CHALMERS
UNIVERSITY OF TECHNOLOGY

How digital intermediaries in Sweden support the diffusion of solar PV

Master's thesis in Quality and operations management

HANNA SINCLAIR DAHLSTRÖM
LUCAS LAZAROO

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. E2022:115

REPORT NO. E2022:115

How digital intermediaries in Sweden support the diffusion of solar PV

HANNA SINCLAIR DAHLSTRÖM
LUCAS LAZAROO

CHALMERS
UNIVERSITY OF TECHNOLOGY

Department of Technology Management and Economics
Division of Innovation and R&D Management
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2022

How digital intermediaries in Sweden support the diffusion of solar PV
HANNA SINCLAIR DAHLSTRÖM
LUCAS LAZAROO

Supervisors: Hanna Rydehell, Ingrid Johansson Mignon
Examiner: Ingrid Johansson Mignon, Department of Technology Management and Economics

REPORT NO. E2022:115
Department of Technology Management and Economics
Division of Innovation and R&D Management
Chalmers University of Technology
SE-412 96 Gothenburg
Telephone +46 31 772 1000

Cover: Solar PV system at Chalmers Kårhus in Gothenburg, Sweden.

Typeset in LaTeX
Printed by Chalmers Reproservice
Gothenburg, Sweden 2022

Abstract

Transitioning towards the widespread use of sustainable energy systems is imperative if the world is to successfully mitigate the challenges posed by climate change. Solar energy offers the potential to reduce gas-house emissions, and Sweden has the potential to accelerate its proliferation among the residential population, who have showed an interest in adopting this energy solution. However, a significant knowledge gap exists among a majority of those interested, with 46 percent of Swedes stating that they are not well-informed enough to invest in solar PV. Moreover, research has highlighted informational barriers as a large challenge that potential solar PV adopters must to overcome. Digital middle-actors - also known as intermediaries - have the ability to help adopters overcome these informational issues by providing information to them in a setting widely available to many, i.e. the Internet.

This thesis has posed three research questions which have all been answered. First, how do digital intermediaries support solar PV adopters and what support roles do they serve. Second, it has studied how digital intermediaries are structured to create, deliver and capture value. Lastly, what trade-offs exist in the business models of digital intermediaries. To enable this exploration, a qualitative cross-case study was done by examining the business models of six digital intermediaries acting on the Swedish solar PV market.

First, the findings showed that digital intermediaries primarily support solar PV adopters in the pre-decision and decision making phase of adopting solar PV technology, with one out of six intermediaries also providing some post-decision support. An example of what type of support is given are informational texts, interactive tools such as investment and solar production calculators, facilitating a connecting between adopters and solar PV suppliers as well as providing information about adopters' responsibilities and information of suppliers' installation performance. The roles these intermediaries take in order to provide these differing type of support is that of content providers or also match makers or (informal/formal) regulators.
Second, the results show that digital intermediaries create value by providing the aforementioned type of support, and deliver it through their websites and in some cases also directly engaging with adopters through other means such as via phone conversations. Moreover, digital intermediaries can act as non-profit actors and are then either publicly or self funded, thus bypassing the need to capture value through through the support they provide. Alternatively, digital intermediaries can also operate on a for-profit model, and instead choose to solicit payments from a network of partnered solar PV suppliers when acting as match makers, or by extracting client fees from adopters who have already installed solar PV systems on their roof when acting as an informal regulator. Additionally, while all intermediaries were found to support residential adopters, match makers also catered to solar PV suppliers through their brokering services.
Third, it is evident that regardless of being a for-profit or non-profit intermediary, provision of free content is expected if adopters are to engage with what they have to offer and something digital intermediaries must offer regardless of how they choose to capture value. For non-profit intermediaries, their strength lies in the fact that they are publicly or self-funded which enhances the credibility in the content they provide. However, this also means that they are unable to guide adopters to specific solution providers. The reverse trade-off exists for for-profit intermediaries, who are able to help link adopters with specific suppliers. However, their neutrality is compromised because they are biased towards nudging adopters to use suppliers in their network of partners.

Keywords: Solar photovoltaics, diffusion, intermediaries, business models, cross-case study, adopter

Acknowledgements

First, we would like to thank our examiner and supervisor, Ingrid Johansson Mignon and Hanna Rydehell respectively for the opportunity to learn more about the solar PV industry and the impact intermediaries and their business models have in transitioning society towards a more sustainable future. Moreover, we would also like to thank them for the guidance they provided throughout the thesis and their sharing their insights into the studied topics. We would also like to thank Lisa Winberg for her help in questions both related to the topic studied and the process of materializing the thesis.

Lastly, we would like to extend our sincerest appreciation to all the people who participated in the interviews and facilitated to the understanding of how middle-actors enable the spread of solar PV technology.

Thank you!

Hanna Dahlström and Lucas Lazaroo, Gothenburg, June 2022

Contents

List of Figures

List of Tables

Abbreviations

PV	Photo-voltaic
RET	Renewable energy technology

1 Introduction

This thesis is qualitative examination of middle-actors acting in a digital setting whose mission is to help consumers wanting to adopt solar PV systems. The thesis is done in conjunction with a research project regarding the impact business models have on the diffusion of solar energy, carried out at the division of Innovation and R&D Management at Chalmers University of Technology. In this section, we outline the background, aim and research question that the thesis focuses on.
In section 2, the underlying theory regarding intermediaries, solar PV diffusion and business models are outlined. Section 3 outlines how the chosen method used in the thesis. Section 4 details the results and section 5 presents the analysis on the results. Lastly, sections 6 and 7 presents the discussion and conclusions respectively.

1.1 Background

A successful transition to sustainable energy systems is a requirement to thwart the adverse consequences of climate change, and requires the use and escalation of several renewable energy sources (Pacala and Socolow, 2004). Solar energy offers the potential for reducing greenhouse gas emissions, with the usage of solar photovoltaic (PV) systems predicted to reduce carbon emissions by 69–100 million tonnes by 2030 (Shahsavari, 2018). For solar PV to contribute to a more sustainable society, it can be up-scaled at a utility level (Iacobescu and Badescu, 2012), industrial level, commercial level, residential level or combination of all four (Lindahl et al., 2020). Adoption at the residential level has risen in countries such as the United States (Schelly, 2014) and Germany (BMWK, 2020) and has also begun to accelerate in Sweden (Lindahl et al., 2020). In 2020, 3% of Swedish residential homeowners had a solar PV facility installed, and 52% believe they will own one in the next ten years (Svensk Solenergi, 2020). However, a significant knowledge gap has been detected in the Swedish market with 46 percent of Swedes saying they are not well-informed enough to invest in solar PV technology despite a large interest to do so. To enable widespread solar PV adoption on a residential level requires a short and straightforward decision-making process for its adopters (Rai, 2013). To facilitate such decision-making, it is thus important to provide potential adopters with access to clear information on the technology in question (Rai, 2013).

Research has highlighted several challenges that adopters of solar PV face, which may help explain why widespread diffusion at the residential level has yet to be realized. For example, potential adopters have previously faced difficulties with finding information on technical aspects of solar PV, and financial concerns regarding a long-term profitability of the investment (Jager, 2006). Adopters also need to gather a vast amount of information before deciding whether or not to invest in solar PV, which is can be remedied by the easy access to information on the internet (Rai, 2013, Ratchford, 2001). Due to the high amount of information required, it is critical that customers are given reliable information so that data collection may be kept to a minimum (Yacouel and Fleischer, 2012). In order to boost adoption, Rai and Robinson (2013) emphasize the significance of supporting adopters in addressing informational gaps and technological uncertainties surrounding solar PV. Here the Internet plays a key role in filling such informational gaps, by providing information on functional features and price in an efficient manner (Ratchford, 2001).

Intermediaries have previously been shown to help adopters overcome adoption challenges and facilitate the diffusion of solar PV (Bergek, 2020, Sovacool et al., 2020). Parag and Janda (2014) describes intermediaries as a form of broker, acting between different parts of an innovation system. They stated that an intermediary's main roles were to connect, translate and ease the flow of knowledge between

parties. Intermediaries were said to facilitate collaboration between actors on different levels, promote innovations and support a well-functioning multi-level governance, thereby helping potential adopters overcome the challenges they face when deciding whether or not to invest in solar PV. Examples of intermediaries in a sustainable energy system were informal and semi-government energy agencies, energy service companies and providers, local communities, and networking platforms.

By providing trustworthy, accessible information on solar PV requirements, installation and maintenance, intermediaries could aid solar PV diffusion on a non-utility level in Sweden by decreasing the total cost investment cost as well as the decision time (Rai, 2013). Here, digital intermediaries are particularly useful, by spreading information with the help of the internet to a wider public than non-digital intermediaries could, since they are not bound to a specific region or geography. Many people use digital information channels to source information (del Águila-Obra et al., 2007), and studies have shown that digital intermediaries help adopters in their decision-making process by helping them sort out relevant information (Yacouel and Fleischer, 2012).

For example, Hyysalo et al. (2018) demonstrated how digital intermediaries such as Internet-based energy communities, have played an important role in broadening the market for renewable energy technologies (RET) beyond early adopters such as enthusiasts and environmentalists. They have done so by increasing exposure, eliminating ambiguity, and providing site visitors with clear information about new technological possibilities, thereby assisting in meeting the specificities of different local contexts. Stewart and Hyysalo (2008) expanded on the role of digital intermediaries, stating that these actors are crucial to the social learning that occurs when dealing with new technologies, for example, by bridging the network and knowledge gaps described by Rai and Robinsson (2013). Digital intermediaries in the renewable energy sphere have recently emerged on the Swedish market, such as digital pricing comparison sites for solar PV which allows users to compare different suppliers and provide tools to make estimations in terms of cost and energy produced. Potential adopters need a substantial amount of information to take a decision weather or not to invest in solar PV (Rai, 2013), and digital intermediaries will have an impact on that outcome since they help adopters highlight relevant information. Digital intermediaries need to balance providing trustworthy, neutral information, with ensuring a profitable business (Teece, 2010, Sarkar et al., 1995, Chircu et al., 2000). The company structure gives an insight to understanding this balance between neutrality of information and profitability. It is therefore important understand the source of funding (Mignon and Kanda, 2018) and how these digital intermediaries provide value to their customers, which can be done by examining their business models (Timmers, 1998).

