected by cognitive and ambiguous factors as much as the previously established tangible characteristics (Selwyn, 2003).

As discussed in section 2.1.3, the adopters' perception influences their attitude towards using a new technology and the perception differs between the potential adopters. Highlighted by Joseph Schumpeter (1947) in his early work on evolutionary economics and entrepreneurship, individual characteristics lead people to perceive opportunities and make sense of new technologies in different ways, e.g. if, when and how to adopt an innovation. Any adoption decision is preceded by the formation of a perception, dependent on the mental framework of the adopter - thus, the adoption process starts before the adopter is introduced to the technology (Seligman, 2006). Investigating adopter perception is therefore important to fully grasp the diffusion process. Understanding how different adopters perceive innovations is particularly important for policy makers and managers, as a more nuanced view of this process has many implications for policy design and managerial practices.

Previously, as described, misleading assumptions of adopters and the adoption process have commonly been portrayed in diffusion literature, which could deceive policy makers and firm managers when striving for efficient solutions (Mignon, 2016). Acknowledging the distinct heterogeneity amongst adopters implies the cruciality for policy makers and managers to account for such variations. Indeed, due to the individual perceptions and drivers, it is hard to create any singular measure to fit an entire group of adopters. Consequently, it is important that policy makers and managers ensure space for many different adopters to co-exists (ibid). For policy makers, this could entail reconsidering one-for-all policies, and instead focus on segmenting the policy framework to target specific motives and drivers (Bergek & Mignon, 2017).

2.2 Business models

Even though the capabilities of new technologies might outperform incumbent products, successful diffusion is not guaranteed - not only because of the various, complex aspects of diffusion dynamics highlighted above, but also because the technologies need to be embedded in a useful BM in order to achieve a successful market entry (Chesbrough & Rosenbloom, 2002). On the one hand, the BM is an essential tool for the supply-side that reflects how a firm perceives the needs of its customers and how they can be met (Teece, 2010), and on the other hand, BMs allow for the demand-side to better understand how to gain value from the technology and remove potential barriers for adoption (Strupeit & Palm, 2016). Once an innovation has established its presence on the market, the exchange between firms and customers are guided by the market mechanisms, with the BMs as the core reference point in communication (Bidmon & Knab, 2018). In the sections below, the basic concept of the BM will be introduced, followed by a top-down discussion along three main dimensions considered to be of importance when analysing BMs in our context: how the BM is shaped by the market it operates in, how the BM can be utilised by the firms' in the market, and how the BM should be designed with regard to the adopters.

2.2.1 Business model concept

The concept of the BM has received significant literary attention the last two decades. A good BM is essential to any successful business, whether it is an established enterprise or a new venture (Magretta, 2002); and further highlights distinct differences in firms successes or failures as it constitutes a useful unit of analysis set apart from the product, firm, industry or network (Zott et al., 2011). However, there is a lack of a common understanding and unified definition of the concept. Various interpretations have emerged as scholars from different disciplines have contributed and emphasised different perspectives. The result of this has been a general confusion about what to include and associate with the concept, where BMs frequently are thought synonymous and referred to as business strategy, business concept, revenue model, economic model or business process modelling (DaSilva & Trkman, 2014).

In the field of e-business, Trimmers (1998) proposed one of the most cited definitions, namely: "*an architecture for the product, service and information flows, including a description of the various business actors and their roles; and a description of the potential benefits for the various business actors; and a description of the sources of revenues*". In contrast to this description, Alt and Zimmermann (2001) based their interpretation on six constitutive components: *mission* - the firm's goals and value proposition; *structure* - addressed product, customer and industry; *processes* - focus on elements of value creation; *revenues* - describe sources of revenues; *legal issues* - needs to be contemplated with regards to each component; and *technology*.

These are just two examples of the vast amount of definitions that emerged within BM research, and highlights the differences in both how definitions are formulated, and what components are included. In more recent times, researchers have made efforts to clarify confusion among diverging definitions, and managed to reveal some common themes. Zott et al. (2011) revealed that most BM definitions accentuate the concept of value - they seek to explain how value is created and/or captured, and amongst the multiple definitions included in their study, the most recurrent component is the customer value proposition.

In line with this, a widely accepted definition which thoroughly accounts for the notion of value is proposed by Teece (2010). His work is based on the role of BMs across industries and has been used by scholars as a foundation of research within the area of sustainability (Schaltegger et al., 2012). In order to avoid confusion, and with regard to the relevance in relation to our topic of investigation, the definition by Teece (2010) is used in this thesis: *"a business model articulates the logic, the data, and other evidence that support a value proposition for the customer, and a viable structure of revenues and costs for the enterprise delivering that value. In short, it is about the benefit the enterprise will deliver to customers, how it will organize to do so, and how it will capture a portion of the value that it delivers"*.

To provide further clarification of the different components of a BM, so-called BM frameworks have been established (Bankel & Mignon, 2022). In this thesis, the framework by Richardsson (2008) will be used - a framework which provides a comprehensive picture and captures the many themes and elements recurring in the various BM definitions, while at the same time providing a simple, logical structure with a value-oriented focus. The three components of the framework are outlined and explained below:

- The value proposition: what the firm offers to its customers, who these customers are, and the strategy to win these customers.

- The value creation and delivery system: how the firm creates and delivers that value to its customers and the source of its competitive advantage, which includes resources and capabilities, the organisation (activity system and business processes), and its position in the value network (links to suppliers, partners and customers).
- Value capture: how the organisation generates revenue and profit, including revenue sources and the economics of the business.

2.2.2 Business models and the market

The market represents the broadest level of analysis with regard to BMs, since it encompasses both the producers, consumers, institutions and all other factors that might affect the diffusion of a technology and the development of an IS. The critical function of BMs in facilitating a society-wide transition can be attributed to the fact that they have the potential of changing the market - through catalysing the introduction of new technologies into the mass market, BMs have the possibility of contributing to the transformation of the socio-technical regime (Sarasini & Linder, 2018). From a system-wide perspective, the BM functions as a “market device” that facilitates the interaction between the different players involved in the IS, connecting production to consumption (Doganova & Eyquem-Renault, 2009). As such, its activities span across the borders of the focal firm; the BM connects the technological niche to the broader regime level, and helps in building markets by providing a reference point of communication about the innovation, facilitating learning processes and managing expectations between the stakeholders, thus creating a social network revolving around the new technology (Bidmon & Knab, 2018).

While the introduction of new technology might disrupt an existing market, completely new markets can also be created by reinventing BMs using the same, old technology (Bidmon & Knab, 2018). In the market for mobility, innovative BMs such as car-sharing provide a way for firms to change user practices and set the transport system on a more sustainable path (Sarasini & Linder, 2018). Some new BMs allow for the opportunity of integrating multiple technologies from different sectors, which further opens up the market opportunities (Motta et al, 2015). At the same time, the existing BMs in the market might also impede transformation. Some markets are characterised by industry recipes - a dominant BM logic develops that reflects how the firms perceive the needs of their customers and how these needs can be met (Bohnsack et al, 2014). The BM exerts a strong influence on the links, rules and structures in the overall system and consequently reinforces the stability of the socio-technical regime as actions are reproduced and aligned (Bidmon & Knab, 2018). The core idea of the incumbent BMs determine the strategic decisions of firms, which can prevent them from seeing the potential of new opportunities and ideas (Doz & Kosonen, 2010).

Conversely, it has been acknowledged that the evolution of BMs, as well as their success, are affected by the characteristics of the specific market they operate in (Strupeit & Palm, 2016). The existing institutional framework plays a significant role in hindering or encouraging the development of new BMs. The institutional financial landscape, e.g. the availability of subsidies, grants and investors, strongly influences what type of BMs are feasible or profitable (Casper & Kettler, 2001). The politico-institutional and socio-institutional aspect is also of importance. The former includes the regulatory factors that determine the activities of a firm across the whole value chain - BMs must match the legal framework - while the latter describe how BM design choices are influenced by isomorphism - firms strive to create legitimacy for external stakeholders and best practices are imitated in competitive environments (Provance et al, 2011). Moreover, the development and success of BMs is to an extent reliant on the customers in the particular market the firms serve. Systemic factors such as cultural differences in terms of norms and values lead to varying barriers for consumers, and hence the viability of a certain BM will be different across markets (Strupeit & Palm, 2016).

2.2.3 Business models and firms

Firms are a central component of the market and the IS as a whole (Bergek et al, 2008a). Responding to a perceived demand - or anticipating demand - firms introduce new products in order to earn revenues. However, innovations can't guarantee firm success on their own, but need sufficient BM design and implementation - together with mindful strategy analysis - in order to reach commercial success (Chesbrough & Rosenbloom, 2002).

Strategic management literature emphasises the notion of strategic fit and its acknowledged importance for firms' performance and decision-making (Altunay et al. 2019). The internal perspective - aligning different strategies and goals at various levels and functions of the firm - includes both vertical and horizontal alignment. Regarding BMs, vertical alignment refers to the alignment of a firm's overall corporate strategy and the individual BMs within the organisation (Wadström, 2019). Corporate strategy guides the direction of the entire organisation, including the firm's overarching goals, objectives and business prioritisation (Cornelius du Preez & Folinas, 2019; Bowman & Helfat, 2001). Thus, as BMs focus on creating, delivering and capturing value on a specific product market, the corporate-level decision influences what BMs are suitable to adopt (Altunay et al. 2019).

Horizontal alignment refers to the fit between BMs and the different business units- and functions (Wadström, 2019). For instance, novel technologies can be more or less aligned with existing BMs in terms of value proposition, distribution channels, resources and assets, partnerships etc. This impacts the likelihood of pursuing niche innovations - in general firms are more likely to pursue a technology which aligns more with their current BMs (Altunay et al., 2019). A higher degree of horizontal alignment means less reconfiguration of existing value creation, delivery and capture processes and networks (Wainstein & Bumpus, 2016), possibility to exploit synergies between businesses (Wadström, 2019) and often entail that niche innovations are easier to recognize overall (Bidmon & Knab, 2018).

In contrast to internal alignment, a firm must also consider external - or environmental - alignment, which refers to the fit between a firm's strategy to its environment (Altunay et al., 2019). In this case, the environment includes both task environments - external factors which impact the activities the firm performs, i.e. competing firms, suppliers and customers; and institutional environments - external regulatory, normative or cognitive rules (Scott, 1992). Alignment of task environments could be determined by the fit of BMs and the pre-existing industrial configuration (Strupeit & Palm, 2016), and an example of institutional alignment is the fit of a BM and a firm's wish to gain political goodwill (Richter, 2013).

2.2.4 Business models and adopters

Adopters of technology can be categorised into groups belonging to different markets, but they are also necessary to analyse on a more micro level, as individual adopters. As established in the earlier sections, adopters are acknowledged to have varying characteristics and investment motives. This heterogeneity is also reflected in what BMs the adopters prefer. Despite being centred around the same technology, the attitude towards different BMs can vary greatly between different segments of the market (Liao et al, 2019). Different individuals emphasise the attributes of a BM differently; while some believe the price incorporated in the value proposition is of high importance, others instead value attributes related to sustainability, such as the resources used in the production process (Viciunaite & Alfnes, 2020). In line with the importance of technological compatibility, the offered BM needs to be well-matched with the existing practices, resources and habits of the individual (Strupeit & Palm, 2016). All in all, this points to the fact that the BM needs to be tailored differently between different segments - and even within segments - of the population of adopters to meet the varying needs (Teece, 2010). The adaptation of BMs for different individuals extends beyond just the value proposition to also include how to reach the customers and create awareness about the product (Horvath & Sabo, 2018).

From the adopters' point of view, the BM plays a crucial role in removing barriers for adoption. As we alluded to previously, some technologies are more complex than others; here, the BM can help the customer understand the technology more easily by packaging it into a relatable context and reduce the perceived risk (Huijben & Verbong, 2013). If an adopter has technical concerns about the use and implementation of a product, these concerns can be resolved by incorporating the services of intermediaries in the value proposition of the BM (Strupeit & Palm, 2016). If an adopter is not capable of financing a one-time purchase, this can be remedied by offering a BM structured around leasing (ibid).

Developing innovative BMs to address potential adoption challenges can allow for completely new segments to adopt a technology (Mont et al, 2006). Furthermore, in line with what has been highlighted about socio-technical transitions, BMs can influence the behaviour and practices of a large group of adopters (Tunn et al, 2019; Bocken, 2017). Some BMs puts a requirement on the adopter to be more involved in the down-stream process of production (Mostaghel & Chirumalla, 2021), while other BMs can create completely new roles for the adopter, with more influence and active participation in the market (Zepter et al, 2018; Azarova et al, 2021).

2.3 Adopters' perceptions of business models - the case of solar PV

It is clear that the diffusion of an innovation is dependent on a multitude of factors, such as the surrounding IS (Negro et al., 2012), the characteristics of the innovation (Rogers, 2003) and most importantly, the characteristics of the adopters (Mignon, 2016). Furthermore, BMs have also been discussed as having a considerable impact on the diffusion of technologies (Chesbrough & Rosenbloom, 2002; Bidmon & Knab, 2018), as they change the market (Sarasini & Linder, 2018), are important tools for firms to commercialise innovations (Bolton & Hannon, 2016) and facilitate adoption (Huijben & Verbong, 2013). What is left to explore is the adopters' perceptions of solar PV and solar PV BMs specifically. In the following section, the conclusions from DOI- and BM-literature will be combined to provide further insights on this subject.

2.3.1 Adopters perceptions of solar PV

In section 2.1.4, the adopters' internal mental processes were highlighted as an elevated topic in recent DOI literature - adopters of innovations are heterogeneous (Mignon, 2016), and their identity, habits and investment motives notably influence their attitude towards adopting new technologies (Seligman 2006; Selwyn, 2003). In line with this, several studies have highlighted the importance of considering the heterogeneous motives and driving forces behind the investment decisions of solar PV adopters. Bergek & Mignon (2017) find that economic and environmental motives are generally significant, but there is variation within these motives and there are other frequently occuring motives. In terms of economic investment motives, these include wanting to be eligible for lower tax rates, reduce energy costs, earn money and having access to resources suitable for the use of solar PV.. Moreover, adopters have non-economic motives and invest in solar PV because they want to become independent, have a technology interest, are forced by regulations, to enhance their image and due to environmental benefits (ibid). Palm & Tengvard (2011) confirm that environmental concerns are often a main motive, and that such concerns can be expressed in multiple ways - some adopters want to set an example and get recognition from the members in their network, while others simply want to live in harmony with nature.