Business models allow for the understanding of how a company is structured to provide value to a given customer, and their plan to generate a profit (Teece, 2010). Thus, it allows one to understand whether an intermediary's operations is designed to provide support that is aligned with the interest of the customer (Richardson, 2005) and how they plan to earn profit (Teece, 2010). The concept of examining business models of renewable energy providers has been used by previous scholars since it is said to have benefits for research (Jolly et al., 2012, Horváth and Szabó, 2018, Brown et al., 2019). The study of business models for RET companies reveals opportunities to accelerate the diffusion of said technology (Jolly et al., 2012). For example, Jolly et al. (2012) demonstrated that experimental business models for solar PV ventures were being up-scaled in India, since their experimental designs had the potential to increase solar proliferation. Brown et al. (2019) illustrated how an intermediary called Energiesprong- a dutch government-funded energy initiative - facilitated business model innovation for consumers seeking to retrofit their houses with technologies such as solar PV. This was achieved by the intermediary, who through their functions were able to reduce transaction costs through standardization, economies of scale and supply chain integration. Similarly, Nolden et al. (2020) discovered that intermediary-facilitated business models were emerging in England's solar PV community through the use of intermediaries. These intermediaries played a crucial role in brokering and managing increasingly complicated energy issues for their customers and were able to standardise

energy agreements between stakeholders to reduce transaction costs and increase the amount of PV installations.
However, a mapping of who these intermediaries are, how they are structured to deliver value to adopters and how they might differ has yet to be explicitly detailed. Aspeteg and Bergek (Aspeteg and Bergek [2020]) investigated diffusion-oriented innovation intermediaries in Sweden for both solar and wind power, but did not focus on their digital activities. Loock (2020) reviewed the significance digital technologies had on business model innovation and its effect on addressing bottlenecks for a European energy transition, but did not incorporate the role intermediaries play in this part.

The potential of digital intermediaries to decrease the investment cost and decision time for solar PV adopters is linked to their business models. The link between intermediary's business models and diffusion, together with the needed balance between profit and neutrality, makes it important to examine those business models more closely. Understanding the opportunities, limitations, and environment surrounding solar PV is critical for researchers and policymakers because it allows them to establish regulations that foster viable business models for people who use the technology (Richter, 2013).

1.2 Problem identification and thesis aim

A primary concern of solar PV adopters is overcoming informational barriers (Rai, 2013) and intermediaries have previously shown the ability to facilitate solar PV diffusion by supporting adopters (Aspeteg and Bergek, 2020). Considering that many rely on digital information channels to source their information (del Águila-Obra et al., 2007) and that digital intermediaries have previously been shown to help consumers sort out information that is relevant for them (Yacouel and Fleischer, 2012), it is pertinent to understand how these digital intermediaries are designed to help adopters of solar PV specifically. Moreover, these adopters seek neutral and trustworthy information (Rai, 2013), and digital intermediaries must balance this provision while ensuring that a profit is made (Teece, 2010, Chircu et al., 2000). We aim to understand these aspects by studying the business models of digital intermediaries. By examining this aspect, we strive to ascertain how digital intermediaries support adopters in the process of adopting solar PV technology, what value they provide and how they are able to financially sustain themselves. Additionally, we aim to understand the similarities and differences between digital intermediaries.

1.3 Research questions

With the established problem and aim of the thesis, the following research questions are derived:

- RQ1 How do digital intermediaries support the adoption of solar PV and what roles do they serve?
- RQ2 How are the business models of digital intermediaries within the solar PV market structured to create, deliver and capture value?
- RQ3 What are the trade-offs that exist in digital intermediaries' business models?

1.4 Scope

This study is done as a supplement to a research project at Chalmers University of Technology which seeks to understand how innovative business models can facilitate the spread of solar technology with a goal to understand how these can be applied in Sweden. Thus, this thesis has chosen to specifically only explore digital intermediaries on the Swedish market to better understand how they support adopters in the country. The thesis does not guarantee that an exhaustive mapping of

all digital intermediaries will be executed but strives to compare and contrast a selection of digital intermediaries.

2 Theory

In this section, theoretical concepts necessary to answer the thesis' research questions are presented. First, the role intermediaries have supporting residential adopters of solar PV is presented. Next, the relevance of examining business models in a solar PV diffusion is presented. Thereafter, the concept of digital intermediaries their business models are detailed.

2.1 Intermediaries and their role in solar PV residential adoption

Scaling up the use of solar PV generation can occur at multiple levels in society. At the highest level, the utility-scale level, solar PV generation is produced by utility companies and the electricity is then distributed to end consumers (SolarReviews, 2022). At lower ordinal levels, solar energy can be produced on industrial, commercial or residential level (Lindahl et al., 2020). When measuring the share of annual installed PV capacity in Sweden during 2020, the two largest segments were the residential segment (43%) and the the commercial segment respectively (40%), while the utility level's installed capacity represented a smaller margin (15%) as did the industrial segment (1%). Although support schemes have been initiated to increase the installed capacity at a utility level in Sweden(Lindahl et al., 2020), there also exists a potential to increase the installed capacity at a residential even further. According to the Swedish solar trade association, Svensk Solenergi (2020), 3% of all private citizens own a residential solar facility while 52% would like to own a PV system within ten years time, suggesting that a significant increase in installed capacity is possible on the residential elvel as well.
However, while high hardware and installation costs have often cited as a large prohibitive factor (Girardeau et al., 2021) for consumer adoption, it is not the only challenge solar technology is faced with in relation to its spread (Jager, 2006, Rai and Robinson, 2013). A non-monetary barrier which potential adopters must overcome are various types of informational hurdles which allow adopters to find solar PV adoption an attractive investment (Jager, 2006, Rai and Robinson, 2013). Not only must adopters be able to retrieve a sufficient amount of information, but research has shown that there is an emphasis on having access to information channels which they put a a high degree of trust in (Rai and Robinson, 2013). For instance, Palm and Lantz (2020) found that information campaigns performed by municipalities in Sweden and directed towards homeowners led to a 29% increase in submitted and approved subsidy applications.

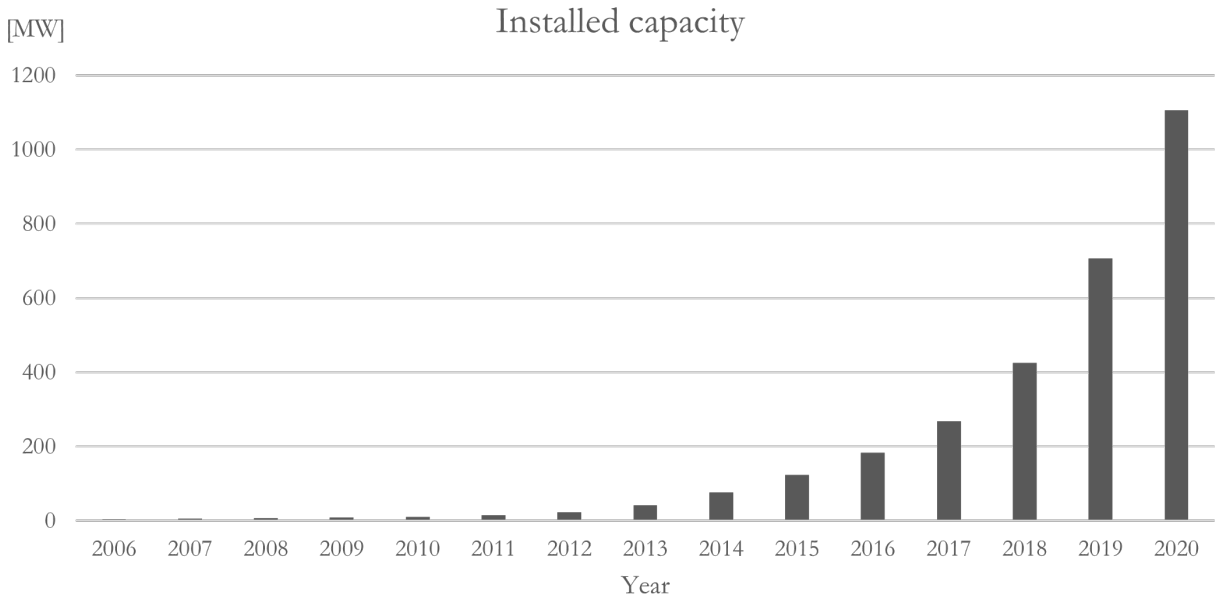

Figure 1: *Total installed PV capacity in Sweden (Lindahl et al., 2020).*

In solar PV adoption context, intermediaries have the potential to accommodate this need when acting as bodies that are independent from any technology provider and have done so in sustainability transition contexts (Bergek, 2020, Sovacool et al., 2020). Intermediaries - more colloquially known as middlemen or mediators - are entities which act between two or more persons or parties to facilitate some type of action (OED Online, 2022). This term can be considered a rather general description, as the identities, roles and activities they can engage in differ considerably depending on the context which they are situated in (Bessy and Chauvin, 2013). As an example, a marketplace such as Amazon and real estate brokers can both be considered intermediaries as they facilitate action between different parties, although what they do in terms of activities likely differs. Thus, many different context-specific terms for intermediaries have arisen. In sustainability literature, Howells' (Howells, 2006) concept of the *innovation intermediaries* - organizations or bodies that acts intermediates in an innovation process - garnered considerable influence among those who studied intermediaries acting in this context (Bergek, 2020, Hyysalo et al., 2018, Klerkx and Leeuwis, 2009). However, most of this literature is centered around intermediaries involved between actors engaged in the development of innovative technologies and not its diffusion (Janssen et al., 2014, Katzy et al., 2013, Polzin et al., 2016). Aspeteg and Bergek (2020) called intermediaries focused on the diffusion of new renewable energies *diffusion intermediaries*, with the distinction between them and innovation intermediaries being that the former acts in a setting where at least on of the parties is a technology adopter. To elaborate, diffusion intermediaries concern themselves with challenges related to the adoption of a technology rather than the development of it (the latter being the primary issue innovation intermediaries seek to support) (Aspeteg and Bergek, 2020). A illustrative example of this is shown in Figure 2, where a diffusion intermediary can act as a broker between a solar PV adopter and a solution provider.

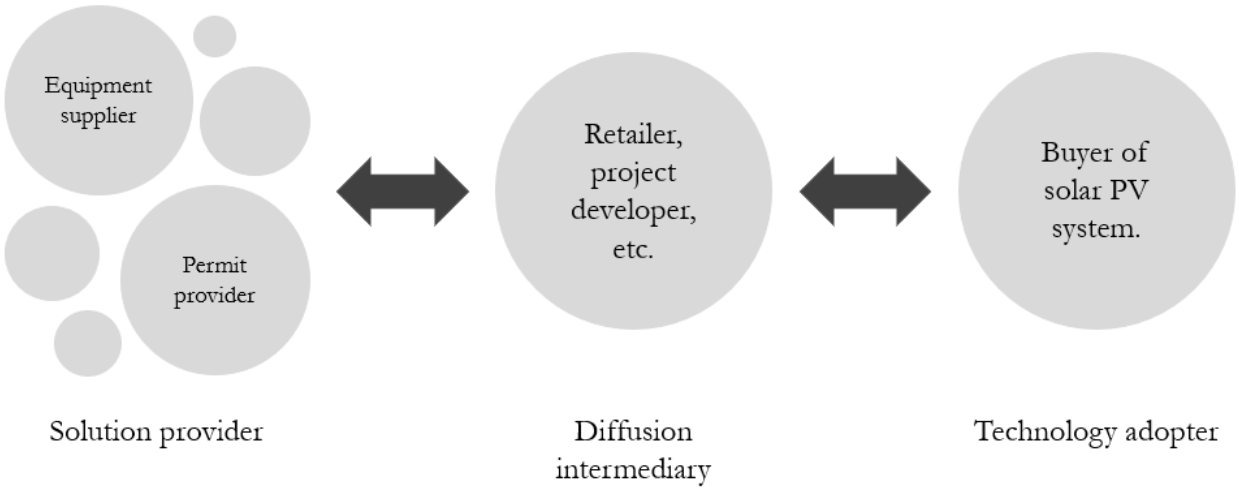

Figure 2: *Intermediaries can broker between solution providers and technology adopters (Bergek, 2020).*

To understand the support intermediaries helping solar PV adopters can provide, we use the results found by Glaa and Mignon (2020), who studied the intermediaries supporting adopters of RET in Sweden. Using a framework to characterize the decision process of an adopter (Damanpour and Schneider, 2006), Glaa and Mignon (2020) identified the support RET intermediaries (including solar PV intermediaries) provided during the different decision phases an adopter experiences. Figure 3 presents the decision process and the corresponding support intermediaries can provide adopters.
In the pre-decision phase, intermediaries can advocate for the innovation and market it, provide information about the innovation to potential adopters, help them identify adoption opportunities or facilitate networking and collaboration to adopters. Collectively, these efforts help adopters to realize a need for the technology and drive them to make a decision whether or not to adopt it.
In the decision-making phase, intermediaries can once again coordinate collaboration and create networks for adopters to partake in. Alternatively, intermediaries can themselves engage in providing business and investment advice, or support adopters through technology evaluation and selection.
Once a decision has been taken to adopt the technology, RET intermediaries can help the adopters by providing funding support, defending their interests, providing implementation and post-implementation services as well as helping them to configure the technology to their needs. Moreover, help can be facilitated by coordinating efforts between different subcontractors or mediating other stakeholders involved in the adoption process. (Glaa and Mignon, 2020)
Glaa and Mignon's (2020) framework in Figure 3 thus serves as a useful tool to understand the challenges solar PV adopters face and the particular issues that intermediaries aiding in the technology's diffusion can potentially remedy.

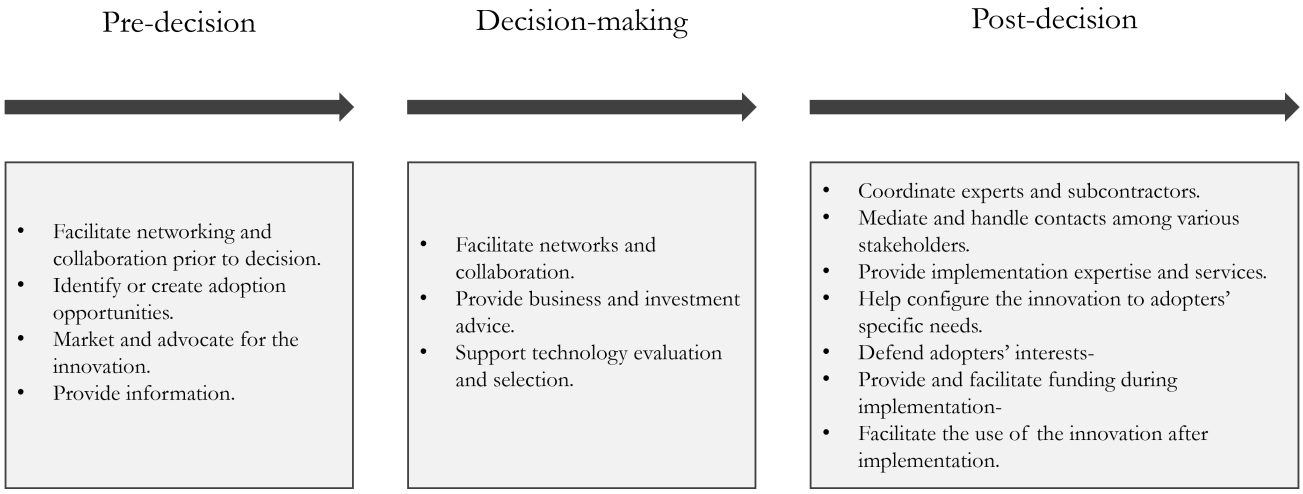

Figure 3: *Intermediary support provided to adopters of RET (Glaa and Mignon, 2020).*

While it is useful to identify what support intermediaries provide, the diverse nature in which they can facilitate this support (e.g. contrasting the aid innovation intermediaries and diffusion intermediaries provides) means that their differences cannot be overlooked (Hodson and Marvin, 2010). Therefore, it relevant to categorize intermediaries based on a set of shared characteristics to better assess if inferences can be made in terms the support they provide (Mignon and Kanda, 2018). Establishing a typology allows the evaluation of differences and similarities among intermediaries acting in shared contexts. This notion was argued by Mignon and Kanda (2018), who sought to identify similarities and differences between intermediary reorganizations to consider when shaping policy design in a sustainability transition setting. To achieve this, they devised a typology which facilitated a comparison based on three main characteristics which were contended to be distinguishing attributes in regards to policy design.

The first of these were differences in *source of funding*, which are typically divided into intermediaries that are either funded via public or private sources (Mignon and Kanda, 2018). The former group often receive funding through governmental budgets while the latter are typically financed by charging client-fess through provision of services. Public intermediaries commonly manifest as government and science partners, research or innovation agencies, organizations created to drive sustainability initiatives or universities (Hansen and Klewitz, 2017). Examples of privately funded intermediaries are various types of consultancies (Mignon, 2017) and typically operate on a for-profit model, although non-profit intermediaries such as industry associations do exist (Rohracher, 2009. Mignon and Kanda (2018) argues that the source of funding is important, as it inherently affects the opportunities and limitations inherent with an intermediary. Elaborating on this assertion, they claim that it affects the roles and activities intermediaries undertake, the technological neutrality of their support (e.g. whether they support a specific technology or a mix of different technologies). Moreover, it impacts the longevity of an intermediary organization and how long they can be guaranteed financial aid to operate. Finally, it also determines the content in their intermediation activities and their legitimacy (the degree of formal and informal acceptance as an impartial actor). From a policy perspective, they argue that short-term funding can result in losing competencies which are acquired over a long time and that instability of funding may lead intermediaries prioritizing their own survival instead of focusing on activities which further innovation transitions.