Studies have also looked at how barriers and uncertainties in the solar PV adoption process (Rai et al., 2016) - as well as how attributes and utility components of market actors (Aspeteg & Mignon (2019) - impact the motivations to adopt. Rai et al. (2016) highlight the main determining factors on the mode of adoption as the concerns about the supplier's operations and maintenance of the technology, as well as the financial returns of the solar PV system. In line with DOI-literature, they emphasise the role of information channels affecting the decision-making process. Installers and neighbours have an important, but supplementary, role both in the decision to adopt. Installers can gain significant influence and dominate the stream of information from the outset of an initiated relation, and peer-effects of neighbours provide information channels and motivation for new potential adopters in close proximity (ibid). However, the value of information from peers and installers is shown to be conditional on marketing, or other events, that have taken place before in the decision-making process. Aspeteg & Mignon (2019) show that solar PV adopters have both differences and similarities in their perception of the attributes and utility components of solar PV intermediaries, as well as the expected value of the services provided by them. Intangible attributes such as service-mindedness and legitimacy are determining factors, as well as the need for support for design and installation, and support for the adopter's sense of control.

2.3.2 Business models for solar PV

In order to evaluate adopters' perceptions of solar PV BMs, there is a need to establish the set of BMs for which analysis can be based on. This section calls attention to the main BM categories that have received particular attention in solar PV literature, as well as outlines a set of BMs that will lay the foundation for the continued empirical work of this thesis. The main categories of BMs consist of: *host-owned* (from here HO), *third-party-ownership* (from here TPO), and *community solar* (from here CS) (Bankel & Mignon, 2022), and are described more in detail below.

HO BMs are the most widespread solar PV BMs and refers to a model where the owner of the solar PV system also owns the facility where it is installed, and controls the electricity produced - whether it is sold or used by the owner themselves (Horváth & Szabó, 2018). It puts more responsibility on the owner and is often associated with higher risk and more challenges (Drury et al., 2012). This includes making the investment upfront (Huijben & Verbong, 2013), handling technological features and choice of suppliers, potentially with limited knowledge and experience (Aspeteg & Mignon, 2019).

TPO BMs refers to a model where the owner and user are different actors. The owner operates the solar PV system on the customer's facility in a different location (Drury et al., 2012). Solar service firms usually offer leasing contracts or power purchasing agreements (from here PPA) as means of payment, relieving the customer from upfront investments. Here the customer enters a contract, either with monthly payments, or agrees to pay for electricity at a fixed price. Further, in this model, third-party service firms often take responsibility for maintenance of the installation and usage, reducing the challenge of advanced technological features and lack of previous knowledge and experience (Horváth & Szabó, 2018).

CS BMs refer to a model where the ownership of the solar PV system is shared within a community. The systems are often located on local land or community buildings, where the members of the community can either sell the electricity using PPAs or use the electricity themselves (Nolden et al., 2020). The BM can be operated by various types of community members including different organisations such as utilities, nonprofits and other solar project developers, as well as residential homeowners (Horváth & Szabó, 2018). The benefits and drawbacks from these types of BMs depend on the specific circumstances within a community (Mignon & Rüdinger, 2016).

Bankel & Mignon (2022) recently categorised the BMs of 241 solar PV companies in Sweden, providing an overview of the most occurring BMs on the Swedish market. This categorization of solar PV BMs will be used when exploring adopters' perceptions. The authors find that solar PV BMs can be categorised based on similarities in the components of the BM-framework defined by Richardsson (2008), where the core offer by the company is the defining feature. The categories are presented in Table 1 below.

Table 1: Solar PV business model components (Bankel & Mignon , 2022)

Solar BM Category	Use[1]	Value proposition	Value creation & delivery system	Value capture
Technology provision	52	Packaged solar PV components for a standardised solar plant. Primarily targeted at private households that can install the plant themselves.	Bulk purchasing, warehousing, and packaging of solar PV components.	Sales of solar packages at a higher price than the unit price of each component. One-time payment at point of sales.
Turnkey provision	215	Complete and hassle-free procurement and installation of a tailored solar plant that is ready for immediate	Manage and coordinate all aspects of the solar installation process (including technology procurement, plant design and installation) from start to finish.	Added margins on the cost of material and labour for managing the process.

[1] This number refers to the number of companies to employ the specific BM.

Solar BM Category	Use[1]	Value proposition	Value creation & delivery system	Value capture
		use. Primarily targeted at private households, farmers, apartment-, and commercial property owners.		One-time payment at completion.
EPC provision	6	Complete and hassle-free procurement, installation, and ownership of a tailored large-scale solar plant that is ready for immediate use. One point of contact. Targeted primarily at large businesses and electricity retailers.	Managing everything before, during, and after the installation process (including obtaining plant location, financing, monitoring, maintenance). Collaboration with financial institutions, municipalities, local communities, and grid-operators.	Added margins on the costs of material and labor for managing the process. Predictable revenue streams for monitoring and maintenance. One-time payments at completion and annual/monthly fee for monitoring and maintenance.
Leasing provision	8	Access to a solar plant for production and use of electricity. No operational responsibility or up-front costs. Primarily targeted at commercial property owners.	Financing, technology procurement, plant design and installation, operations, maintenance, and ownership of a solar plant located on a customer's roof.	Predictable revenue streams that altogether exceed the costs. Monthly payments over a predetermined leasing term.
PPA provision	6	Simple and predictable procurement of large amounts of solar electricity via Guarantees of Origin. Hedging against electricity market volatility. Primarily targeted at large businesses and commercial property owners.	Financing, technology procurement, plant design, installation, operations, maintenance, and ownership of a large-scale solar plant (including obtaining plant location). Collaboration with financial institutions, municipalities, local communities, and grid-operators.	Predictable revenue streams that altogether exceed the costs. Long-term monthly payments via a power purchase agreement.
Consulting provision	13	Impartial consulting services (e.g.	Application of technical expertise and impartial position	An hourly/daily fee for access to

Solar BM Category	Use[1]	Value proposition	Value creation & delivery system	Value capture
		pre-study, tendering, project management, plant inspection). Primarily targeted at apartment- and public property.	(in relation to technology and installation providers).	expertise that is higher than the cost of personnel providing the services.

Technology provision is a type of HO BM, where the adopter purchases all components of the technology and is solely responsible for the installation and implementation of the solar PV system. Thus, this BM is generally cheaper than other HO BMs, such as turnkey provision. Firms often target this BM towards residential adopters - private households, farmers etc. - who usually invest with the aim of self-consumption of electricity. The value proposition mainly consists of the provided technology components, either offered individually or as a bundle (Bankel & Mignon, 2022).

Turnkey provision is another type of HO BM, where the adopter purchases a complete package of the solar PV system, customised for the specific adopter's preconditions and ready for immediate use. This BM is often targeted to a wider range of adopters, including both residential and commercial, where the core offer can vary to a great extent. The value proposition mainly consists of the hassle free process - everything from components, tailored design to installation is included - but could further entail monitoring and maintenance of the system, as well as providing the adopter with information and financial advice. Although the provider might work with suppliers of their own, the firm remains the single point of contact for the adopter (ibid).

EPC provision stands for engineering, procurement, construction, and is the third HO BM in this framework. It resembles the turnkey BM in many ways, with the main difference being the scale of the projects. Due to the different focus in scale, EPC BMs are targeted towards larger adopters, such as utilities and industrial property owners. Another difference is the activities included in the offer; these can range from finding suitable locations for the solar PV systems to additional intermediary roles such as collaborations with local communities and municipalities. Beyond these differences, the value proposition of hassle free procurement is indistinguishable from turnkey provision (ibid)

Leasing provision is a TPO BM - as such, the adopters' do not own the solar PV system themselves, but are instead allowed access to the system and the produced electricity. The targeted customers are both commercial adopters and residentials adopters. The value proposition chiefly consists of the access to solar PV systems and electricity without any operational responsibility - the leasing provider handles all operations, maintenance, monitoring and financing - or need for upfront investment. Instead the adopter enters a leasing contract and agrees to a monthly payment scheme (ibid).

PPA provision is the second TPO BM within the categorisation framework, and naturally shares resemblance with the leasing provision. PPA is a contract through which adopters are allowed access to solar PV electricity; however, this must not include the systems themselves. The electricity is usually delivered through the grid where adopters are provided Guarantees of Origins (GOs) linking the production and consumption. The targeted adopters are often larger actors, in line with EPC provision. In contrast to leasing, the value proposition is focused on simple and large-scale procurement of electricity at a fixed price, allowing adopters to hedge against an otherwise volatile electricity market. Further, the PPA provider takes responsibility for all operations, maintenance, monitoring and financing, but also fosters relationships and collaboration with municipalities and local communities as seen in the EPC model (ibid).

Lastly, consulting provision proposes value through ad-hoc services from an impartial actor. These services can include pre-studies, engineering and offering evaluation, depending on what the adopter wants. Some providers extend the offered activities to construction, installation, monitoring, and operations - in doing so, increasing the ways of capturing value. Consultants charge adopters an hourly fee for the use of their services (ibid).

2.3.3 Adopters perception of solar PV business models

Reflecting on the reviewed literature, we can state that adopters of solar PV have been shown to have heterogeneous investment motives and drives (Bergek & Mignon, 2017) and differing opinions of what is important when receiving help from intermediaries with the adoption process (Aspeteg & Mignon, 2019). Different solar PV BMs remove different barriers for the adopters of solar PV (Horváth & Sabo, 2018) - in line with this, Strupeit & Palm (2016) highlight that BMs for solar PV diffuse in accordance with contextual factors of the market they serve; for instance, in the US, customers have low financial capabilities and value the minimization of transaction costs, which is reflected in the popularity of TPO model, while in Germany, consumers are more stationary and PV is considered a long-term, economic investment - hence the HO BM is more popular.

This all indicates that adopters might have varying perceptions about the different BMs for solar PV, with different underlying reasons for why they prefer choosing one BM over another. However, there is an apparent lack of research regarding this topic - despite an extensive literature review, we have found no empirical account for how adopters perceive and make sense of BMs for solar PV, confirming the need to address the research gap.

The role of the BM in the sustainable transition has been emphasised on multiple occasions so far, as well as the importance of developing a qualitative understanding of the adopters of solar PV - the adopters are the key component in the diffusion process, as they themselves make the final decision to adopt a technology (MacVaugh & Schiavone, 2010). By conducting in-depth research on adopter perception based on a common, established set of BM for solar PV, we can get a sense of what is the perceived value and the perceived missing value of the existing solar PV BMs, as well as what factors influence these perceptions. In doing so, we can identify if there is a mismatch between how policy makers and scholars believe adopters perceive BMs and the adopters' actual perception - providing a holistic perspective that helps policy makers to accurately design policies intended to increase the uptake of solar PV, contributing to reaching the desired outcome of accelerating the sustainable transition.

3. Methodology

In this chapter, the methodology of the thesis is presented in detail. First, the research- context and strategy is explained and argued for in line with theory on research design and methods. Second, the methods for data sampling, data collection, and data analysis are outlined. Lastly, the strengths and weaknesses of the researchers' choice of methods, as well as the quality criteria for the thesis, is reflected upon and discussed.

3.1 Research context

This thesis is conducted within the frame of an on-going research project on innovative BMs for solar PV within the department of Innovation and R&D Management at Chalmers University of Technology. This had certain implications on the research, as the process of developing the research questions were guided by the overarching scope and goals of the project at large. Being part of this project further assisted in the process of data sampling as information and lists of a number of solar PV adopters in Sweden were easily accessible.

The thesis is designed as a qualitative case study on adopters' perceptions of solar PV BMs in Sweden. The geographical context of the study has significant implications and should be addressed. Sweden is chosen as the country of analysis for several reasons. Since the liberalisation of the energy market in 1996, a relatively large heterogeneous group of RET adopters has evolved and the motives to adopt differ between wind, solar and hydro (Bergek et al., 2013), which calls for a need to examine each group separately. The Swedish market for solar PV has grown exponentially in the last decade and comprises both industrial, commercial and residential adopters (IEA, 2020), and in terms of solar PV capacity, Sweden lies above the global average per capita (Palm & Lants, 2020). Lastly, the previously conducted work within the on-going research project at the department of Innovation and R&D Management at Chalmers University of Technology provides a BM landscape to build upon. In sum, this allows for the analysis of a sufficiently developed market for adopters' of solar PV BMs.

3.2 Research strategy

Choosing a suitable research strategy is an essential part of any dissertation, as the strategy defines the relationship between research and theory and consequently what methods that should be used to carry out the research. When deciding research approaches, scholars are generally faced with two options: quantitative or qualitative. While the two approaches both have their merits, and can be used in conjunction, they incorporate different philosophical assumptions - ontological and epistemological considerations - about the nature of research and the object of investigation. (Bell et al., 2019). A quantitative study often takes a deductive approach; namely, hypotheses are constructed based on theory and measured against quantifiable, externally existing phenomena. Conversely, a qualitative study takes an inductive approach, where socially mutable phenomena are observed to generate new, generalizable theories (ibid). As such, qualitative research is more concerned with investigating human behaviour than the what, where and when of quantitative analysis (Merriam & Tisdell, 2015).

In line with the explorative nature of the research scope, this study is of inductive nature. The topic of investigation is largely uncharted; before any quantitative analysis can be done, researchers must gain a deeper understanding of adopters' perceptions of solar PV BMs. Moreover, a qualitative approach is deemed more appropriate when investigating the behaviour of individuals (Bell et al., 2019), and in our case, as discussed in the frame of reference, adopters' perceptions are largely based on individual characteristics and mental frameworks, subject to social phenomena. Thus, the study employs a qualitative research strategy that emphasises interpretivism and constructivism.

3.3 Frame of reference

Reviewing literature is an integral part of the research process, and provides justification for research questions and research design as well as prepares researchers on how to collect and analyse data in an informed way (Bell et al., 2019).

To construct a frame of reference, the reading of literature took off in works recommended by our supervisors, and was complemented by a search process for further literature structured around relevant keywords. Keywords such as: "solar PV", `"business models", "adoption", "adopter motives", "socio-technical transition" and "innovation system" were then used to narrow down the search. This contributed to a better overall understanding of the research field and related literature streams, provided a basis for the construction of an interview guide, and was further utilised in the analysis and discussion process.

3.4 Data collection

The collected data are both of primary and secondary nature. Primary data was mainly collected and used in order to answer the first research question - to gain insight of the solar PV adopters' perception previously unexplored. Secondary data in the form of reviewing and writing the frame of reference, helped to understand the current state of the field of research and laid the basis for analysis, which - in combination with primary data - contributed to answering the second and third research questions.