The second characteristic, *scope of action*, refers to the spatial boundaries which the intermediary operates in. Here, different frame of references are exemplified by Mignon and Kanda (2018). For example, some emphasize a technological transition perspective and view intermediaries as operating on a system or actor level. On a systemic level, intermediaries engage in networks and focus

on affecting the strategic development of the system (e.g. by articulating demand for research or advocating change in the current knowledge infrastructure) (Mignon and Kanda, 2018). On an actor level, intermediaries provide aid to individual entities or through bilateral relations (i.e. between two parties) (Mignon and Kanda, 2018). Conversely some have instead examined intermediaries from a geographic viewpoint, limiting the scope to a regional or city level (Hodson et al., 2013. Mignon and Kanda (2018) explain that authors commonly differentiate intermediaries based on a selected scope of action and emphasize its importance, although it is uncertain how these differences affect policies. From their own results, Mignon and Kanda (2018) found that actor-level intermediaries were better suited at serving needs on an individual level, but require more resources than system-level intermediaries. However, the latter group are conversely poorer equipped at meeting any specific need, instead more adept at addressing broad groups of actors.
The last characteristic used by Mignon and Kanda (Mignon and Kanda, 2018) was *recipient(s) of intermediary support*. While intermediaries by definition act as a link between other actors, Mignon and Kanda found that innovation intermediaries who are studied usually skew towards either supporting the supply-side of innovation (i.e. actors who focused on developing innovation) or demand-side innovation (those who seek to adopt innovation, i.e. adopters). This distinction is noteworthy, because it determines the nature of the activities and roles which the intermediary employs. As an example, intermediaries who focus on the supply-side of innovation may support them by facilitating commercialization (Bessant and Rush, 1995 or help create legitimacy and spreading awareness about new technologies and practices (Kanda et al., 2015). Those focused on aiding the demand-side of innovation - commonly referred to as user-side intermediaries - do not control the technology use, but can provide advisory services to users regarding different technologies (Owen et al., 2014) and help them overcome challenges in the adoption process of innovations (Mignon, 2017). Since the different recipients of intermediary support result in different activities undertaken, it follows that their use may differ in regards to policy purposes (Mignon and Kanda, 2018). As an example, supply-side intermediaries may be particularly relevant for policies which seek to target innovation development (Fichter et al., 2016), while policies affecting demand-side intermediaries may better affect the diffusion rate of sustainable innovations (Kanda et al., 2015).

While intermediaries have the ability to support solar PV adoption, it is also important to highlight the trade-offs that come from balancing their self-interest with those of both adopters and stakeholders involved in the diffusion process (Klerkx and Leeuwis, 2008). To elaborate, these actors must ensure that they maintain financial sustainability while ensuring that they meet the needs of those that they are intermediating between (whose primary interest may not align with either the intermediary or each other). As Klerkx and Leuuvis explains (p.374, 2008): *brokers are effective when they strike an acceptable balance between economic interests of buyers and sellers and their own profit.*
Referencing the earlier study by Mignon and Kanda (2018) as an example of this, they found that intermediaries that financed themselves by selling services to private clients are inclined to accelerate their projects in order to maintain their business model and stay financially sustainable. As a consequence, they are incentivized to hasten the project process which some did by limiting the selection of alternatives their clients are presented with.
Janda and Parag (2013) further emphasizes that middle-actors have their own agendas that are not necessarily congruent with larger, societal, goals. As they explain in the context of improving the energy performance in buildings, actors such as architects and engineers are obliged to meet requirements in terms of providing energy-efficient solutions, not exceed them (as this would likely cost them additional resources). To change this behavior and work towards achieving the best energy-efficient results, Janda and Parag (2013) contend that building professionals would have to have their economical goals aligned with the provision of the aforementioned energy goals.
Therefore, it is worth examining how intermediaries are designed to operate to understand how they

balance the aforementioned trade-offs present. I.e., studying how they intend to create and deliver value to their intended customers while also ensuring that they generate revenue and make a profit to survive. This concept is known as a business model and is detailed further in the following section.

2.2 Business models and their relevance for solar PV diffusion

In order for diffusion of solar PV to continue, the drivers of diffusion (i.e. actors that facilitate its propulsion) must be able to operate successfully (Dewald and Truffer, 2012). However, changes in market conditions such as modifying the feed-in tariff (Dewald and Truffer, 2012) or decreasing the subsidies granted to for adopting solar PV (Lund, 2014) can adversely affect these actors as they can lead to fewer willing adopters in their market, risking their financial well-being (Karakaya et al., 2016). Examining an organization's business model reveals how they are structured to offer, create and profit from value given to their customers (Teece, 2010). Additionally, it also directs the relationship organizations have with their suppliers, competitors and the broader business environment (Teece, 2010). These aspects are fundamental to understand how companies (e.g. intermediaries) 'do business' and are able to operate in a given market (Zott et al., 2011). In the context of sustainable transition literature, studies on energy policy have highlighted the importance of business models in sectors such as heat energy production (Okkonen and Suhonen, 2010), electrical cars (Kley et al., 2011) and algae bio-fuel (Nair and Paulose, 2014). The business models for suppliers of solar PV has also been researched (Karakaya et al., 2016) and their role in helping firms spread technological innovations has been acknowledged (Teece, 2010, Baden-Fuller and Haefliger, 2013). As an example, Karakaya et al. (2016) illustrated how a local solar PV supplier in Germany faced challenges at a time when diffusion was affected by reduced adoption rates, diminishing feed-in tariff for PV installations and a decreased turnover per PV system installation. By examining the supplier's business model, they showed how the the company had relied on operating on a "local" level and that adopters were supposed to keep their solar PV facilities for a long time to fully benefit from the previous feed-in tariff set. The company studied lacked the resources to change their business model to adapt to the new developments on the market. Thus, Karakaya et al. (2016) exemplified both how policies in the energy sector affected solar PV actors and that businesses are not always capable to innovate on their business model in order to adapt to new market conditions.

Business models in general have been the subject of much research in recent decades (Zott et al., 2011). Zott et al. (2011) notes that interest in the area gained traction between 1995-2010. A search using the EBSCOhost database indicates that this trend has continued to grow since then, with the term being a focal point in over 270,000 peer reviewed texts between 2011-2021. However, there is is a lack of commonly agreed upon definition when referring to business models. This is not a consequence from lack of trying, as many researchers have laid out proposed definitions over the years. In Table 1, we see a selection of proposed definitions for the concept known as a *business model*. As can be seen, all of these definitions either encapsulate the act of offering something of value or the ability to generate a profit (most explicitly mention both, with Timmers (1998) and Foss and Saebi (2018) being exceptions in each case). Bearing in mind that the presented definitions in Table 1 are only a sample of those that have been proposed, some have claimed that there is no unified concept for what constitutes a business model, instead lending itself to many interpretations (2011). The plethora of definitions infers that one should be precise when discussing the topic of business models.
Timmers (1998) who concerned himself with emerging business models of e-commerce enterprises of the time, viewed business models themselves as insufficient in realising a firm's business mission. Following his definition illustrated in Table 1, he posited that to assess the viability of a company it needed to be complemented by a marketing strategy. Combining both of these elements is how he chose to define what he called the marketing model, which allowed a company to assess how to 'do business' in a sustainable manner. Osterwalder (2004) offered a contrasting viewpoint of business

models, where he conceptualizes them as an abstract representation of a company's 'business logic', i.e. how they are organized to make money. Further diverging from the perspective of Timmers (1998), he viewed the business model as forming a coherence between business strategy and process, acting as a 'glue' between them. Teece (2010) offers yet another outlook. Elaborating on his outlined definition (illustrated in Table) 1, he conceives that a business model encapsulates the mechanisms used by a company to create value (through its products or services), to dictate how that value is delivered to their customers and how they are able to capture value off it (converting the value provision into profits for the company). While similar to the paradigm offered by Osterwalder (2004), in so far that both consider it a design for how value is provided and profited from, Teece (2010) separates business models from the domain of business strategy. He explains that business models are more generic than a business strategy and many that of its features are imitable by competitors (in contrast to establishing a sound strategic plan). Thus, strategy analysis is a required and complementary step to design a competitively sustainable business model. While strategy analysis is invariably linked to business models, he asserts that this process is a separate exercise which merits its own focus, as it is more granular than the process of designing a business model. Phrased differently, business models reflect a company's hypothesis of what customers want (in the form of a product or service), how they want to receive it and what they will be willing to pay in order to do so. The business strategy is what ensures that the company has a differentiated and competitive advantage when executing on their business model.

For this thesis, Teece's (2010) conceptualization concerning business models will be used. His work has examined business models role in innovation management (Teece, 2010, digital enterprises (Teece and Linden, 2017 and these contributions have been used by other scholars to build a theoretical foundation in their research of digital transformation (Verhoef et al., 2021, Warner and Wäger, 2019) and in the area of sustainability (Pieroni et al., 2019, Schaltegger et al., 2012).

Table 1: *Selected business model definitions.*

Author(s), Year	**Definition**
Timmers (1998)	The business model is: • "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." (.p 4)
Amit and Zott (2001)	"A business model depicts the content, structure, and governance of transactions designed so as to create value through the exploitation of business opportunities." (p. 511)
Osterwalder (2004)	"A business model is a conceptual tool that contains a set of elements and their relationships and allows expressing a company's logic of earning money. It is a description of the value a company offers to one or several segments of customers and the architecture of the firm and its network of partners for creating, marketing and delivering this value and relationship capital, in order to generate profitable and sustainable revenue streams." (p. 15)
Chesbrough (2007)	"In essence, a business model performs two important functions: It creates value, and it captures a portion of that value." (p. 22)
Teece (2010)	"A business model articulates the logic, the data and other evidence that support a value proposition for the customer, and available structure of revenues and costs for the enterprise delivering that value." (p. 179)
Foss and Saebi (2018)	"In other words, a business model is a bundle of specific activities and activity systems conducted to satisfy the perceived needs of the market, along with the specification of which parties (a company or its partners) conduct which activities, and how these activities are linked to each other." (p. 13)

In addition to providing a definition of what a business model 'is', many researchers have shared a list of components that a business model can be considered to be comprised of. These are useful to distinguish themes and building blocks identifiable in any enterprise's business model (Zott et al., 2011).

As with the concept of business model, the components that constitute them have been interpreted in many different ways in literature. Richardson (2005) proposed a business model framework which integrated a firm's theory about how to compete (i.e., strategy) to its execution. Thus, applying his model allows one to create a map picture and analyze how a given firm has chosen to execute their intended strategy. Although the framework does not elucidate what aspects of a business model inherently leads to a competitive advantage and superior performance, it does allow one to systematically compare and contrast firms' business models against each other. In addition, it facilitates inferences being made between a chosen business model and performance (Richardson, 2005). Richardson's (2005) framework resembles Teece's (2010) conceptualization of a business model, choosing to define the framework to consist of a *value proposition* component, a *value creation and*

delivery part and a *value capture* aspect. The framework is presented in Figure 4 with its components and their corresponding elements.

Value proposition

The value proposition refers to who the company has chosen to cater, i.e. their *target customers* and the *offering* the company has chosen to provide through their products or services. Moreover, the value proposition also relays the firm's *basic strategy* of how to win customers and gain a competitive advantage on the market, i.e. answering why should their target customers choose the firm in question over a competitor. (Richardson, 2005)

Value creation and delivery

The second component, value creation and delivery, describes in further detail how the firm's theory is put into action. It explains the *organizational* aspects needed to enable the firm's value proposition such as the business activities they undertake and the value chain they use to deliver that value. Moreover, it also denotes the company's position in the value *network*. I.e., whether they collaborate with any business partners and how, if they have and suppliers and how they interact with customers. Lastly, it also describes the *resources and capabilities* uses to optain a competitive advantage. (Richardson, 2005)

Value capture

A firm's value capture component explains how they plan to generate revenue (their *revenue sources*) and profit from their business. A firm's ability to generate profit is reflected in their economic model and besides considering the sources of revenue of a firm also reflects the costs that the firm has chosen to incur, i.e. *the economics of their business.* (Richardson, 2005)

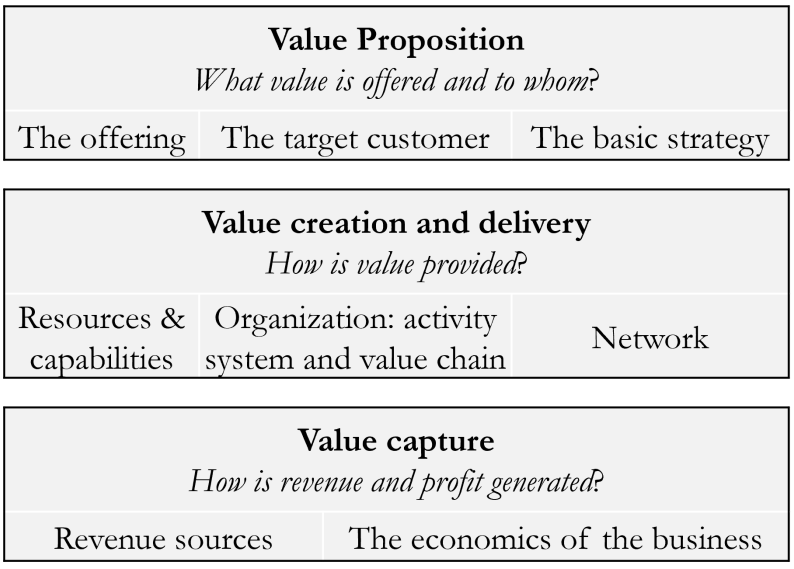

Figure 4: *Richardson's business model framework. (Richardson, 2005)*

To summarize, a business model articulates how a company is structured to *create and deliver* value to a customer segment, formulated into a *value proposition.* Additionally, it also explains how the company intends to profit from their activities, also known as their design for *value capture* (Teece,

2010).

2.3 Digital intermediaries and their business models

In this section, the role that digital intermediaries fulfill is initially outlined. Thereafter, commonly exhibited business models used by digital intermediaries are presented in order to understand how these type of actors chose to operate.

2.3.1 Digital intermediaries and their role(s) they fill

When relating the importance of business models to intermediaries in the context of solar diffusion, we previously mentioned that information barriers was a challenge that adopters need to overcome (Jager, 2006, Rai and Robinson, 2013). In a scenario where information is asymmetrically distributed, value can therefore be propositioned on the dissemination of said information (Bessy and Chauvin, 2013). In this setting, intermediaries can provide value in a number of ways by gathering, processing and distributing information (Cash et al., 1999). Those seeking credible information may need someone to help them define problems, understand information and provide judgment which intermediaries have the potential to provide (Cash et al., 1999). The rise of information and communications technology (ICT) - more specifically, the Internet - has led to an unprecedented amount of information being accessible to an equally extraordinary amount of people (Ratchford et al., 2001). Assessing what data can be considered reliable or not on the platform is not a trivial matter, and as explained digital intermediaries have arisen to provide support by helping sort out information to those who use the Internet (Yacouel and Fleischer, 2012). The abundance and significant presence of digital intermediaries such as Amazon, Google, Airbnb illustrate that many rely on the. Similar to the disparate nature of intermediaries in other settings however, those who operate in a digital domain can also vary in what roles and activities they chose to engage in depending on the context (Perset, 2010).

As we previously established, the need for credible and trustworthy information is a important factor for facilitating solar PV adoption (Jager, 2006, Rai and Robinson, 2013). Chircu et al. (2000) investigated the relationship between the amount of expertise consumer perceives a digital intermediary to posses and their trust towards them. They found both of these attributes to positively affect customers' willingness to use a digital intermediary's services as trust and expertise increased. Traditional (non-digital) intermediaries, they claimed, have the advantage of building expertise and trust through their direct interaction with customers. In the case of digital intermediaries however, consumers often have to rely on self-service technologies that cannot always replicate human aid. This point is exacerbated for complex transactions (such as solar PV (Rai, 2013)) when uncertain outcomes are involved, where consumers are also unable to ascertain product and service quality by themselves. From their research results, they concluded that high levels of trust in digital intermediaries was essential when consumers were faced with complex transactions online (Chircu et al., 2000). Chircu et al. (2000) argued that digital intermediaries should seek to focus on features which build reliability (thereby increasing trust in their platform) and also providing intelligent search technologies and help (lowering the required expertise needed to be held by the consumer).

Much research has been done to ascertain the role which intermediaries can fill in the digital landscape (Perset, 2010, Sarkar et al., 1995, Anderson and Anderson, 2002, Barnes and Hinton, 2007, Brousseau, 2002, Giaglis et al., 2002). In their report detailing the social and economic role of internet intermediaries, the Organization for Economic Co-operation and Development (OCED) outlined the six different roles which are outlined in Figure 5 (Perset, 2010). As can be seen in the Figure, the

upper roles, *Internet access and service providers* and *Web hosting, data processing and content delivery* are third-party producers that facilitate the use of the digital medium, but do not actively engage in the intermediary activities related to this thesis (namely, the diffusion of solar PV technology). Similarly, *Payment systems* and also *Internet search engines & portals* are not likely to directly concern themselves with specifically aiding in the spread of solar energy technologies (however, we acknowledge that it is likely many use search engines to find information on the subject). The remaining types, *Participative networked platforms* and *E-commerce intermediaries* either allow for discussion surrounding specific topics or facilitate the transaction of products and services and are thus relevant for further examination. For example, Hyysalo et al. (2018) showed that energy internet forums (which fall into the category of participative networked platforms) helped accelerate the spread of heat pumps in Finland by providing clearer information and less uncertainty regarding technology options. Another, contrasting, example is that of online booking sites (falling into the category of e-commerce intermediaries) providing information on hotels lead to an increase in customers willingness to pay premium prices. This can be linked to Rai et al.'s (2016) assertion that overcoming informational gaps is pertinent for capital-intensive investment opportunities such as solar PV systems. Due to the benefit both participative networked platforms and e-commerce intermediaries can serve in market diffusion of solar PV, we elaborate on these roles further in-depth.

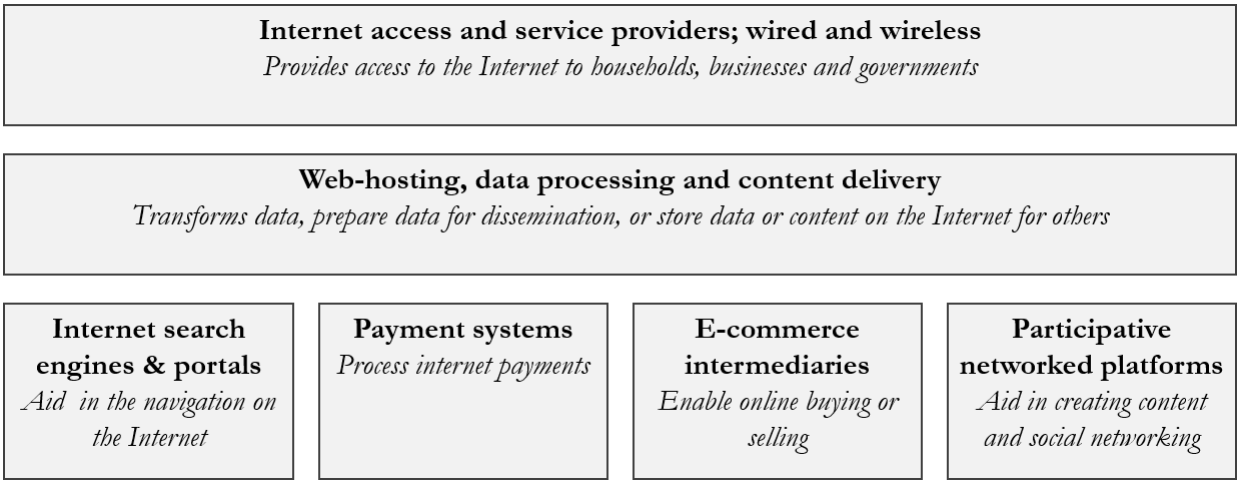

Figure 5: *Representation of internet intermediaries' roles according to the OECD (Perset, 2010).*

Participative networked platforms are intermediaries who facilitate social communication and information exchange (Perset, 2010). Their use relies on ICT platforms to allow users to create, collaborate and distribute various types of information on the selected platform. Examples of participative networked platforms are blogs, wikis and other text-based collaboration formats and social network sites. As mentioned, Hyysalo et al. (2018) researched how internet forums for heat pumps affected the proliferation of its use in Finland. They found that these internet communities act as a key user-side intermediary through various types of intermediary activities. Firstly, they help qualify available market information and act as a balance from assessments made by entities that may be affected by their own self-interest in their judgment. Furthermore, these communities allow users to voice complaints and improvement opportunities on a neutral platform. Lastly, they act as a platform to articulate demand and seek help for specific problems and considerations for individual users.
Web e-commerce intermediaries are those that connect buyers and suppliers on an electronic market and facilitate the transaction between them such as Amazon (Perset, 2010). Much research has been done into the roles that e-commerce intermediaries can provide (Anderson and Anderson, 2002, Barnes and Hinton, 2007, Brousseau, 2002, Giaglis et al., 2002, Sarkar et al., 1995).