The primary data collection consisted of semi-constructed interviews. This kind of interview method is fitting when the interviewee seeks information within specific topics, but wants a dimension of freedom to explore potential knowledge gaps (McIntosh & Morse, 2015) - thus, this method was suitable to employ in this thesis, as descriptive answers about individuals' behaviour were needed to understand adopters mental frameworks, while still adhering to specific themes and questions in order to compare findings and draw generalisable conclusions. To achieve this, we constructed an interview guide with predefined topics and guiding questions for each topic - related to our research questions and derived from the frame of reference - while simultaneously trying to remain responsive and probe the interviewees responses. The interview guide included four themes; theme 1: Our introduction - a short presentation about ourselves, the research project at Chalmers and the thesis; theme 2: Interviewees introduction - an open question letting the interviewees introduce themselves, with some follow up questions about their educational and professional experience, as well as general interests and hobbies; theme 3: Process of investing - exploring the interviewees' overall process of investing in solar PV and their motives and driving forces behind their decision; and lastly, theme 4: Arrangement for investing in solar PV - asking the interviewees to describe how they went about investing, what type and arrangement they chose and for what reasons. We purposefully wanted to avoid confusing the interviewee with the word BM as most adopters do not think of the arrangement of the solar PV system that way. The interview guide can be seen in Appendix A.

Before the interviews with adopter 9, adopter 18 and adopter 19, the guide was emailed to the interviewee on their request. For the rest of the adopters, we sent an email with a quick description of the project and our thesis purpose. Due to the fact that most of the interviewees were geographically dispersed around the country, and for efficiency reasons and preference from both sides, all interviews have been conducted via digital video interviews on zoom or through regular phone calls. Both researchers were attending all interviews - one responsible for leading and asking questions, and the other for taking notes. More often than not did the researcher taking notes contribute to the conversation with insights or additional questions.

3.5 Data sampling

A purposive sampling technique was initially utilised as we aimed to select and reach units directly with reference to the research questions and purpose of the paper. When a limited number of interview subjects were reached, the approach was complemented by so-called snowball sampling, where interview subjects were asked to recommend other possible participants. (Bell et al., 2019)

The sampling segments were based on the current market structure in Sweden. The main market segments and their respective market share are: 43 % residential (35 % single-family houses, 8 % multi-family houses, > 1% facilities), 41 % Commercial (facilities), > 1% Industry (facilities) and 15 % centralised (ground) (IEA, 2020). Noteworthy, within the residential segment, single-family houses constitute the absolute majority and was therefore the focus in our study. Regarding sample size, the concept of data saturation is often used to guarantee qualitative rigour in business research. The main idea is to continue with sampling until no new or relevant data emerges, or until conceptual categories are fully understood (Bell et al., 2019). While it was hard to specify the amount of interviews it would take to reach saturation in this case, our estimates ranged between 20-30 interviews, based on discussions with our supervisors. Considering the current size of the identified adopter segments, this would then yield 9-13 interviews with residential adopters, 8-12 commercial adopters, 3-5 centralised adopters and 1 industrial adopter. The industrial adopter category is seen as synonymous with the commercial adopters in this paper, with the main unifying factor being an organisation taking the adoption decision compared to residential adopters. Due to the structure of the focused BMs and the scope of this study, centralised adopters - which in this context alludes to organisations constructing centralised solar PV parks - will be excluded as these actors mainly provide BMs for both residential and commercial adopters to invest in. To conclude, this yielded a goal to reach for interviewing 10-14 residential adopters as well as 10-14 commercial adopters. In relation to residential and commercial turnkey adopters, saturation was reached after a total of 22 interviews - 12 interviews with residential adopters, and 10 interviews with commercial adopters. However, due to difficulty of finding adopters of BMs other than turnkey, saturation can not be considered to have been reached overall.

The on-going research project had put together a comprehensive list of adopters which allowed us to get in touch with the identified market segments. Additionally, we reached out in our personal networks, as well as did our own research exploring industry websites and articles looking for potential subjects to complement the list. Both researchers reached out by email and/or phone to potential subjects in order to schedule a time for an interview, or were contacted by potential interviewees through one of our posts on social networks. Out of the residential adopters, a majority were found through a facebook group called “Solceller Energilagring Mikroproduktion Forum”, where we outlined the purpose of the study and expressed the need for applicants. A minority were found through close friends who responded to our post on social media. Out of the commercial adopters, a majority were contacted through targeted emails, either to someone on the provided list, or through finding contact details online. We started out accepting all interviews to exclude a selection bias among potential data sources. After conducting multiple interviews, and saturation for turnkey started to form, an effort was made to include certain BMs - i.e leasing provision and PPA provision - as these were underrepresented. When approaching commercial adopters, we aimed at reaching the responsible person for their investments in solar PV. If that was not possible, we tried to reach someone who was included in the investment decision process, or had distinct knowledge about it.

3.6 Data analysis

Drawing from Bell et al. (2019), the concept of grounded theory was used, where the data set is iteratively scanned for certain themes - an approach which emphasises finding and identifying patterns. It resonates well with a qualitative research strategy and this particular study, since it is an uncharted area of research which makes it important to incorporate themes in an on-goin process. For instance, when finding new areas or topics of interest, the researchers can draw from those insights and add questions in the interview guide; similarly, we might realise that the individuals in one of our identified adopter segments have converging perceptions, leading ut to put more effort into another group (Glaser & Strauss, 2017).

Qualitative interviews generate large amounts of data, which could be complicated to analyse. To alleviate the process from solely relying on analysis of the transcriptions, we took thorough notes during the interviews (Bell et al., 2019). However, in line with Bell et al. (2019), were we well aware of the importance of being highly alert and responsive. This helps when following up interesting answers, prompting and probing any questions or inconsistencies in the responses - a process which could be interrupted if the researchers are focusing on taking notes. To avoid this issue, both of us were present during all interviews; one was responsible for documenting and taking notes, while the other asked the questions. This strategy decreases the risk of distraction during the interview, where one researcher always focuses on the interviewee, while still allowing for detailed note-taking. Our roles were alternating between the interviews, but equally distributed, thus both were leading and taking notes on 11 interviews respectively. The notes were thorough and written almost as transcriptions trying to include the majority of the answers. Subsequently, following each interview session, we manually complemented the notes with complete transcriptions, and coded and analysed the freshly collected data with the aim of developing new theory that could be continuously compared and revised along the rest of the data collection process. The coding entailed grouping data into categories, based on a combination of induction and deductive theory from the frame of reference, which allowed for easier comparison and saturation of the essential elements derived from the data set. (Bell et al., 2019)

Unlike quantitative data, where the data is matched with standardised codes, the qualitative method entails the researchers interpretations of data to shape the emergent codes. Importantly, this study does not only explore individuals' perceptions of the subject of solar PV BMs, but the analysis process is dependent on the researchers' interpretations of those perceptions. To determine adopters' perception of solar PV BMs, the researchers had to rely on an interpretation of the adopters' expressed opinions and thoughts, in relation to the value proposition of the different BMs. This undoubtedly put a lot of pressure on the researchers to conduct the analysis within the canon of good practice. We argue that through a transparent methodology and closely following the recommended practices of Bell et al. (2019), the method for analysis upheld required standards.

3.7 Methodology discussion

Due to the uncharted field of research and the explorative nature of the study, it proved quite a challenge to gain a high level understanding of the current literature on adopter perception. However, with the close and active participation of our supervisor and the members of the ongoing research project, this challenge could be effectively handled. Additionally, we would like to emphasise the smoothness of the data collection process. Reaching adopters and getting them to agree to be interviewed was surprisingly uncomplicated. Once initial contact was established, the entire sample of adopters were engaged and happy to share their experience. The extent to which they answered the questions were noteworthy, which we argue is a strength of our findings.

3.7.1 Discussion on data quality

In addressing the research quality of this thesis, the quality criterias credibility, transferability, dependability and confirmability were used. These criteria are often applied for qualitative research; according to scholars, the application of the widely used criteria within quantitative research - namely validity and reliability - might not be appropriate when exploring more than one account of social reality. (Bell et al., 2019)

Credibility entails to which degree the research is carried out in good faith, in other words to which degree the researcher's representation of the respondents' constructions are correct (Bell et al., 2019). In order to ensure credibility, both researchers were present at all interviews, which allowed for a confirmation of what was said, and guaranteed that the researchers had the same interpretation. On this note, both researchers also analysed all the notes and transcriptions. This was done iteratively in line with the grounded theory approach, which provided insights enabling improvements in carrying out the consequent interviews and a better understanding of the respondents constructed realities.

The second criteria, transferability, has to do with the extent to which the study can make general claims. There is an empirical issue to account for, i.e if the findings hold in other contexts, or at other times (Bell et al., 2019). First, we argue that through being transparent in our methodology, and disclosing the interview guide in Appendix A, this increases transferability as readers can view the entire research process. Second, we must acknowledge the research context, as well as the respondents included in our sample. The research context of Sweden constrains the findings to certain geographical and contextual factors. Moreover, regard to the distribution of respondents within the sample, some reflections are appropriate. In the sample of commercial adopters, it is evident that the segment of real estate organisations are overrepresented, and considering the total sample of interviewed adopters, there is an overrepresentation of turnkey adopters. This affects the transferability of the outcome of the study - particularly with regard to the commercial adopters. However, considering the overrepresentation of turnkey overall, we argue that the interviewed sample is representative of the Swedish adoption landscape, and that the data provides a substantial springboard for the research on adopters' perception of solar PV BMs.

The third criteria, dependability, focuses on data stability. More specifically, it ensures that similar data can, or would have been, generated in a replicated study (Bell et al., 2019). Dependability can be verified through thorough documentation and auditing, which we argue has been done accordingly in this thesis. Tools and documents such as notes, transcriptions, video and audio recordings have been utilised and saved for observation. It could be argued that the same person should have led and respectively taken notes during the interviews to improve consistency. However, we argue that due to both researchers being present at all interviews, the consistency of the performance could be ensured. This further gave both researchers the opportunity to learn and gain insights on the different roles enhancing the process through post interview discussion. In line with auditing, our supervisor has perpetually looked through our work and redirected us when she believed it to be necessary. Lastly, the thesis has been peer-reviewed once during the project, and once at the end, further contributing to dependability.

The last criteria, confirmability, is concerned with research bias. Although it is impossible to be completely objective, the researcher must not let personal values and theoretical inclinations affect the research process or results (Bell et al., 2019). In this thesis, bias has been reflected on since the beginning. The sampling approach began with evaluating the Swedish market structure in terms of available solar PV BMs and adopter categories in order to gain a representative sample frame. This was done to ensure certain market segments, and avoid a biassed contribution. Moreover, it should be noted that this thesis being part of a larger research project might have transferred bias onto the researchers, as the superior experience and expertise of the members of the project naturally had a strong influence on the chosen processes. However, we believe that this was not the case, and that the relationship has been an advantage and contributed to the quality of this thesis. Lastly, there is a risk that the researchers' interpretation of the adopters' perception inflicted bias on the results, but - as argued - this risk was minimised by following the canon of good research practice.

4. Empirical findings

In the following chapter, the empirical findings from the study will be presented. The adopters' perceptions of the solar PV BMs offered by firms in Sweden will be summarised according to the BM framework derived by Bankel and Mignon (2022). However, there is an exception in the structuring of the results: EPC is not included as a specific BM category; instead, it is replaced by the investment alternative of CS. Among the interviewed adopters, there is not a distinct perception of having invested in the EPC BM. From a consumer perspective, the aspects of EPC are arguably sufficiently captured by analysing adopters' perception of the turnkey BM or PPA BM, as these BM categories are similar to EPC in the value proposition, value creation and delivery system and value capture. Conversely, while firms do not employ a specific BM tailored for CS, the design of this investment alternative differs from the other BMs and has unique implications for adopters, thus making it relevant to include.

In many instances, the commercial adopters and residential adopters have congruent perceptions about the different BMs. For the sake of brevity, whether the scope of the findings refers to the perception of a commercial adopter or an individual adopter will only be specifically highlighted when it is deemed essential for the resulting analysis. Below, a summary of the interviewed adopters is presented:

Table 2: Summary of interviewed adopters

Residential adopters	**Gender**	**Role/position of interviewed adopter**	**Business model**
Adopter 1	Male	Pensioner (Ex entrepreneur and engineer)	Turnkey & consulting provision
Adopter 2	Male	Development manager	Turnkey provision
Adopter 3	Male	Pensioner	Turnkey provision
Adopter 4	Male	Working with electric vehicles	Technology & Turnkey provision
Adopter 5	Male	Electrical engineer	Turnkey provision
Adopter 6	Male	Working with energy systems	Turnkey provision
Adopter 7	Female	High school teacher	Turnkey provision

Adopter 8	Male	Mechanical engineer	Turnkey provision
Adopter 9	Male	Energy and solar consultant	Technology provision
Adopter 10	Male	High school teacher	Turnkey provision
Adopter 11	Male	Pensioner (Ex journalist)	Community solar
Adopter 12	Male	Sales at large energy company	Community solar
Commercial adopters	**Type of business**	**Role/position of interviewed adopter**	**Business model**
Adopter 13	High school	CEO	Turnkey provision
Adopter 14	Bolt retailer	Purchasing manager	Turnkey provision
Adopter 15	Plant retailer	Environmental and energy coordinator	Turnkey provision
Adopter 16	Real estate	Energy strategist / consultant	Turnkey, consulting & PPA provision
Adopter 17	Real estate	Energy strategist	Turnkey & consulting provision
Adopter 18	Real estate	Project manager	Turnkey & consulting provision
Adopter 19	Real estate	Energy engineer consultant	Turnkey provision
Adopter 20	Hospital	Technical manager	Turnkey & consulting provision
Adopter 21	Real estate	Chief technology officer	Turnkey provision
Adopter 22	Real estate	Property manager	PPA provision

4.1 Adopters' perceptions of consulting provision

Most of the interviewed residential adopters are not aware that firms offering consulting provision for solar PV exist. Instead, the adopters often gather knowledge and information themselves before making the decision to invest. The process of searching and gathering information entails reading - both in trade journals or in online communities - and concerns technical details about the installation process and system components as well as what solar PV supplier to pick. Adopters also make contact with governmental agencies to discuss what norms and regulations are to be applied for the system. In some instances, they discuss with friends or colleagues with experience from investing themselves or from working in the solar PV industry. For instance, adopter 10 got introduced to the investment opportunity through a close friend who previously worked with sales of solar PV. He credited him for sparking his interest but also as a sounding board for discussing which supplier to use and answering general questions about the investment. Among the interviewed commercial adopters, the use of consulting provision is more wide-spread. However, the most common approach identified among the adopters - both with regard to commercial and residential - is to simply consult with the company that is providing the procurement and installation of the solar PV system.