Sarkar et al. foresaw (1995) foresaw that intermediaries would continue to serve a useful purpose in society and that a shift towards the digital medium was likely. Arguing that contrary to the zeitgeist of the time (the 1990's), that the infrastructure provided by the internet would strengthen the position of intermediaries. In their research, they identified ten detailed functions that digital intermediaries would serve which are displayed in Table 2. These functions were deliberately unbundled from any particular role, with the authors arguing that the role of intermediaries would be multifaceted.

Similarly, Anderson and Anderson (2002) also argued that commercial intermediaries would still be needed and that their role was changing as the Internet continued to rise in popularity. In contrast to the functions outlined by Sarkar et al. (1995), Anderson and Anderson (2002) outlined three value creating roles (each constituted by three generic functions) also displayed in Figure 2. They further contended that informational services, activities placed within a role they called *matching*, would have to be offered to consumers free of charge due to the fact that increased market information would reduce arbitrage opportunities. Instead, they postulated that there would be an increased focus on providing a *problem solving* role wherein intermediaries would profit from solving customer as well as producer problems. This would also lead to an increase focus on working with many partners, as companies would realize that no single organization could do everything by themselves.

Table 2: *Roles and functions of commercial and digital intermediaries as described by Anderson and Anderson (2002).*

Role	**Function**
Matching	Information about sellers Information about buyers Information about products
Requisitioning	Economies of scope Economies of scale Time-and-place-utility
Problem solving	Guarantee versus quality uncertainty Preserving anonymity Tailoring goods and services

As Teece (2010) described, the general aim of business models are to define how a company will create and deliver value to their customers, while turning a profit. He further claimed that business models have taken on a more prominent role in the last decade as a result of factors such as the development of the internet and e-commerce, as well as the global restructuring of financial services. This is supported by Wirtz et al. (2019), who argue that business models in digital contexts differ from traditional business models and are one of the main drivers of the digital sphere's innovation and start-up rate. They assert that today's increased innovation rate has been facilitated in part by a larger attention on a firm's business model. Elaborating further, they explain that since our information society relies on digital goods, business models have taken on a more prominent role in developing a competitive strategy in modern business. According to Teece and Linden (2017) when discussing digital enterprises, *"A good business model explains how and why customers, suppliers, and complementors interact with the company through the digital interface. As circumstances change, it provides guidance as to the ways the value architecture can be altered and a systemic framework for maintaining overall coherence." (p.2).* Following this train of thought, they add that the next-generation competition is also changing how firms operate, collaborate and compete, with competition not so much being on a firm against firm level as business ecosystem against business ecosystem one. A business ecosystem consists of a number of firms that collaborate (and can also directly compete against each other) to

create and sustain new markets and products. Thus, the value capture component of a business model must find a balance where profitability is not only attained by the focal firm in an ecosystem, but it's partners that belong to the same group.

Many researchers have taken an interest in identifying different types of business models that digital companies possess. In Table 3 we present a selection of digital business models which can be found by digital intermediaries which either fall in the category of participative networked platform or e-commerce intermediary or information providers. These showcase the value proposition they provide as well as how they earn money (when applicable).
Timmers (1998), was one of the first who attempted to classify emerging digital business models. Encompassing a multitude of different domains within the digital realm, he identified ten different business models, those which can potentially be found among the digital intermediaries discussed are shown in Table 3. He did not only concern himself with a specific subset of company types or markets, and thus provided a wide array of typologies. As an example, he presents *3rd party marketplaces*, *virtual communities* and *information brokers* as different types of business models. The examinatory depth of these business models is sparse when compared to later research however. Wirtz et al. (2019), who takes a more general perspective similar to Timmers (1998) proposes four different types of business models for Business-to-consumer (B2C) enterprises, with most of these also shown in Table 3. In contrast to Timmers (1998) however, he denotes that business' generally can be categorized in one of these four types, with each having their based on their value proposition and provides an in-depth evaluation, providing several subsets of niche digital business model for each type. The OECD also provides a categorisation of different types of digital business models. Like Timmers (Timmers, 1998 contribution, these can be said to be more brief in their description of each business model type (perset2010economic).
Though previous examples have focused on commercial digital business models in particular, some research has also been allocated into the study of digital business models for public organizations. Janssen et al. (2008) developed a taxonomy for web-based business models based on a systematic survey of 59 governmental websites in the Netherlands, as they found the concept of business models appealing for public sector organizations. A notion supporting this appeal was asserted by Winkel (2005) in 2005, who wrote that there existed many opportunities to digitally transform traditional governmental offerings, but that many of them were content at merely having an Internet presence at the time. Janssen et al. (2008) identified eight different governmental business models in the digital medium, a selection of these presented in Table 3. The research was specifically focused on the value proposition these different business models held, with little being said regarding their financing structure. Ranerup et al. (2016) interviewed 14 (digital) representatives from Public Service Platforms (PSP) in Sweden to increase their understanding of the business models behind them. The organizations covered the education, healthcare, elder care and public pension sectors with the expressed value proposition to provide information in their specific sector and in certain cases provide comparison services between different options. In contrast to what they described as the traditional view value proposition of PSP business models - the provision of neutral information about alternatives with the ability to compare and choose - they found that the emerging view was to promote their own services, promote the choice and reflection on these choices as well as facilitate user judgment.
Similar to how previous literature regarding business model and their definition share commonalities, the presented research into digital business models share similarities. Though differences exist between the selected business model types shown in Table 3, most mention:

1. Some type of *content provider* who generates revenue through advertising or alternative fee scheme.
2. A *match maker* who enables trade between a business and consumers where revenue is gener-

ated through commission.

3. Some also mention a *community platform* that allows users to create and share content with each other where revenue is generated through advertisements or alternative sources.

Table 3: *Selected business model typologies.*

	Timmers (1998)		
	Virtual communities	**Information brokers**	**3rd party marketplace**
Value proposition	Organizations provide an environment for its members to add information.	Information services to add value on the available data found on the internet.	Marketing a company though a third party to increase supplier-side demand and reduce marketing costs. Customers benefit from lower priced products and services.
Revenue model	Membership fees or advertising. Company's can add communities as a add-on in which case no revenue is intended to be generated by the virtual community.	Subscription fees, one-off service fees, advertising.	service fees, transaction fee, or percentage on transaction value.

	Wirtz et al. (2019)	
	Content	**Commerce**
Value proposition	Compiling information into content on a domestic platform.	Initiation and/or settlement of business transactions.
Revenue model	Indirect revenue sources such as advertising or donations. For governmental organizations, public budget resources.	Commission fees on goods sold.

	OECD (2010)		
	Fee model	**Brokerage model**	**Voluntary donations / community models**
Value proposition	Free information and services are provided with an added option of "premium" add-ons	Market makers who bring buyers and sellers together and facilitate transactions.	Intermediary platforms provide an environment for content creators to share content.
Revenue model	Monthly subscriptions fees, usage charge fees, item charge fees	Commission on transaction, membership fees:	Sale of ancillary products and services, voluntary donations, advertising or subscriptions for premium services

	Janssen et al. (2008)		
	Content provider	**Market**	**Virtual communities**
Value proposition	Provision of static and dynamic information from a single organization to match citizens' needs. Often the first attempt in establishing an online presence.	Serve as a link between supply and demand to intermediate between providers and those seeking provision.	Creation of a community of recurring citizens who are linked by a shared interest in a certain topic.
	Collaboration		
Value proposition	Enables electronic participation and discussion among citizens, business, and public administration to facilitate policy-making projects and decision-making.		

3 Method

In this section the chosen research design is described, detailing how the studied case subjects were chosen as well as how data was collected and analyzed. Thereafter, a discussion regarding the chosen method is outlined.

3.1 Research design

According to Bell et al. (2018), qualitative research is appropriate for studies in which theory is used as a foundation for research objectives, and the data collected consists of words and images rather than numbers. Furthermore, the particular research questions in this thesis have not previously been studied in depth, making this research exploratory. Thus, a qualitative research approach was used to examine the digital intermediaries acting on the Swedish solar PV market with respect to the thesis' research questions. To achieve this goal, a selection of digital intermediaries were chosen as subjects for a multiple-case study. While the study partly aimed to review the adoption challenges these intermediaries' help adopters overcome, the primary unit of analysis has been the business models utilized by these organizations. Thus, the main perspective in regards to primary data collected has been from the view of the organizations selected for case study.
The study commenced with secondary data gathered through literature reviews as well as an evaluation of existing digital platforms in the PV sphere. A literature review was performed to understand the theoretical underpinnings relevant to examine the role intermediaries play in the diffusion of innovations. The first theoretical theme explored was literature concerning adoption of new innovations was reviewed to understand the process which adopters experience when embracing new technologies such as solar PV systems. Thereafter, research concerning intermediaries' roles and functions in facilitating the spread of innovation was studied. To finally conclude the initial theme of innovation and intermediaries' part in the process, research concerning digital intermediaries were reviewed to understand the theoretical concepts of this subset of actors in particular. The last theme examined were business models, specifically how previous research has chosen to define and model them. Thereafter literature regarding digital enterprises were reviewed to understand what types and descriptions previous research has produced. Existing digital platforms were then examined in order to develop inter-textual coherence and understand the existing situation in terms of what platforms exist, how they operate, and where value creation occurs from both a business and a standpoint.

3.1.1 Case selection

The cases selected for study was based on purposeful sampling to encompass intermediaries who used their digital presence as a medium to facilitate the spread of solar PV technology into society. Based on this criteria, organizations were identified using search engines with keywords in Swedish such as "solar cells", "solar cell information" and "solar cell help" as queries. Based on the search results, actors who fulfilled the definitions of being innovation intermediaries, diffusion intermediaries and internet intermediaries were identified and their websites were reviewed to preliminary ascertain the value creating aspects their digital intermediation facilitated in the context of solar PV diffusion. Thereafter, each organization was contacted to inquire the possibility of scheduling an interview with a representative of their choosing. The result yielded six different organizations selected for study, each being interviewed once.

The intermediaries which were studied are presented in Table 4. As can be seen in the Table, the four first intermediaries presented are non-government affiliated entities solely targeting the solar

PV market while the last two intermediaries are both government agencies. In contrast to the former actors, government agencies' main business activity is not solely focused on facilitating solar PV support. Additionally, they are larger in terms of financial means (when comparing their budget to the revenue of the private actors) as well as in number of employees. The latter group has also existed longer than the intermediaries solely focusing on solar PV. When examining the solar PV market, all intermediaries focus on residential customers, with most intermediaries also serving additional segments as will be detailed in the individual findings of each intermediary.
Regarding the government agencies, it is acknowledged that the concept of a business model is most commonly applied on organizations that operate on a for-profit model which these two intermediaries do not. Specifically, the aspect of capturing value is usually referred to an enterprises' ability to generate revenue or profit as explained in section 2.3. Since these two intermediaries receive funding through governmental means, they have not established a way to capture value directly from their activities. Despite this, it was still of interest to determine how they were structured to create and deliver value to solar PV adopters, thus the framework was also applied to these case subjects.

In terms of all digital solar PV intermediaries studied, the selection of case subjects represents consists of six out of fifteen intermediaries which we were able to identify. We excluded intermediaries which had a website, but provided little more than contact information as digital intermediaries because their digital activities did not offer any apparent value to potential adopters. The nine intermediaries which identified as digital intermediaries and not a part of the the case selection were omitted because they they declined the request to participate in an interview or chose not to respond to our inquiries. Of these nine, five offered some type of quote comparison service and four were a solar PV supplier themselves.

Table 4: *Table with case subjects.*

Organization	**Main business**	**Founding year**	**Organization form**	**Number of employees**	**Revenue (2021) / Budget (2022) kSEK**	**Targeted solar PV market segments**	**Interviewee position**
Hemsol	Solar PV	2020	Private limited company	2 - 10	736 (R)	Residential, solar PV suppliers	Founder
Solcellskollen	Solar PV	2017	Private limited company	2	1 134 (R)	Residential, housing cooperatives solar PV suppliers	Founder
Solenergikvalitet	Solar PV	2020	Private limited company	2	192 (R)	Residential, solar PV suppliers	Founder
Bengts villablogg	Solar PV	2009	Non-profit actor	1	Unknown (R)	Residential, policy makers	Founder
Energimyndigheten	Energy use and supply	1998	Government Agency	400	419 387 (B)	Residential	Analyst
Elsäkerhetsverket	Electrical safety	1993	Government Agency	55	71 592 (B)	Residential	Director

3.1.2 Data collection and analysis

The six cases listed above were built from interviews and secondary sources, presented in Table . The data was initially collected by reviewing the digital platforms (i.e. websites) for each selected intermediary. This was supplemented through other secondary data sources such as financial reports for the private companies to ascertain their financial performance, where a for-profit motive was clearly present. Thereafter, a single semi-structured interview was held between the period of February and March 2022. Each interviewee were asked the same set of open-ended questions pertaining their business model as conceptualized by Teece (2010), namely questions to elucidate how they sought to create, deliver and capture value. Additionally, questions regarding any partnerships they had established to help them in the aforementioned matters. Each interview was held through online

Table 5: *Table with type of data collected and information extracted.*

Data type	Financial reports / Appropriation directions	Intermediary's website	Interviews
	↓	↓	↓
Information gathered	Financial performance or budget size, number of employees, number of operating years	Value proposition, value delivery, value capture	Value creation, value delivery, value capture

communication platforms, was recorded, and lasted between between 30 - 60 minutes each, with one person from our group leading the interviews. The recordings where then transcribed and the transcriptions were used for the basis of the thesis' analysis. For the non-government-affiliated actors, all of the interviewees were the founders of each respective entity as illustrated in Table 4. For the government agencies, a director responsible for technical matters was interviewed one of the agencies, while the other was a financial analyst who was responsible for the provision of their solar cell intermediation activities.
The analysis for each case was first done separately, using the theory from the literature review as the basis for interpreting the data together with the transcripts from the interviews. First, the data was compared to the intermediary criteria presented by Mignon and Kanda (2018) and mapped accordingly. Thereafter, their intermediary roles or functions were compared to the literature pertaining intermediaries. A comparison of the business model literature and the data was next reviewed. Lastly, the challenges they help adopters overcome as presented by Mignon and Bergek (2016) were analyzed. After each individual analysis was done, a cross-examination was performed to highlight similarities and differences among the case studies.

3.2 Method discussion

Each interview was performed by the same individuals, thus there was internal consistency in how the interviews were executed and interpreted. However, due to the different responses and nature of each studied organization, there was some variation in what type of follow-up questions where asked. Transcription of the interviews enabled data to be communicated with complete correctness across the group members.

Regarding the validity of the study, Sweden has its set of characteristics which may differ its digital intermediaries from other countries. Firstly, Sweden's does not produce any solar PV systems in any noteworthy capacity and source the technology form global value chains . Thus, it has a rather well-developed ecosystem of diffusion intermediaries (Aspeteg and Bergek, 2020). Secondly, Sweden is ranked as one of the top three countries when it comes to its propensity to adopt and explore digital technologies as a key driver for economic, business and government transformation (IMD, 2021).
It is worth noting that none of the selected intermediaries are responsible for supplying, installing or otherwise directly dealing with solar PV technology directly in any manner. During the selection process, intermediaries which did partake in such activities while simultaneously providing digital intermediation were contacted, but none responded favorably to being interviewed. It is possible that the chosen selection method resulted in a bias toward intermediaries targeting the demand-side of innovation discussed by Mignon and Kanda (2018), as these tools are often used by consumers (Jerath et al., 2014).

4 Results

In the results section, we present the data that was collected for the selected case subjects. The information is structured according to the business model framework brought forth by Richardson 2005 as seen in Figure 4. I.e, we present each intermediary's *value proposition*, *value creation and delivery* and *value capture*, using the corresponding elements that belongs to them. Lastly, many of the case subjects discuss working with solar PV suppliers, who in the context of this interview are to be viewed as the actors that both supply solar PV products and are responsible for their installation.

4.1 Overview of case subjects

As shown in Table 4, six digital intermediaries were selected as case subjects for the study. The first two, Hemsol and Solcellskollen, are both private intermediaries whose primary value offering and revenue source is that of a digital quote comparison service. The latter two private or non-government affiliated intermediaries are Solenergikvalitet (IFSEK) and Bengts villablogg. The former intermediary, IFSEK, relies on performing inspections of solar PV systems and has incorporated digital elements in their offering which will be explained in this section's detailing of the intermediary. The latter intermediary, Bengts villablogg, is a blog discussing solar PV technology, run by a sole individual on his free-time. The last two intermediaries, Energimyndigheten and Elsäkerhetsverket, are government-affiliated with specific missions set by the Swedish government which affects solar PV adoption. All intermediaries digital presence was enabled through a website, a summary of each intermediary and their relevant websites can be seen in Table 6.

Table 6: *Table with case subjects and their website.*

Intermediary	**Website**
Hemsol	hemsol.se
Solcellskollen	solcellskollen.se
IFSEK	solenergikvalitet.se
Bengts villablogg	bengtsvillablogg.info
Elsäkerhetsverket	Elsakerhetsverket.se
Energimyndigheten	Energimyndigheten.se/Solelportalen

4.2 Hemsol

Value proposition

Offering
Hemsol offers a quote comparison service for solar PV systems aimed. In addition to their quote comparison service, which is their main business activity, complementary features are offered to visitors of their website.
The company offers three digital services to provide users with value which facilitate adoption, these are:

- A quote comparison service.
- Various informative texts directed towards those interested in installing solar PV on their house roof.
- An investment and solar production calculator.

Target customers
Hemsol primarily targets residential households but plans on offering their quote comparison service to housing cooperatives and companies seeking to install solar PV (in addition to single house-hold consumers who they currently target).

Basic strategy
Their purpose is to provide easily accessible and educational information related to solar PV and serve as a bridge between solar PV suppliers and adopters.

Value creation and delivery

Organization: activity system and value chain
For their main offering, the quote comparison service, users are prompted to fill in a form with their name, address and contact information, after which they are contacted (via phone) by one of the company's representatives who asks questions to understand the specifics of the users' house and inquiring about potential solar PV related preferences (such as wanting a charging box). After this sequence, the company provides the user with up to four quotes from local solar PV suppliers (which they have established a partnership with) with no obligations to initiate a transaction neither with Hemsol or any of the recommended supplier. The quotes detail the price that the project would cost and product information such as effect of the panels and included warranties provided by the supplier. The suppliers in Hemsol's partnership network that are sent a quote request are those that Hemsol have formed business relationships with, and are responsible for the procurement and installation of the solar PV systems.

The informative texts that they provide are found on their website. These either take the form of a shorter paragraph or in a longer format such as blog posts or articles. Among the topics divulged within these texts are the benefits of owning a solar facility in Sweden, factors to consider when deciding whether or not to invest in a solar facility and how the installation process unfolds as well considerations surrounding it.