4.1.1 Perceived value of consulting provision

There are some cases of adopters - mainly commercial - who have made use of consulting provision and perceive the value proposition to be attractive. Two commercial real estate adopters (adopters 18 and 21) have a contract with a consulting firm and continuously employ their services to help with inspecting on-site roof conditions, determining the best installation set-up, project management etc. The project team tasked with handling the solar PV development within these organisations is quite small, and consulting provision is perceived as providing the right knowledge and alleviating the workload. Another commercial adopter, adopter 16, employed the services of a large consulting firm during their first round of investments; after having received aid with procurement and project management, the commercial adopter then felt that they were sufficiently knowledgeable to handle additional investments without consultants. Similarly, residential adopter 1 employed one hour of third-party consultancy before making his first round of investment. Albeit satisfied with the result, he does not feel the need to make use of the service for his second round of investment.

The same residential adopter expressed a wish to be able to discuss what solar PV supplier to use with an external party, and stated that it was difficult to identify such independent consulting companies for solar PV. Another residential adopter, adopter 6, made contact with house inspection firms to sort out the site-specific conditions for solar PV investment, but determined that it would be too expensive to employ their service. Additionally, residential adopter 4 experienced problems with the delivery and installation of his system, and expressed a wish for certified electricians to be included or provided by the installation firm. Navigating the technical landscape for the solar PV system components, the installation process for solar PV, and the solar PV system supplier landscape is described by many adopters as a jungle. A couple of adopters (adopters 4 and 5) perceive that some firms are looking to make easy money without necessarily having the right knowledge base. Adopter 8 recounts being met with indifference and abrasiveness when questioning suppliers about the type of solar panels provided and the technical components included in the system. To conclude, there is an expressed interest and perceived value - although implicit - for third-party consulting among a handful of residential adopters. When asked hypothetically, these adopters confirm that they would have considered using consultancy provision during their investment if the opportunity would have been presented to them. It should be mentioned that the type of consultancy needed differs depending on the situation of each adopter.

4.1.2 Perceived missing value of consulting provision

As mentioned earlier, most adopters have not opted for consulting provision; they rely on the company that is providing the installation or procurement of the solar PV system to provide all the necessary information. Commercial adopter 22 states that they usually procure different tenders, and after choosing an offer they leave everything to the supplier; similarly, residential adopter 10 describes that he trusts the supplier to plan and optimise the investment. For many adopters, the services of solar PV installation and procurement firms have been sufficient - consultancy provision is to some extent perceived as being a part of the solar PV supplying firm's task, and hiring additional consulting provision is not perceived as adding value

Furthermore, adopters appear to value reduced points of contact. It is perceived as less troublesome to only work with one company, and the fact that the chosen solar PV supplier sometimes hires external partners to do the installation does not seem to impact or change this perception. Although not widespread, there is also a perception regarding the competence of consulting firms - adopter 5 believes they lack the proper knowledge and thus do not bring any real value.

4.2 Adopters' perception of technology provision

Technology provision is almost exclusively targeted towards household adopters, which is reflected in the interviews; for the commercial adopters, technology provision has not been a potential alternative. The interviewed residential adopters are generally aware of the existence of technology provision, but similarly, for most of them, this BM was never considered when they invested. A few residential adopters - in particular the ones with a technology interest and related technical experience from their profession - have considered technology provision as a viable investment alternative.

4.2.1 Perceived value of technology provision

The adopters that considered investing in technology provision perceive it as an opportunity to save a large part of the total investment cost. This is seen as the main value adding attribute of the BM - the cost aspect is further highlighted as the principal driving factor among the few adopters who actually invested in technology provision. Additionally, some adopters perceive that installing the solar PV system themselves is a fun and manageable task - adopters 4, 6 and 9 considered it to be a good opportunity to learn about the technical details of the installation process and the solar PV system itself.

4.2.2 Perceived missing value of technology provision

A common obstacle for the adopters who have considered technology provision is the reluctance to be perched upon the roof, which is a necessity to mount the installation - it is perceived as dangerous. Adopter 4 made use of technology provision during his first round of investments and performed the installation work himself, but it was done without proper scaffolding and thus felt unsafe. In a second round of investments, the same adopter bypassed using a solar PV retailer in Sweden and procured system components from a subcontractor to get a better price, and then employed an installation firm to mount the system, which he perceives as a preferable solution. A few adopters (adopters 4, 5, 6 and 8) state that they thought about mounting the solar PV system on the ground; this is seen as less dangerous and the adopters are therefore more inclined to use technology provision in this case, but other factors, such as a lack of suitable ground space, worked against choosing this solution.

Another aspect contributing to the perceived missing value of the BM of technology provision is the complexity of the technology and the installation process. For a majority of the adopters, technology provision is perceived as far too technically advanced to constitute a viable option. Even for some adopters (e.g. adoper 5 and 6) who are well versed in related technical fields, installing the system on your own is perceived as a rather difficult task with many norms and regulations to adhere to - thus favouring turnkey solutions in order to have a smooth investment process. Adopter 10 and adopter 8 have heard of instances where people who have installed themselves experience functional problems - or hazardous consequences, such as fire from overheating components - and unlike turnkey, technology provision does not come with operational guarantees if anything goes wrong. The perceived risk of technology provision is also related to the size of the solar PV system - adopter 10 installed a couple of small solar panels on a summer cottage, but did not consider it to be a possibility for the main residence. Additionally, there is a legal requirement in Sweden to be an electrician to perform the installation work, which adopter 5 expresses constituted a hindrance for adopting the BM and affects his perception of the usefulness.

It should be noted that there are certain adopters who believe technology provision is a manageable BM in terms of technological complexity. Of the adopters who considered installing themselves but never opted for it, adopter 2 and adopter 6 state that they are more open to doing it in a second round of investments due to now having received experience and knowledge about the implementation. However, in a number of cases, a deciding factor in not choosing technology provision is related to a lack of time or energy. Some adopters (adopter 1 and 2) perceive they do not have the amount of time required to become knowledgeable about the subject; while other adopters (adopter 5 and 6) perceive they do not have enough time to perform the installation work themselves. Adopter 2, who was presented with the option of technology provision, states he has done a lot of previous renovation work on the house in the past and is now busy with his kids, which made him decide to reject the BM fairly quickly.

4.3 Adopters' perception of turnkey provision

Turnkey provision is the dominant choice of BM both for residential and commercial adopters. Often, this is the only alternative offered from suppliers and the only model considered by the adopters before their investment decision. There are different variations of turnkey solutions, with varying degrees of included components and services, as well as different levels of transparency and control given to the adopter. Some adopters express a desire to be involved in the overall process - this might include being able to do some of the administrative work themselves or partake in the calculations and installation design; contrastingly, other adopters want to rely completely on the employed company with no requirement to be involved beyond the point of providing investment capital. A general distinction between these two perspectives is the level of previous knowledge, technical experience and technology interest, where the more knowledgeable adopters tend to be more interested in being involved. In light of its popularity, turnkey provision is the most covered BM during the interviews - where the perceived benefits often are emphasised. Even though some distinct differences can be seen between the two segments of residential and commercial adopters, most arguments in support of this BM are quite similar.

4.3.1 Perceived value of turnkey provision

Two valuable aspects of this BM are repeatedly highlighted by the interviewed adopters: (1) the fact that the solution is delivered and installed as a complete package ready for use, and (2) the aspect of owning the system themselves. With regard to the first aspect, common remarks were emphasising the smoothness of the process; residential adopter 10 describes how a date was set and the installation was finished within a couple of days - nothing was required by him beyond the point of investing. In general, reducing complexity is perceived as value adding, especially for adopters with limited technical knowledge or previous experience, but even amongst the more knowledgeable. Investing in solar PV is perceived as a complex task overall, as outlined in the section on perceived missing value for technology provision. The technology is perceived as intricate and novel, and dealing with installation norms and regulations contribute to the uncertainty - turnkey provision addresses this barrier. The perceived smoothness of turnkey is also reinforced by the value capture model of one-time fixed investment cost - residential adopter 6 highlights that he generally prefers to purchase everything at once compared to having a lot of moving costs.

Additionally, the lack of time or energy is frequently raised as a reason for the perceived value of investing in a complete package deal. Residential adopter 3 brings up his age; getting old hinders taking on certain projects and turnkey enabled him to invest. As mentioned in the section on technology provision, the time constraint is both acknowledged with regard to the installation itself and the surrounding activities, such as gaining knowledge about the technology in general and the different options and suppliers to choose from. Several residential adopters (adopters 1, 2, 5 and 6) describe that they have limited available time and are occupied with other tasks; similarly, commercial adopter 15 highlights that their company often has multiple other projects running - thus turnkey seems the best fit. In line with these arguments, most adopters mention the benefits of stability and reliability of trusting one supplier or company to handle everything, as is the case when opting for turnkey provision.

The perceived reliability is further strengthened by the various guarantees included in turnkey solutions. Adopter 10 did not have to pay anything until control checks were made ensuring that everything was working, which gave him a serious impression and was perceived as comforting and reassuring. Multiple residential adopters (adopters 3, 7 and 10) highlight guarantees of being promised a certain amount of electricity and being compensated if the amount is not delivered. Conversely, for other solar PV BMs, there is a perceived lack of similar guarantees and thus missing value compared to the turnkey model.

Regarding the other aspect of turnkey - owning the solar panels yourself - several valuable components have been raised. Many adopters (adopters 4, 6, 8, 15, 16, 18 and 21) highlight that one determining factor for their growing interest in turnkey solutions is the decreasing prices of solar panels in recent years, making the investment economically sustainable. Although there are multiple investment motives, an absolute majority of the adopters underline the economic aspect as the most important factor in the investment decision; when comparing turnkey to the other BMs, the respondents agree on the economic benefit of owning the solar PV system. First and foremost, there is no additional party capturing part of the value created. While the BM requires up-front investments, it is perceived as more economic in the long run with less variable costs, leading to a lower pay back period than leasing for instance. Secondly, owning the system is perceived as increasing the value of the house or facility on which the system is installed - both by providing clean energy and reducing operational costs. On this note, the possibility of reducing the energy costs affects the adopters perception of value; for several adopters (adopters 4, 5, 6, 15 and 20) turnkey is perceived as the most effective and simple way to reduce their external energy consumption and thus their costs. Some residential adopters (adopters 4 and 6) describe themselves as large consumers of energy, which contributes to the reason to invest in solar PV and more specifically owning systems themselves. Lastly, while not as important for all of the adopters, adopter 4 regards the opportunity of selling excess electricity back to the grid as an essential factor in the economic calculation, which is perceived as possible mainly via the owning aspect of turnkey. Similarly, residential adopter 8, he states that the investment would not have been possible without accounting for the revenue generated from selling. While this aspect is mainly considered by the residential adopters, commercial adopters are increasingly perceiving selling excess production as favourable due to the recent rise in electricity prices. As a consequence of this development, commercial adopter 18 explains that they have started to build solar PV systems that exceed the production cap for energy tax, as the implemented tax is counteracted by the revenues.

Another factor contributing to the perceived profitability of owning the system is the available subsidies. Most of the turnkey adopters have made use of monetary support in their investment process, but their given degree of importance varies. For some, the subsidies were solely an added bonus; a couple of commercial adopters (adopters 17, 19 and 20) perceive the investment as economic without any subsidies at all, a sentiment shared by a few residential adopters (adopter 1, 2 and 10) - partly due to the decrease in solar PV system prices. However, several residential adopters (adopters 3, 4, 5, and 6) state that subsidies were a deciding part in going forward with the investment. For example, residential adopter 6 believes she would have abstained from the investment if the subsidies weren't available at the time of her investment, and residential adopter 5 highlights that they played a vital part in his calculations. While some commercial adopters (adopters 15 and 21) perceive the subsidies to be important, the perception is figurating to a lesser extent here due to the fact that the solar PV investment sum is usually quite small in relation to the overall business operations of the commercial adopters.

Moving on from the perceived economic element of owning the system, the argument of being self-sufficient is also pointed out frequently by the residential adopters as an appreciated element of the value proposition. Turnkey is perceived as enabling them to rely less on the external grid - a determining investment motive for some. Owning the system and being self-sufficient is closely related to control and stability, and has both a practical and a philosophical meaning for the adopters. Residential adopter 6 states that their house is located remotely and he is therefore experiencing regular power failures. Accordingly, installing a host-owned system allows him to properly manage the electricity supply. Residential adopter 5 dislikes being bound to a third-party, and perceives being self-sufficient as valuable in the case of nation-wide emergencies or catastrophes. Multiple adopters (adopter 1, 2, 4, 5, 6 and 10) have - or plan to get - an electric vehicle, which is highlighted as another component in being self-sufficient; they want to be able to charge their car directly from the roof, which is only perceived as being possible through turnkey. Drawing on what was previously discussed about selling excess electricity, owning the system is perceived as giving the adopter complete control over the production from the solar panels, allowing them to decide to either consume or sell based on the current market situation. From a philosophical standpoint, turnkey is also related to what the adopters describe as "the good feeling of owning something". The adopters value knowing it is their own system, and enjoy being able to see it on the house - in particular the technology interested adopters. All of the interviewed residential turnkey adopters monitor the production of their system via an app, which is perceived as both a fun hobby and a practical tool that allows them to plan their consumption.

For several of the commercial adopters (adopters 16, 17, 19 and 21), political and marketing incentives were repeatedly mentioned in relation to turnkey. Owning the panels and having them installed on your facility is perceived as important and valuable in order to optimise the communication strategy. More than one commercial adopter (e.g. adopter 16 and 21) emphasised the fact that solar PV is mainly a symbolic gesture. Adopter 16 states that their buildings are very energy demanding and there are other areas to focus on where the reduced emissions per invested SEK are greater, such as improving the overall energy efficiency of their businesses. The perceived value of turnkey is also related to the operations, the technical knowledge and the resources of the commercial adopters. Many of them are used to the aspect of investing with long time horizons and have their own service organisation and technicians engaged in maintenance; adopters 15 and 16 describe that owning the solar PV systems themselves thus comes natural, specifically with the lack of work surrounding the solar panels during the use period.

4.3.2 Perceived missing value of turnkey provision

In general, the perceived missing value of turnkey provision is rarely brought up by the adopters. This investment option is by and large perceived as relieving adopters from the challenges outlined in detail above. When asked about the main challenge of the BM - or potential imaginable challenges - the upfront investment costs and overall high price of turnkey are often brought up. The need for upfront investment naturally requires the adopter to have available capital at the time of the investment. When asked about the perceived value of the other BMs, their lack of upfront investments are usually mentioned as a perceived advantage. The more knowledgeable and technically experienced adopters call attention to the fact that the installation part of the turnkey BM constitutes a large part of the total cost. The possibility to install themselves is therefore perceived attractive to avoid these costs - highlighting the drawback of this more capital heavy alternative. Furthermore, some of the commercial adopters (adopter 16 and 16) point out that they only invest in a turnkey solution if they own the property. Adopter 15 attributes this reasoning to the long pay-back periods and general long-term planning needed - thus, owning the solar system on rental properties is perceived as risky.

4.4 Adopters' perception of leasing provision

From an adopter perspective, the awareness of solar PV leasing provision as an alternative for investment is in many cases non-existent. Consequently, some of the adopters do not have any perception about this BM. Nevertheless, there are a number of adopters who know of the possibility of solar PV leasing provision - or are familiar with the leasing concept in general - and as a result exhibit distinct opinions about the BM.

4.4.1 Perceived value of leasing provision

Plenty of adopters recognize the value of saving up-front investment capital when opting for easing provision; this is the main perceived benefit of the BM. On this note, residential adopter 9 highlights leasing as an easy way of taking a loan, and an option to get the system installed quickly. Among commercial adopters, some (adopters 14, 15, 17 and 18) perceive leasing as a plausible alternative if - hypothetically - the company would be engaged in multiple other capital heavy operations. Furthermore, commercial adopter 19 imagines leasing to be a valuable solution if the product in question is very technical, and requires the hiring of additional personnel to manage and service it. However, as none of the interviewed adopters have invested in leasing provision, there is a general lack of perceived value. Mostly, the adopters express negative opinions about the BM, and the possibility of saving up-front investment capital is outweighed by the perceived missing value associated with the BM.

4.4.2 Perceived missing value of leasing provision

Leasing provision is perceived as less economic than turnkey - despite saving investment capital, you are ultimately perceived as making more money if you personally own the solar PV system. A common perception is that someone else - the third-party - is making the money or getting the benefit in leasing provision, and that leasing provision comes with a longer pay-off period, consequently decreasing its attractiveness. Adopters 2 and 6 perceive leasing as an expensive loan, and would rather extend the loan on their house or apply for a "solar loan" from the bank to finance a host-owned solar PV investment. A majority of residential adopters (adopters 1, 4, 5, 6 , 8, 10) state that they have a habit of saving money, and perceive that it is not reasonable to buy something if you cannot afford to own it yourself.

In line with what has been previously discussed about the perception of turnkey, the adopters express that leasing provision does not come with the same feeling of control and stability. Adopter 6 perceives that you cannot control the use of the produced electricity in the same way, for instance being able to export electricity to the grid whenever you want or use it to charge your electric vehicle. The lack of control extends to any problems that might arise with the system - adopters 4, 6, 8 and 22 do not trust the leasing provision company to fix errors, and perceive themselves to be responsible for maintenance of the system as it is on their roof anyway. Furthermore, as highlighted with turnkey provision, there is a rather intangible aspect of owning the system for the adopters that leasing provision does not give - it just does not feel as good to rent something.

It should be noted that a lot of the residential adopters do not have any previous experience with leasing. Commonly it is perceived as a complicated concept with a lot of terms, and it is sometimes a problem to have to employ and trust a third-party. Others highlight the aspect of moving; adopter 8 does not plan to move, and thus want to make permanent investments, while adopter 7 perceives leasing as a problem if they want to move. Adopter 7 expresses uncertainty whether you can transfer a leasing contract to someone else if you want to sell the house; if a host-owned solar PV system was installed on the house, its value would be included in the selling price. Adopter 10 has previous positive experience with leasing cars, but does not perceive the situation to be the same for solar panels, as you do not need to sell them and they need less service during their lifetime.

The interviewed commercial adopters largely have the same perception about leasing provision as the residential adopters. First and foremost, it is not perceived as economically beneficial as turnkey, and if you have the investment capital - which is often the case for commercial actors - it is not perceived as logical to let someone else receive a part of the profit. Similar to residential adopters, several commercial adopters (adopters 14, 16, 17, 20 and 21) express a desire to own, and in general strive to avoid leasing products needed for their business. Other commercial adopters (adopter 15, 20 and 22) do in fact have experience with leasing in their operations, but the argument of opting for this BM is context specific and product specific. Adopter 15 states that for products that “get used” and need a lot of service, like cars, it makes sense to lease, but that is not the case with solar cells. As discussed earlier, solar PV systems are not perceived as requiring a lot of maintenance after installation, and commercial adopters often have their own departments or employees engaged in maintenance work. Thus, it does not make sense to hand over that responsibility to someone else, especially if you are paying them for it. Lastly, adopter 20 recollects a bad leasing experience with regard to another product; the leasing company went bankrupt and the adopter remained stuck in the leasing contract - something he considered as an important learning experience about the downsides of this BM.

4.5 Adopters' perception of PPA provision

PPA provision entails procurements of large amounts of energy via guarantees of origins, mostly directed towards larger commercial or industrial adopters. Accordingly, most of the residential adopters are not aware of the alternative. Among the commercial adopters, a few have considered PPA and implemented it for solar PV, while others have used this BM for other types of energy or heating supply solutions. However, in general, the PPA BM seems rare in comparison to the other options, and has often not been offered as an alternative for the adopters.

4.5.1 Perceived value of PPA provision

Multiple commercial adopters (adopters 16, 17, 19 and 21) state that they are open to considering PPA provision for solar PV in the future. In line with the value proposition of the BM, PPA is commonly perceived as a possible option for covering large parts of the adopters total energy consumption. For instance, adopter 21 states that PPA would become interesting if their customers increasingly demand renewable energy, and as a result more investments in solar PV overall is warranted.

Adopter 16 who invested in an on-site PPA solution states that the main reason for choosing this BM was the fact that they did not own the facility themselves, and therefore it did not make sense to own the installed solar PV system. Adopter 15 confirms this; PPA provision is sometimes perceived as a possible investment option for individual facilities if the facilities are owned by someone else. In contrast to the residential adopters' perception of leasing, the trust factor of entering third-party agreements - which is the case with PPA - is in general not a perceived issue for commercial adopters.

Noteworthy, there is commercial adopter 22 who invested in a PPA solution for a self-owned facility. Their choice of BM is partly attributed to an internal prioritisation of investment capital. There was not sufficient allocation for opting for turnkey, and the decision process thus boiled down to either leasing or PPA. The absence of up-front investment costs is a perceived benefit in this case. However, compared to leasing, PPA is perceived as alleviating the adopter of risk to a higher degree if any obstacles were to appear - both during the installation process and the use period. The same commercial adopter also highlights the modus operandi in their business as a contributing factor; in general, they lease equipment, products and services and then add the costs of these to the customers' housing rents. Consequently, PPA feels like a smooth add-on to this process, whereas a turnkey solution, financed by their own capital, would be more difficult to include.

4.5.2 Perceived missing value of PPA provision

For commercial adopters 16, 18 and 19, the most important aspect when considering large scale contracts of energy is the combination of low prices and the level of clean energy - the amount of emission per invested SEK. According to them, the alternatives to solar PV - as illustrated by their current contracts to buy energy from wind- and water power - provide an overall better deal with regard to emission per invested SEK, compared to a pure solar PPA option. Additionally, adopter 19 perceives it to be improbable to be able to cover a substantial part of the total energy consumption with solely a solar PPA.

Most commercial adopters have invested in solar PV to cover a smaller portion of the individual energy consumption of their properties and facilities, and have in this case opted for turnkey systems installed at the different sites. The same sentiments as discussed with regard to turnkey and leasing apply for PPA - the adopters prefer to own, partly for functional reasons. The usefulness of PPA is related to the nature of the product and the amount of maintenance or service needed. Adopter 18 even perceives it to be cheaper to hire additional maintenance than to let the supplier provide it in a PPA solution.

It is further emphasised, and mentioned with regard to turnkey, that a driving force behind the solar PV investment for a couple of the commercial adopters (adopters 16, 17, 19 and 21) is of a political nature - due to the size of their facilities, solar PV can only contribute to a minor share of the energy consumption. It is important to be seen as an organisation with environmental focus and concern, and to be quick to adopt environmental technologies in comparison to competitors; from a marketing perspective, PPA is not perceived as effective as owning and showing off the solar panels themselves. Adopter 15 confirms the importance of showing external stakeholders that they are environmentally conscious, which is easier when owning something yourself; for the 6 facilities where they have installed turnkey solar PV systems, they had plans to digitally showcase the solar panels production in the entrance of each specific facility.

A key lack of value associated with PPA is illustrated by the economic return - for the case of solar PV, PPA is not perceived as economically sound as opting for turnkey. In line with what’s been said about leasing - PPA is arguably the same BM but scaled for bigger actors - you are perceived as getting a larger share of the economic return if you own the solar PV system yourself. Adopters 17, 18 and 21 perceive that PPA comes with additional costs such as risk premiums, interest rates and less profit margins due to a third party being involved. Based on previous experiences, adopter 15 perceives that setting up a contract for PPA is as taking a lot of time, with many actors to involve - compared to the frictionless and quick option of turnkey.

4.6 Adopters' perception of community solar

CS has in general not been considered as an alternative at the time of adopters' investment. Most of the residential adopters are not aware of the existence of this BM and do not have knowledge about the way it functions. A handful of both commercial and residential adopters are previously acquainted with CS, and thus have more thorough perceptions of the BM.

Worthy of mention, the investment processes of the two adopters who invested in CS were highly dependent on their social context. For adopter 12, being an employee at an energy company in daily contact with knowledgeable customers expressing an interest in solar energy - his own interest started to grow which eventually led him to invest in CS. Adopter 11 had previously bought shares in a wind power-cooperative, but the cooperative was shut down, after which they decided to switch to CS.

4.6.1 Perceived value of community solar

When provided with an explanation, some of the adopters (adopters 2, 6, 7 and 15) that were previously unaware of CS perceive it to be an interesting solution with future potential - especially if investment capital is lacking. Moreover, investing in CS is not perceived as mutually exclusive to investing in other BMs - for instance, one turnkey adopter (adopter 4) is currently part of a wind power community. Interestingly, adopters 4 and 6 express that they would rather invest in CS than leasing; it is perceived as less of a risk as not owning the solar panels if they are not installed on your own house, and there are less intermediary actors receiving part of the earnings.

For adopters 11 and 12 who have invested in CS, the economic aspect was not the main driving factor; rather, they had a desire to invest in green energy and CS is perceived as a comfortable, anonymous and fun way to do so. These adopters had no possibility of putting solar panels on their own compounds - one resides in an apartment complex, and the other had unfavourable conditions with the roof of his house; thus, CS was a suitable option. Adopter 12 further highlights a lack of capital as a contributing factor - CS is perceived as an affordable investment.

The CS parks these two adopters have invested in operate differently. In the former, you get a yearly deduction on your electricity bill based on the production; in the latter, you do not receive the produced electricity - instead, there is the choice of buying more shares with the revenues from the electricity production or receiving a yearly economic return. Regardless, neither of the adopters perceive that there has been any problems with the co-owning aspect of the solar plant.

4.6.2 Perceived missing value of community solar

According to adopters 2, 4 and 6, when put in comparison to the other BMs for solar PV, CS is not perceived as making the adopter independent in the same way as host-owned, e.g. turnkey. The ability to become self-sufficient was highlighted as a common driving factor when choosing to invest in solar PV and this is not achieved to the same degree with CS - you are still connected to an external grid. The possibility of monitoring your solar panels through an app, which many adopters enjoy, is also perceived as disappearing with CS. Multiple adopters (adopters 2, 3, 5, 8 and 10), in particular the ones with a technology interest, enjoy having the benefit of seeing the solar panels work and appreciate the direct connection between the production of the panels and the electricity consumption of the estate. Due to these reasons, adopter 2 states that investing in CS feels similar to other types of capital investments, and suggests that a personalization of the shares bought, perhaps with an app, could diminish this feeling.

Another highlighted drawback is the lack of control with this category of solar PV BM - adopters 2 and 8 perceive that you cannot control the production and use of electricity in CS to the same extent as host-owned. Adopter 8 perceives that co-ownership of a solar park could possibly create friction, and if anything were to happen with the solar panels you are put in a precarious position. The trust factor in relation to third party agreements, as discussed earlier concerning adopters' perception of leasing, is prevalent here as well.

While a sustainability interest has been a driving factor behind the decision to adopt solar PV among the interviewees, the choice of BM is for many adopters determined by the possibilities of a reasonable economic return. On this note, CS is in general perceived as a less economically sound investment compared to host-owned. For instance, adopter 4 states that you have to pay both the grid owner and the state when using electricity from a CS park, while producing on your own compound is completely free. Adopter 17 perceives that CS comes with economic risk - there is an inherent uncertainty in the investment due to the varying electricity prices, especially for larger investment sums. Furthermore, by adopters 2, 3 and 7, CS is not perceived as an investment in the house, which is - as mentioned with regards to the turnkey BM - an important aspect to consider when choosing the BM.

The sentiments above are also shared by the residential adopters who have invested in CS; they know they are not losing money on the investment, but perceive host-owned would be more economically beneficial. To bring in more - and larger - actors, adopter 11 believes the economic aspect of CS needs to be stronger. In addition, he perceives a need for CS to be more connected to the local context - e.g. in terms of who is reaping the benefits - to create more engagement.

4.7 Empirical findings summary

In the empirical findings presented above, the interviewed adopters' opinions and thoughts on the existing BMs for solar PV in Sweden have been highlighted, thus answering our first research question - how adopters perceive different BMs for solar PV. In line with the existing literature on DOIs (Rogers, 2003) and adopters of RETs (Bergek & Mignon, 2017; Bergek et al., 2013), there is a substantial heterogeneity in how the adopters perceive the different BMs. In many cases, the adopters place different amounts of importance on the elements included in the value proposition of the BMs. Table 3 summarises the perceived values and missing values in relation to each BM.

However, common themes have also been identified throughout the interviews. The results show an overwhelming majority of adopters opting for the turnkey provision BM. The perceived value of turnkey are both of a practical nature, such as the economic return, but there are also more abstract advantageous factors, e.g. reducing complexity and addressing the positive feeling of owning something yourself. In general, an interesting distinction can be seen with regard to how the adopters perceive host-owned BMs and third-party ownership BMs. Using the solar PV BM framework as a guideline (Bankel & Mignon, 2022), it appears that the adopters mainly consider the value proposition for host-owned BMs; conversely, for TPO BMs such as PPA and leasing, the adopters also consider the value capture to a certain degree - a commonly perceived drawback of TPO BMs is the fact that the supplier continuously receives a part of the created value. Moreover, the value proposition of TPO BMs is not completely understood, as many adopters perceive that they would still have an operational responsibility if opting for these.

It is important to acknowledge the potential subjectivity derived from these findings. Due to the almost unanimous choice of turnkey provision adoption among the interviewees, there is an obvious bias to account for in favour of this model. After already having invested in this option, it is natural for the adopters to highlight the benefits and suppress the drawbacks for their choice - and vice versa for other BMs. To minimise and prevent bias in our results, efforts were made to target and reach out to adopters of the more rarely adopted BMs. These efforts yielded some results, as adopters of CS and PPA provision were identified, but finding adopters of leasing provision still proved a difficult task. To a certain degree, this does speak to the current market structure in Sweden, where a few BMs dominate the solar PV market - as illustrated by the solar PV BM framework (Bankel & Mignon, 2022). Thus, we argue that the empirical findings provide a representative view of the Swedish adopters perceptions of the different solar PV BMs.

Table 3: Main perceived values and missing values of the different BMs for solar PV

Business model	Perceived value	Perceived missing value

Consulting provision	- Providing knowledge and information - Project management and installation set-up - Alleviating workload - Choice of supplier and components	- Not perceived as adding value, part of suppliers tasks - Unnecessary point of contact - Perceived lack of competence and knowledge
Technology provision	- Saving large part of investment cost - Fun, opportunity to learn	- Complexity of technology and installation process - Hazardous consequences and functional problems - No guarantees - Certified electrician needed - Time and energy consuming
Turnkey provision	- Time-efficient - Reducing complexity - Stability and reliability - One point of contact - Guarantees - Economic advantages - Self-sufficiency - Feeling of owning - Being able to see and monitor the panels - Political and marketing incentives - Strategic fit - Control of production and consumption	- Upfront investment - High costs - Not suitable for commercial rental facilities
Leasing provision	- Saving investment capital - Avoiding hiring maintenance	- Less economically beneficial than owning - Longer pay-off period - Less stability - Less control - Lack of trust in third-parties - Less of a good feeling compared to owning - Lack of experience, complicated concept
PPA provision	- Larger scale - Suitable for commercial rental facilities - No up-front costs	- Less environmental compared to other PPA energy alternatives - Less economically beneficial than owning

	needed - Less risk and responsibility compared to leasing	- Commercial adopters used to owning - Less political and marketable - Time consuming - Multiple points of contact
Community solar	- Saving investment capital, affordable - Not mutually exclusive to other BMs - Less of a risk to other TPO BMs - Less intermediary actors - Comfortable - Anonymous - Fun	- Less economically beneficial than owning - Less self-sufficient - Less control - Less monitoring - Less feeling of owning - Possible friction of co-ownership - Third-party trust issues

5. Analysis

In this chapter, the empirical findings of the study will be analysed utilising the reviewed literature on DOI and BMs in the frame of reference, with the intention of answering the second research question - what are the main factors influencing adopters' perceptions of solar PV BMs. The analysis is divided along three dimensions: how adopters' perceptions of the BM are influenced by the IS and the market, how adopters' perceptions are influenced by characteristics of the innovation; and lastly, how adopters' perceptions are influenced by the characteristics of the adopter.

5.1 The innovation system' s influence on adopters' perceptions

The impact of system-level components such as market structures, networks, institutions and infrastructure on the diffusion of technologies is outlined extensively in previous research (Negro et al., 2012; Carlsson & Stankiewicz, 1991; Grübler, 1991; Mignon, 2016). Our empirical findings accentuate this sentiment, and highlight that the influence of these system-level components can be considered to extend to the adopters' perceptions of solar PV BMs.

5.1.1 Institutions

System-level strategies directed towards stimulating adoption and mitigate system obstacles are discussed in the frame of reference, where hard institutions - specifically in terms of policies - are emphasised as means to increase available public funding (Jacobsson & Karltorp, 2012; Smith, 2000; Bergek et al., 2010). In line with this, the institutional financial landscape, such as subsidy programs, is frequently highlighted by the adopters as having an effect on their perception of the solar PV BMs. The empirical findings show that most adopters made use of monetary support in their investment process, and multiple adopters emphasise it as a deciding factor. Turnkey provision has shown to be the dominant choice of BM, where the perception of economic benefits is partly strengthened by the available subsidies for HO BMs. This coheres with Casper's and Kettler's (2001) remarks that the availability of subsidies strongly impacts what type of BMs that are feasible or profitable. While Casper and Kettler (2001) explore this from the perspective of a firm, the same argument appears to hold true for the adopters in our case.

Although regulation in many instances strives to alleviate hinders to adoption, regulation and norms can also increase the complexity of the adoption process. As our findings show, multiple adopters perceive regulation and norms as something rather difficult to adhere to, to which adopters sometimes respond by choosing the turnkey provision BM. In line with the notion that BMs must match the existing legal frameworks to be feasible for adoption (Provance et al., 2011), the legal requirements of needing to have certified electricians for the installation of the solar PV system are outlined as a problem by the adopters. This was often brought up in the context of technology provision; according to some adopters, technology provision was attractive due to the possibility to save investment capital and an alternative that matches their technical interest and knowledge. However, the current regulation on required certification posed a limitation to the availability of this model, even though the adopters perceived they possess the required skills to install themselves.

5.1.2 Infrastructures

Both DOI and IS literature acknowledge the importance of the infrastructure component in the diffusion of technologies (Negro et al., 2012; MacVaugh & Schiavone, 2010). In accordance, the existing physical infrastructure is identified as a factor affecting the adopters' perceptions of solar PV BMs in some cases. Not having continuous access to the electricity grid had an impact on the perceived attractiveness of the BMs for one adopter - the frequent power cuts posed a significant challenge in his everyday life, and his choice of BM was partly reliant on addressing this issue. Compared to a HO BM, a CS BM would have entailed still being dependent on the grid. Contrastingly, other adopters highlight the importance of being connected to the grid in order to take advantage of the economic opportunities stemming from selling excess electricity. In sum, the findings show the aspect of grid connection as having an effect on the adopters perceptions, though with heterogeneous underlying motivations.

It should be noted that missing infrastructure components impeding diffusion, as discussed in literature (Negro et al, 2012), is not a wide-spread occurrence that affects the perceptions of the adopters. In most cases, with regards to the required infrastructure, it is the physical resources of the adopter that determine the perception of the BMs. For instance, the commercial adopters opting for consulting provision motivated their choice with the need of inspecting the conditions of their roof, and two residential adopters choose CS due to not having access to suitable roofs. The resources of the adopter is discussed in more detail in the section on how adopter characteristics influence the perception of the solar PV BMs.

5.1.3 Networks and communication channels

Based on the empirical findings, networks have also been shown to influence the perceptions of the adopters. Interaction is key for technology diffusion; if interaction is non-existant or weak, the adopter will struggle to receive necessary information about the innovation or its implementation process (Rogers, 2003; Wejnert, 2002; Carlsson & Jacobsson, 1997). Our results show that adopters often are introduced to the opportunity to invest through various networks and communication channels. Usually, the residential adopters attribute the moment of introduction to close relations such as family members, friends or colleagues. The information the adopters' receive through their social network form the basis for their perception of the investment. Thus, in line with Selwyn's (2003) proposition on the importance of the social context when explaining non-use of technology, our findings clearly illustrate the significance of social encounters in encouraging the decision to adopt solar PV.

A concluding reflection is that the adopters' interaction with their peers first and foremost influence their initial interest and selection of solar PV suppliers - the adopters do not explicitly state that their network has influenced the way they perceive the different BMs for solar PV. However, it appears that the BM used by the person(s) introducing the investment opportunity is always the BM that is chosen by the adopter, and thus we believe that we can confidently say that the adopters' social network influences their perception of the BMs.

5.2 The innovation' s influence on adopters' perceptions

The characteristics of the innovation and their respective impact on the diffusion of technologies and adopter behaviour (Rogers, 2003; Osorio-Gallego et al., 2016; Moore & Benbasat, 1991) were covered in the frame of reference. In line with reviewed literature, the empirical findings highlight that the characteristics of the solar PV technology affect the adopters' perceptions of the different BMs; the following sections emphasise the impact of technological complexity, the technological novelty and technological compatibility.

5.2.1 Technological complexity

As highlighted in the results pertaining to several of the different BMs, the process of adopting solar PV is perceived as highly complex by a majority of the adopters. Particularly in the context of technology provision, buying the right components and installing the solar PV system yourself is considered a difficult and dangerous task. The expressed diversity and magnitude of regulation and norms to adhere to during the installation process to further increase the perceived complexity. As literature on the characteristics of innovation highlights, the complexity of an innovation is both described in terms of the system-embeddedness of the technology - how it is intertwined with existing infrastructure and systems (Grübler, 1991, Lyytinen and Damsgaard, 2001), and how easy the innovation is to understand by itself (Aiman-Smith & Green, 2002), aligning with our findings on adopters' perceptions on the complexity of solar PV.

The empirical results further align with what has been previously highlighted by BM scholars regarding obstacles to adoption (Rai et al, 2015; Horváth & Szabo, 2018); technological complexity is a key barrier, and BMs can play a crucial role in helping adopters understand and make use of the technology. Consequently, it is no surprise that turnkey provision is the dominant choice - it reduces the perceived complexity as well as the perceived risk of the investment for the adopters. It is arguably safe to say that in the absence of a BM that provides a complete package deal - e.g. turnkey provision - the diffusion of solar PV would have been considerably slower, confirming the role of complexity in diffusion as highlighted in the reviewed literature (Rogers, 2003; Klein & Sorra, 1996).

5.2.2 Technological novelty

The attribute of technological novelty, as presented by DOI scholars (Rogers, 1962), and its impact on adopters perceptions of solar PV BMs seems to be featured at two layers in our case. Firstly, as emphasised by Wells et al. (2010), the results show that the newness of a technology is closely linked to the perceived complexity, as solar PV is perceived as an intricate and novel technology - especially dealing with installation norms and regulations. Similar to the aspect of complexity, the aspect of novelty led some adopters to become fearful and uncertain of adoption, favouring BMs that are perceived as more stable - e.g. turnkey. Secondly, the aspect of novelty extends beyond the technology of solar PV to the BM it is packaged into. The BMs of PPA provision and leasing provision appear to be rather new in Sweden compared to the other BMs, as few adopters are aware of their existence. Naturally, due to their limited occurrence, the adopters' do not completely understand the value proposition, and even harbour mistrust to some extent, highlighting how novelty can contribute to a negative perception.

Nevertheless, compliant with another stream of literature, the results cohere with the perspective that not all adopters perceive newness as negative (Cox & Locander, 1987; Mukherjee & Hoyer, 2001). Some adopters perceive newness as an exciting opportunity - plenty of commercial adopters specifically bring up newness as a motivating factor accelerating their adoption decision. Solar PV is viewed as an exciting option for a sustainable energy supply and organisations want to be on the forefront of environmental awareness; political and marketing incentives push firms to act faster than their competing rivals, and the novelty aspect is therefore of value. However, it is not distinctively clear how the attractiveness of novelty affects their choice of BM.

5.2.3 Technological compatibility

In DOI literature, the adopted innovation's compatibility with the adopters' beliefs, past experiences and needs is frequently discussed as having a significant impact on the rate of diffusion (Osorio-Gallego et al., 2016, Moore & Benbas, 1991; Rogers, 2003); but additionally, the innovation's compatibility with the adopters' other technical tools and infrastructure is also emphasised (Smerecnik & Andersen, 2011). While the importance of the former will be highlighted in another section, this section covers the latter - the technological compatibility of the adopted solar PV BM is identified in the empirical findings as having an impact on adopters' perceptions of solar PV BMs.

It has been highlighted by several residential adopters that their choice of solar PV BM was to an extent affected by the possibility of being able to charge an electric vehicle directly from the produced solar energy - it is convenient, economic, environmental and allows the adopters to become self-sufficient. Some adopters have an electric vehicle and continuously make use of this feature; in other cases, the interviewed adopters state that they did not own an electric vehicle at the time of the investment, but plan to get one in the future. Regardless, the adopters' perceive turnkey provision as the best option to enable such a system as it is installed on your own compound and gives you complete control over the produced electricity. However, the perceived importance of the technological compatibility of the adopted BM is hard to determine - most adopters mention the compatibility with an electric vehicle as an fun add-on feature.

5.3 Adopter characteristics influence on adopters' perceptions

According to DOI-literature, the characteristics of the adopters' affect their propensity to adopt, and thus modulate the diffusion of a new technology (Rogers, 2003). Moreover, recent DOI-literature stresses the fact that the adoption decision is grounded in the adopters' internal mental framework. Adoption is considered to be influenced by the behaviour, habits and identity of the adopters, which ultimately form the basis of a subjective perception of the innovation - regardless of the objective performance of the innovation (Seligman, 2003; Selwyn, 2006). Based on the empirical findings, it is evident that the characteristics of the adopters - which includes their economic status, their personal values and their habits etc. - affect their perception of the different BMs for solar PV.

5.3.1 Adopter attributes

Among the commercial adopters, the capital needed to invest in a turnkey BM is largely perceived as insignificant in relation to the size and operations of their businesses. Similarly, most of the residential adopters carefully plan their solar PV investment and tend to have a high amount of capital saved up. Naturally, this affects their perception of TPO BMs - BMs such as leasing provision relieve the adopter of heavy up-front investments, but since most adopters have capital resources this element of the value proposition is not perceived as particularly useful. Another identified characteristic with regard to both commercial and residential adopters is a lack of time. The turnkey BM effectively addresses this problem by offering a quick and effortless solution, thus contributing to the adopters' perceived value. Furthermore, almost all the interviewed residential adopters exhibit an interest in technology to some extent. The interest is reflected in the adopters' use of an app to monitor their system, but it is not clear whether it is perceived as an explicit component of the value proposition of the turnkey BM. However, what can be stated is that the adopters that find technology provision to be manageable are the adopters that engage with related technical engineering in their profession - as illustrated by Table 2 - pointing to the fact that the degree of technology interest influences how the adopters perceive the different solar PV BMs.

An observed attribute among the interviewed adopters is a lack of awareness of all the existing BMs for solar PV - in particular for the residential adopters. Apart from turnkey provision, the adopters in many instances state that they never considered any of the other BMs. The lack of awareness most likely stems from the fact that turnkey provision is by far the most wide-spread BM. As highlighted by the solar PV BM framework (Bankel & Mignon, 2022), there are only a few firms engaged in offering other BMs and as a result most adopters have not been confronted with them. While the lack of awareness can be seen as a systemic flaw in the IS, it can also be considered as a characteristic of the adopters. Gaining knowledge is the first step in the diffusion process and allows the adopter to start to form an opinion (Rogers, 2003). The interviewed adopters limited knowledge of the more rare BMs contribute to an overall lack of perceptions, and in some cases it is arguably related to a negative perception; for example, leasing provision is not perceived as alleviating the adopter of operational and maintenance responsibility. In reality, ensuring quality of operations and maintenance is a core element in the value proposition of leasing provision, but due to a lack of knowledge and awareness it does not appear to be perceived that way by the adopters.

5.3.2 Habits and practices of the adopters'

As touched upon in the frame of reference, the innovation to be adopted needs to be compatible with the adopter's socio-cultural beliefs, ideas and past experiences (Rogers, 2003) - a sentiment shown to extend to solar PV BMs as well (Strupeit & Palm, 2016). Turnkey is the most popular BM in our studied sample, and in line with this, our empirical findings highlight that the interviewed residential adopters generally lack previous experience with third-party services. The adopters express that they dislike being involved with a third-party, and state that they want to own it if they commit to a purchase. In many instances, the perceived missing value of the different BMs relate to a lack of control - highlighted drawbacks of CS and leasing provision respectively are not being able to control the produced electricity. The aspect of owning something yourself has both tangible and intangible implications; often, it sounds like a principle aligned with the adopters' general beliefs and ideas. The habits of the adopter is a key factor in their mental framework - according to the sensemaking theory, the adopter engages in adoption or rejection activities long before the adopter encounters the technology and an investment decision is made (Seligman, 2006). The fact that the adopters are used to owning products themselves most likely contributes to both the perceived ease of use and the perceived usefulness of the less valued BMs, as illustrated by the adopters' hesitancy and distrust towards TPO BMs.

An interesting difference with regard to habits can be spotted when analysing the interviewed commercial adopters. In multiple cases, commercial adopters do in fact have existing TPO contracts for other products; however, TPO agreements for solar PV are quite rare. Rather than a distrust towards TPO, the notion of strategic fit (Altunay et al, 2021) seems to influence the perceptions of the adopters. Previously, strategic fit has been used to describe the solar PV adoption activities of the supply side - e.g. electric utilities - but the concept appears to be applicable for the demand-side as well. All three levels of strategic fit - horizontal alignment, vertical alignment and environmental alignment - can be identified to some extent in the empirical findings. With regard to horizontal alignment, the perceptions of the commercial adopters are influenced by how well the solar PV BM fits with their existing BMs. TPO BMs are perceived as plausible if the solar PV system is installed on a rented facility; similarly, one adopter attributes their choice of the PPA BM partly to the fact that they lease other products, and are therefore able to easily package all the moving costs together and levy them onto their clients. With regard to vertical alignment, multiple adopters state that they have their own service technicians and therefore perceive the value proposition of TPO BMS to be less useful. Furthermore, the commercial adopters corporate strategy often involves owning rather than renting - that is how the adopters define their objectives and how they want to create value. In line with this, solar PPA is perceived as less useful based on the measurement of invested SEK per reduced emissions, which can be considered as an corporate-mandated selection criteria. Lastly, with regard to environmental alignment, HO BMs are generally perceived as more useful as they allow for better environmental branding in relation to the external society.

5.3.3 The investment motives of the adopters

An additional aspect to consider in relation to the characteristics of the adopters is their investment motives. Throughout the interviews, the determining investment motive is often highlighted as being of economic nature, particularly for residential adopters. In line with previous research on solar PV adoption (Bergek & Mignon, 2017), there are multiple layers to the economic investment motive - adopters perceive solar PV as an opportunity to reduce energy costs, to earn revenues, or to exploit a RE resource such as large and unoccupied roofs. The turnkey BM addresses all of these elements; you can consume the produced electricity without any fees or charges and there is no third-party capturing value, you can sell excess electricity to the grid and the system is installed on your own compound. In sum, the turnkey BM gives the best long-term economic return and as such it is in many instances perceived as the most attractive BM to adopt. Interestingly, this sentiment is diverging from current literature on solar PV BMs, where the financial aspect is highlighted as the biggest benefit of TPO BMs due the lack of up-front investments and a lengthy pay-back period (Horváth & Sabo, 2018). Contrastingly, while both residential and commercial adopters confirm the opportunity to save up-front capital, they generally perceive leasing provision as characterised by a longer pay-back period compared to the HO model, which influences their perception of the profitability of the BM.

Other identified investment motives are an interest in technology - its influence on adopters' perceptions was discussed in 5.3.1 - and a desire to enhance the environmental image, which was discussed shortly in 5.3.2 in relation to the commercial adopters' environmental alignment. Respondents also list sustainability as an important factor driving the investment, but it is not noticeable whether this has any ties to the adopters' perceptions of the different solar PV BMs. One investment motive that is repeatedly brought up by the residential adopters is the wish of becoming independent and self-sufficient. Turnkey provision fulfils this by making the adopter less reliant on the external grid for electricity. The same can be said about leasing provision, but the involvement of a third-party in leasing provision creates less control and stability, and thus reduces the feeling of being self-sufficient. Arguably, technology provision allows for the same degree of independence, but is perceived as less attractive due to other reasons.

5.3.4 The heterogeneity of adopter characteristics

Despite common characteristics and patterns, it should be noted that the adopter perceptions are also characterised by heterogeneity. Previous literature has shown that different individuals emphasise the attributes of a BM differently (Viciunaite & Alfnes, 2020), which is apparent in the empirical findings. Some adopters perceive the opportunity to sell excess electricity as an integral part of the value proposition in turnkey provision, while others do not value this at all; likewise, some perceive technology provision as an quite manageable BM, while others perceive it to be an impossible task to undertake. In line with theory on differing perceptions between market segments (Liao et al, 2019), we are able to discern some differences between the segment of residential adopters and commercial adopters. For some of the commercial adopters, due to the size of their energy consumption, solar PV investment is mainly seen as a symbolic gesture, which is rarely the case for residential adopters. Moreover, while the commercial adopters emphasise the economic drawback of TPO BMs in a similar way as residential adopters, the implications of trusting and involving a third-party is generally not perceived as a problematic element of the value proposition; rather, the commercial adopters are more concerned with how the value proposition fits with their current operations.

The reason for the heterogeneity in adopters perception' can be traced back to the heterogeneity of the adopters (Mignon, 2016) - in our studied sample, they differ in their profession, attributes, invest motives and resources. For instance, in the case of CS, this BM is perceived as particularly useful for the adopters who invested in it because of their housing situation - they were both unable to invest in a system on their own compound but they still had a desire to invest in green energy, for which CS presented a suitable solution. In conclusion, our empirical findings on adopters' perceptions resonate with theory on “goodness-of-fit” (Selwyn, 2003) - adoption activities depend on how the adopting individual make sense of the BM, constrained by structural economic and material factors beyond their reach of change, as well as psychological factors developed as result of the individual’s previous agency.

6. Discussion

The analysis shows that adopters' perceptions of the different solar PV BMs are influenced by a combination of system-level components, the characteristics of the innovation and the characteristics of the adopters. There are the themes outlined in the frame of reference, and as such, there are no findings on adopters' perception that cannot be explained by any of the conclusions drawn in previous research on adoption of new technology, DOI and BMs. However, the study has resulted in empirical evidence illustrating the interplay between the various theoretical themes and the perception of the solar PV BMs among the adopters', which in turn modulate the diffusion of the solar PV technology. A complete picture that simultaneously covers the innovation system, the technology to be adopted and the adopters of the innovation has not, to our knowledge, been constructed before in the case of solar PV. Thus, the analysis both confirms and elaborates on previous theory.

A substantial part of the analysis is dedicated to investigating how adopters' perceptions are influenced by the adopters and their characteristics. This is the component that we have the most data on, which is not very surprising, considering that the adopters are in fact the main focal point of our study. We have repeatedly stated the importance of qualitatively investigating how the adopters perceive the BMs for solar PV, as they are ultimately responsible for choosing to adopt the BM. To this end, although the findings do not highlight concepts diverging from current literature, the study contributes to theory by identifying concrete examples of factors - in particular with regard to adopter characteristics - that influence adopters' perceptions. While it is hard to quantitatively compare the relative significance of the factors that influence adopters' perceptions, the results and the analysis showcase that some factors arguably exert a stronger influence than others, in the sense that they are repeatedly brought up by the interviewed adopters. These factors are summarised in Figure 1, thus answering our second research question - what are the main factors that influence adopters' perceptions of the different BMs for solar PV.

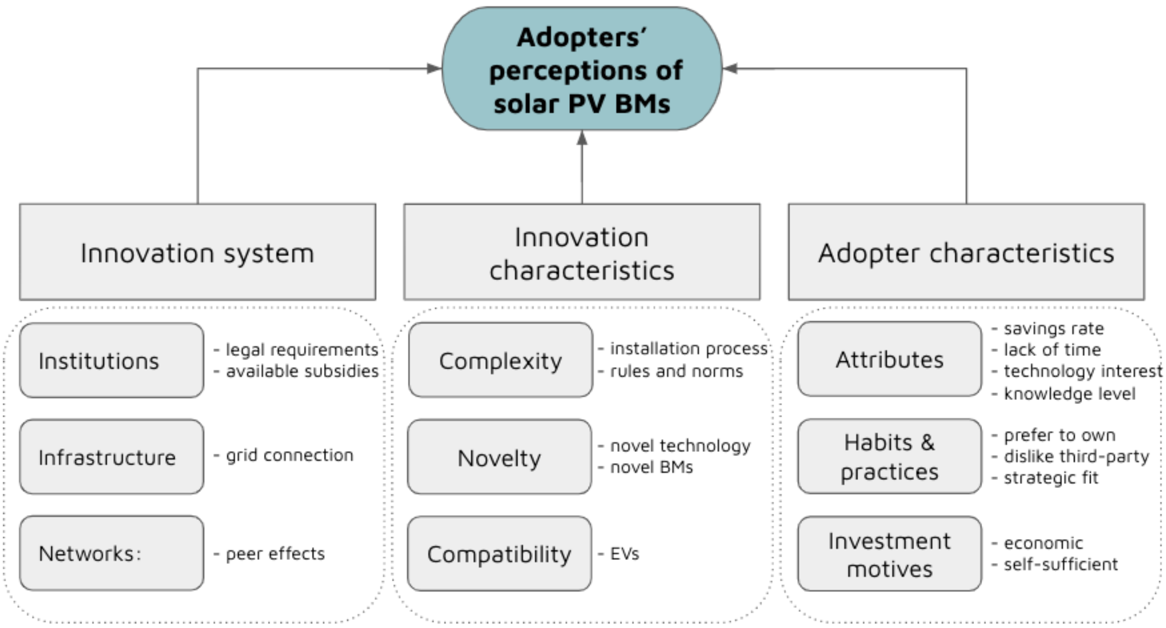

Fig 1. Model of the main factors that influence adopters perceptions of solar PV BMs.

With the end goal of understanding adopters' perceptions, the model contributes to understanding the characteristics of the adopter group, since it sheds light on what attributes, habits and investment motives form the basis for their perceptions of the different solar PV BMs. Moreover, the model incorporates the innovation characteristics and the components of the innovation system, forming the concept of system-technology-adopter, as mentioned earlier. Grounded in the empirical evidence, the model stresses that it is essential to consider all three perspectives when analysing adopters' perceptions. For instance, if one were to consider adopters' perceptions solely based on adopters' investment motives - e.g. the economic aspect - without accounting for how the available subsidies influence the perceived profitability, a crucial aspect of how policies impact the market is misunderstood. Similarly, if the diffusion of solar PV BMs is only analysed based on their fit with the existing policies and legal framework, without reflecting on the fact that adopters' might prefer to own the solar PV system, the importance of how the adopters' mental framework impact the perception of the BMs is missed. Thus, the model connects the institutional side with the consumer side, and vice versa.

With regard to applicability, we believe the model can be used to analyse adopters' perceptions of BMs for solar PV in other contexts as well. The three structural elements and their subgroups are all initially derived from existing literature and empirically confirmed in this thesis. What scholars should be careful of is if there is variation within the parameters of the subgroup, for instance the attributes, habits and investment motives of the adopters. This study was carried out in Sweden, and the characteristics of the interviewed adopters are not necessarily generalizable to other countries. Preferably, the model can first be used as a guiding principle to map the influencing factors, and then, in conjunction with Table 3, the factors can be analysed in the context of the perceived value and missing value of the different solar PV BMs.

An interesting contextual comparison can be made between the empirical findings of this thesis and the diffusion of customer-site solar PV BMs in other countries, as investigated by Strupeit and Palm (2016). Similar to the case of the market in Sweden, the BM landscape in Japan and Germany is also dominated by HO BMs - specifically turnkey provision - while in the US, it is mainly TPO BMs that are diffused. Strupeit and Palm (2016) partly attribute this to the characteristics of the consumers; in Germany, solar PV represents a competitive rate of economic return, the adopters' have a high savings rate and tend to stay put. Conversely, customers in the US have restricted access to capital, move around a lot and have previous experience with TPO BMs. Applying our model to their findings, we can observe that the adopters in the respective countries differ with regard to their attributes, habits and investment motives. Drawing on the apparent resemblance between Germany and Sweden in these factors - and the US as an opposite - reinforces our proposition on the influence of adopters' characteristics on diffusion of the different solar PV BMs.

Furthermore, although not obvious at first sight, the subsidy policies of Sweden and Germany are quite similar. In both countries, subsidies have been targeted at the owner of the solar PV system - in Sweden, via the implementation of green certificates for produced electricity and subsidies for purchasing systems (IEA, 2020); in Germany, via feed-in-tariff for renewable energy producers and low interest loans (Strupeit & Palm, 2016). Due to the structuring of these policy schemes, incentives for adopters to opt for a HO BM have been created - despite the up-front investment costs, owning the system yourself is in the end more economic than leasing it, since you receive a purchasing discount as well as continuous remuneration. This speaks to the fact that the institution plays an important role in facilitating diffusion, again showing the multi-dimensionality at play behind adopters' perceptions of solar PV BM.

7. Conclusions

The aim of this thesis was to examine adopters' perceptions of different BMs for solar PV in Sweden and to explore what influences their perceptions. More specifically, we set out to answer three RQs: (1) How do adopters perceive different BMs for solar PV, (2) What are the main factors that influence adopters' perception(s) of the BMs for solar PV, and (3) What are the implications of the empirical findings for policy makers, firms and adopters?

By reviewing strands of literature that have attempted to explain innovation diffusion and BMs - namely, DOI-theory and BM-theory - a frame of reference was constructed that shed light on the lack of qualitative studies on adopters of solar PV BMs, as well as provided a basis for answering the proposed RQs. 22 semi-structured interviews with adopters of solar PV - 12 residential and 10 commercial - were conducted, after which the adopters' perceptions and of the different solar PV BMs were highlighted and compiled. Lastly, the perceptions of the adopters were analysed in relation to theories presented in the frame of reference, resulting in a conceptual model summarising and elucidating the main factors that influence adopters' perceptions of the solar PV BMs.

For RQ1, the results showed that turnkey provision is perceived as the most attractive BM for a number of reasons. To name a few, turnkey provision is perceived as economically advantageous, reducing complexity, ensuring stability and reliability and allowing the adopter to become self-sufficient. Conversely, technology provision is perceived as saving money, but also hazardous and time consuming, and the perceived missing value of the TPO BMs - such as leasing, PPA and CS - is associated with less economic return, a lesser degree of control and a reluctance to involve a third-party. For RQ2, the analysis shows that the factors can be structured under previously broached topics in research - the innovation system, the characteristics of the innovation and the characteristics of the adopters. Among these core components, more concrete examples can be identified; adopters' perceptions are often influenced by the BM choice of their peers and available subsidies, by the complexity and technological compatibility of the BM, and by the high savings rate, lack of time, their preference of owning and economic investment motive of the adopters.

Thus, our first and second research questions have been answered. In chapter 6, the implications of the findings for theory were reflected upon and discussed. The outcome of the study contributes to theory by exploring a previously uncharted topic, providing new insights and understanding for the perceptions of solar PV BMs among adopters in Sweden. Additionally, a model summarising and connecting components of DOI theory with empirical evidence is presented, that allows for researchers to more easily approach the topic of explaining adopters' perceptions in other contexts. What remains to be answered is RQ3 - the implications of the empirical findings.

With regard to the implications for adopters, taking their limited familiarity with the existing solar PV BMs into account, the thesis provides an extensive overview of the solar PV BM landscape, facilitating an increased understanding for the possible investment options. Moreover, the perception of the BMs are put into the context of the innovation system, the innovation and the adopters themselves - as such, adopters might benefit from seeing their perceived challenges in a different light and consequently becoming better equipped in their search for solar PV solutions. With regards to the implications for firms; although most are perhaps satisfied with continuing offering HO BMs to the adopters, firms specialised in offering any of the less popular BMs or firms looking to extend their product catalogue and attract new segments can use the study to get a sense of how to better tailor their value proposition, value creation and delivery system and value capture to address the perceived missing values of the BMs. For instance, in the case of TPO BMs, adopters' perceptions are sometimes characterised by misalignment in relation to the model's value proposition, for which managers should make sure to improve communication and marketing. By understanding the adopters perceptions' - and their underlying reasons - firms can better meet the needs of the customers for solar PV, ultimately accelerating the sustainable transition.

However, the most important part of the implications from the empirical findings are arguably directed towards policy makers. As problematized in the thesis background, the contemporary agenda implies that policy makers do not completely grasp how the solar PV market and its actors interact, and the empirical findings clearly illustrate how policies influence the adopters' perceptions of the BMs. In order to fully answer RQ3, the key implications for policy makers will be outlined in the section below. Concludingly, we then reflect on this thesis's implications for future research.

7.1 Implications for policy makers

It is critical for policy makers to accurately understand adopters' perceptions of BMs in order to create effective policies in relation to their desired outcomes. Considering the current research gap on this topic, the outcome of the study yields valuable insights for policy makers. When surveying our empirical findings, it is obvious that the BM landscape in Sweden is rather one-sided - turnkey provision is by far the dominating choice. If policy makers want solar PV to reach a higher degree of diffusion, they must strive to generate heterogeneity in terms of the type of BM that is being adopted. To attract new segments that do not possess the identified characteristics of the turnkey adopters, such as a high savings rate and a preference to own; alternatively, to create a variety of attractive investment options for the adopters inclined towards purchasing HO BMs, policy makers should try to address the perceived missing values of the less adopted BMs.

A common, highlighted perceived value of HO BMs is the economic return - conversely, TPO BMs are perceived as lacking profitability. As discussed, the economic investment motive of many adopters influence their choice of BM. Political efforts to provide economic incentives for HO BMs via the introduction of subsidies have been largely successful, and proposodely, policy makers should consider creating economic incentives for TPO BMs as well. Increasing the economic rate of return for leasing provision, PPA provision and CS via subsidy schemes would put these BMs at a more equal footing to turnkey provision.

Moreover, since the lack of knowledge and understanding of the available BMs - in particular TPO BMs - contribute to the adopters' perceived risk, uncertainty and economic downsides, policy makers should make efforts to provide information and educate adopters about these BMs. TPO BMs partly target adopters which do not have the financial capabilities for paying upfront investment, and a core element of the value proposition is to assume full responsibility; nevertheless, very few adopters perceive TPO BMs to be economically advantageous nor alleviating them of operational responsibility. Acknowledging this mismatch, when designing policy instruments for solar PV, policy makers could create information channels and/or collaborate with adoption intermediaries and suppliers to address the issue.

On this note, the perceived complexity of the technology and the perceived complexity of the adoption process creates additional incentives for policy makers to provide educational information. Adopters have been drawn to turnkey provision for this specific reason; the BM effectively addresses the barriers of complexity and uncertainty. For instance, the requirement of certified electricians to perform the installation work and the perceived complexity of installation rules and norms constitutes an obstacle for the adoption of technology provision. Policy intervention could focus on defining clear guidelines and rules for the installation process, or creating specific solar PV certificates for electricians to allow adopters to more easily get in contact with knowledgeable electricians.

Lastly, the empirical findings underline the importance for policy makers to tackle common identified problems, while at the same time considering the heterogeneity of adopters. For example, many adopters' place emphasis on the economic advantage of HO BMs, but they vary in their reasoning behind their investment motives; some want to earn revenues and others mainly want to reduce their energy costs. Likewise, distinct differences can be seen between commercial and residential adopters - for the former, strategic fit and marketing incentives are key concerns. Accounting for the differences among adopters creates an opportunity for creative policy design, but also brings complications for how to do this effectively. At large, policy makers should rely less on one-for-all policies, and strive to create a range of policies to fit the heterogeneity of the adopters. Implementing a policy-mix ensures a variety of adopters and lessens the potential blow if a specific policy is revised or changed. Apart from considering how the perceived missing values of the rarer BMs can be addressed, it should be noted that we also recommend policy makers to further strengthen the attractiveness of HO BMs. By all means, turnkey provision is the most popular BM for a reason, and can contribute to an accelerated diffusion of solar PV in Sweden.

7.2 Future research

This thesis contributes to the literature on DOI and BMs in the case of solar PV, and helps provide a better understanding of adopters' and their perceptions. The introduced model synthesises the influencing factors of the innovation system, characteristics of the innovation and the characteristics on adopters' perceptions, and should provide scholars with a stronger foundation for analysing and understanding the diffusion of solar PV BMs. Considering solar PV currently is the fastest growing alternative for sustainable electricity generation, the characteristics of the technology and the current BM landscape might be subject to continuous change. Thus, we recommend ongoing research on this topic to account for industry and market changes.

In line with this, it is suggested that future research could focus on complementing the findings of this thesis by carrying out additional qualitative studies. As previously discussed, the findings are not necessarily representative outside the context in which the research was performed. It is a rather new topic of investigation and similar studies should be done in other contexts in order to gain a more valid and generalizable result. Since the effort to include all BMs from the framework by Bankel and Mignon (2022) unfortunately fell short - none of the adopters had opted for leasing provision - future studies should aim to include a sample where all BMs are represented. This sentiment also concerns the over-representation of real-estate adopters among the interviewed commercial adopters, and overall that of turnkey adopters in the studied sample.

Moreover, there is a need for quantitative research to adjunct the qualitative method used in this thesis. As we have argued, a quantitative approach should be preceded by qualitative research in order to gain a deeper understanding of the adopters' perceptions. Having now investigated and mapped the perceptions, the findings could pave the way for quantitative measurements. Quantitative measurements could be applicable in the case of a larger set of adopters to study or to measure the perceived relative importance of the elements in the value proposition of the solar PV BMs, contributing to a richer data set and a more complete and detailed picture of adopters perceptions of solar PV BMs.

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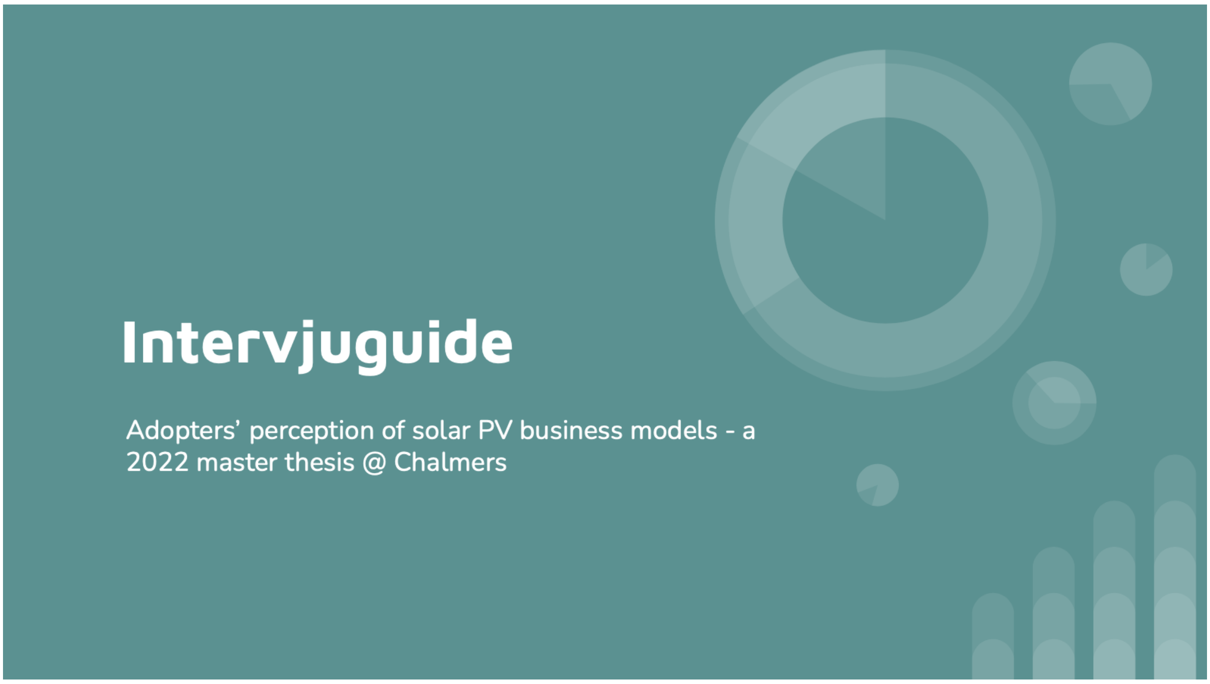
Appendix A

A.1 Interview guide



Tema 1 - Introduction

- **Fråga om lov för inspelning**
- **Vilka är vi?**
  - Vi är två studenter som gör vårt exjobb hos en forskningsavdelning kring
- **Vad gör vi?**
  - Syfte: Vi analyserar..
- **Varför är vi intresserade att prata med dig?**
  - Du som anammare..

Tema 2 - Kort personligt

- **Berätta lite om dig själv?**
  - Utbildning?
  - Jobberfarenhet?
  - Drivkrafter/intressen?
- **Hur länge har du jobbat hos X?**
- **Berätta lite om er verksamhet?**

Tema 3 - Din process i att investera

- **Beskriv gärna din process av att skaffa solceller!**
  - När blev ni intresserade av solenergi? När skaffade ni det?
  - Hur introducerades ni till möjligheten? (marknadsföring, grannar, kollegor, nätet, tidningar, sociala medier..)

- **Varför valde ni att skaffa solceller?**
  - Exempel: Teknikintresse, hållbarhet, ekonomiska anledningar, press från stakeholders, vara förebild, uppnå dröm/förfylla intresse
  - Vad var den starkaste drivkraften?

Tema 4.1 - Upplägg för investering i solceller

- **Hur gick ni tillväga när ni investerade?**
  - Vilket upplägg för investeringen valde ni? (t.ex. installera/importera teknik själv, köpa turnkey, leasa, köpa andelar, osv.)
  - Hur gjorde ni? Fick ni hjälp? Av vem?
  - Hur finansierade ni investeringen?
    - Har ni koll på de stödsystem som finns? Spelade de in i valet? (Investeringsbidrag, solar loans, tax reduction, green certificate etc.)
  - Var det några hinder?

- **Varför var det här alternativet eller upplägget för investeringen mest attraktivt?**
  - Exempel: removing barriers, economic return, sustainability, etc. - vad värderade ni högst?
  - Vem introducerade er till det här alternativet? Hade ni någon vetskap/erfarenhet om det innan?
  - Passar den bra in med er verksamhet/vanor i övrigt? Var det något ni tänkte på?

- **Contextual factors:**
  - Flyttar ni mycket, har ni sparat kapital länge, är ni van vid ett visst typ av upplägg (leasing?),

Tema 4.2 - Upplägg för investering i solceller

- **Har ni koll på vilka andra alternativ och investeringsupplägg som finns tillgängliga?**
  - Exempel: Technology provision, consulting provision, turnkey provision, leasing provision, PPA provision
  - Var det några andra alternativ som ni funderade på? Varför valde ni inte dem?
    - Fanns det några hinder med de andra alternativen?

- **Varför valde ni detta företaget? Värderade ni andra andra företag att köpa från?**

- **Är du nöjd med ditt val såhär i efterhand?**
  - Varför/varför inte?
- Känner du någon annan kvinna, någon som leasar..?

DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS
DIVISION OF INNOVATION AND R&D MANAGEMENT
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden
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