Their third digital service entails the provision of an investment and solar production calculator, offered free of charge to any site visitor. The tool prompts users to fill in their home address and select a desired size for a solar facility based on a GPS map. Thereafter, the calculator provides an estimate of how much energy the hypothetical facility is expected to produce as well as financial metrics, such as the investment size and expected payback period.

While serving an informative role with most of their information located on their website, much of the value created for adopters is delivered through two-way communicative channels. As they stated, each user who solicits a quote, which ultimately leads to revenue for the company, is approached though a phone conversation. Additionally, they also directly help visitors to their site who have yet to fill in any form, but still have inquiries regarding purchasing a solar PV facility. The characteristics of those who initiate contact with the company vary, some of the contacted users know very little about solar cells, as indicated by the type of questions they ask. Others are more knowledgeable and have just a few, often specific, questions they want answered. Then there are those who have already taken in quotes from other sources and are only interested in knowing the prices of the quotes that Hemsol can offer.

One aspect which allows the company to gain users trust is through the provision of a large amount of neutral information on solar PV. The other reason espoused is that their interests are not aligned with any single supplier, allowing them to be an advisor independent from any single partner in their

network (this reasoning is further explained in the detailing of their value capture model).

Network
The suppliers Hemsol chose to work with are whom the company views as their primary network of partners, both in size and importance. The suppliers are companies that sell and install solar PV systems and are based in Sweden. The relationship with their partners entails Hemsol facilitating them with prospects (users of their site who have filled in their quote form) who have shown verified interest in adopting a solar PV system and extracting a fee in return.
For their selection process of partners, they require all suppliers to be in good financial standing as well as possess the required certificates to operate as a business and install solar PV panels. They also require their partners to have a good reputation, i.e. a track record of performing successful installations and satisfying customer needs. Moreover, Hemsol prefers to establish ties with larger suppliers, claiming that these actors have better reach, more resources and result in Hemsol having to cater to less idiosyncratic demands posed by smaller suppliers. This lies in the company's interest, as it allows them to more effectively manage their partner network.

Resources and capabilities
Although Hemsol does receive some direct traffic to their web-page, visitors almost exclusively find their site through Google, these being people who search for some type of solar PV related query. Since their quote comparison service and competitors who also offer quote comparison services provide these free of charge, they allocate considerable resource on their digital marketing activities, as they believe that users simply choose the comparison sites who rank highly on Google. Therefore, they consider their marketing competencies to be their one of their core competencies and their primary competitive advantage on the market. Thus, they conclude that the largest reason why someone would use their services is that they are the top choice when searching on Google. Therefore, the company allocates considerable resources on digital marketing activities, such as search engine optimization (SEO) in order to obtain a high page ranking.

To meet the needs of site users who have filled in their quote form on an individual level, Hemsol employs people to work as company representatives and manage these queries. These people are educated by Hemsol internally to be able to provide their quote users with information regarding the solar PV adoption process. If the company lacks information in-house, they utilize consultancy services from solar PV specialists to acquire the information they seek. This has been done in the past, bringing in advisors to instruct them how installations differ for different type of housings, and to fact-check information that they post on their website.

Value capture

Revenue sources
Hemsol generates revenue either by charging a fee for every quote submitted to one of the four supplier which are sent a quote, or through commission on a successful transaction between a user and a supplier. Both pricing schemes are offered as alternatives to the suppliers they sign as partners, who can chose the model they prefer. This revenue model allows their interests and incentives to be separated from any single supplier.

Economics of the business
From a supplier perspective in the partnership network, Hemsol's business activities enables suppliers to lower their marketing costs when compared to more traditional marketing channels. From a user

perspective, Hemsol does say that some users are suspicious of their value capture model. Since all the services provided by Hemsol are free, these users often inquire how they generate revenue and are afraid that additional fees will be added to the solar PV project for the quotes provided by Hemsol to compensate for their activities. However, the company asserts that such fees do not occur and that quotes provided to users are not higher than if the user would solicit a quote themselves directly.

Their chosen revenue model, does not come without challenges. One such which they were facing as the time of the interview was the large demand of solar PV systems on the market. This resulted suppliers receiving a high organic inflow of customers, which reduced their interest to purchase their prospects from Hemsol, throttling the intermediary's revenue streams. Although they did consider this trend to be temporary, they did note that their business model is contingent on the fact that their partners will be eventually show a long-term interest in buying their quotes. In the meanwhile, Hemsol was financed through other companies which the owners had ties to. Their business also relies on a workforce who can serve as advisers to users initiate contact with Hemsol, which incurs large personnel costs. During the time of the interview, the business had operated for two years and had managed to break-even for the first time, as can be seen in Figure 6. As can also be seen in the figure, the company was still in the process of scaling up their business in terms of revenue when comparing FY 2020 to FY 2021.

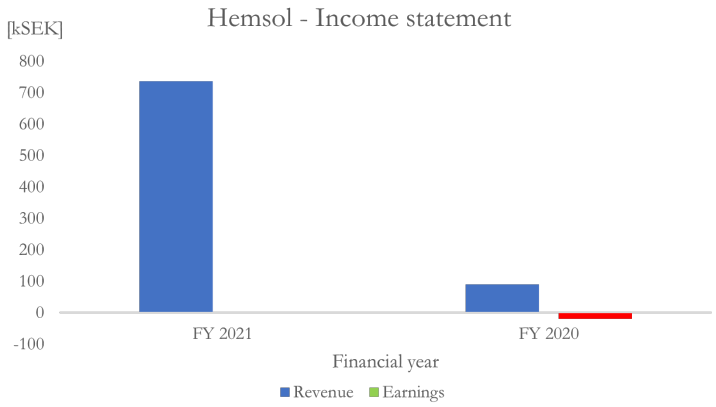

Figure 6: *Hemsol's income statement since its founding.*

4.3 Solcellskollen

Value proposition

Offering
Solcellskollen is a quote provision and information service aimed at those looking to adopt a solar PV system. Most of their visitors wish to what an investment will cost, how large their facility needs to be, what products they should opt for and which suppliers they can trust. These inquiries in turn reflect the services that the company offers offers. These can be characterized as: The services they offer - which constitute their value proposition - are:

- A quote soliciting service.
- An investment and solar production calculator.
- Informative texts aimed at current and potential solar PV adopters.
- A podcast centered around renewable energy.

Target customers
Solcellskollen's primary customer segment are residential households, but they also cater to in a smaller extent to those in housing cooperatives, farmers and some companies interested in purchasing a solar PV facility. Additionally, they also cater to solar PV suppliers.

Basic strategy
Solcellskollen acts as a marketplace between potential adopters and solar PV suppliers by generating quotes that created by users and are sent to local suppliers. In addition, they provide various types of informative content to those who visit their site.

Value creation and delivery

Organization: activity system and value chain
Their main service is the facilitation of quotes between potential adopters and solar PV suppliers. Users interested in utilizing this service service are prompted to fill in their postal code on their website, and receive a list of solar PV suppliers who operate in their geographic area and are partnered with Solcellskollen. These suppliers are also rated on a scale between 1-5 by customers who have used said supplier through Solcellskollen. Suppliers are judged on their performance during the installation process and their customer service given to the adopters. If a user wants to solicit a quote, they need to fill in a form for each suppliers they are interested in. The form needs to contain information such as contact details, property type (residential household, housing cooperative, farm etc.), desired facility size (in m^2), energy consumption and roof slope. The form is then sent from Solcellskollen's website to the specific supplier, who replies to the user with a quote containing different solutions and prices. Thus, the users themselves have the agency in which suppliers they want initiate contact with. Each quote is provided free of charge for the user, with no obligation to purchase a system from any of them.

In addition to their quote service, the company also allows users to calculate a investment and solar production estimate for their hypothetical facility. Similar to the quote service, users are prompted to fill in their geographic location, property type (single household, housing cooperate, farm, etc.), the roof's cardinal direction and energy consumption. More detailed assumptions have default values but can can be modified (such as price per kwH bought and sold, maintenance cost and the system¨s lifespan). In turn, the calculator provides an expected investment cost, payback time and expected energy production, along with other detailed characteristics.

Solcellskollen also hosts various types of informative texts on their website. One page answers frequently asked questions and serves as a primer for those interested in learning more about purchasing a solar cell facility. Here, they answer cursory knowledge surrounding the economics of solar cell facilities, technical considerations such as how a solar facility functions, what products to choose, and rules and regulations that adopters should be aware of before adopting the technology. In addition to this information repository, they also operate a blog which discusses various topics aimed at both potential and current adopters. As an example, they write posts which describe how solar facilities function during Swedish winters, how to assess whether investing in a battery storage unit makes sense, policy changes enacted by the government and developments being made on the commercial market.

Lastly, they also operate a podcast, inviting entrepreneurs, researchers and other people of interest to discuss various topics within the realm of renewable energy systems. In contrast to the other services they render, the content produced on their podcast is seldom focused on areas which facilitate the

adoption of solar PV systems. Rather, subjects are focused on individual's subject matter experiences, examples such as climate politics in the EU, batteries in the electrical system and global trends on the solar cell market. This part of their operations is a side-project birthed by several factors. As described by the interviewee, their financial capabilities to market themselves were limited and they had a genuine interest in engaging with other interested parties in the subject of renewable energies. While they profess that it is unclear exactly what they gain by engaging in the project, they do view it as an important part of strengthening their brand by enhancing their credibility and gaining more attention in from other actors in the industry

Their primary mode of delivering value relies on the digital tools and information hosted on their website, as this is considered to be a more efficient delivery mode than engaging in a dialogue with each prospect. Additionally, their limited personnel size also hinders them from processing large quantities of individual inquiries. Despite this, they do operate a chat module and provide a telephone number for those wanting questions answered directly. However, the volume received is not perceived to be too large for them to handle. Most users who reach out are those that are considering purchasing a solar PV system and pose questions that already is provided on the website. However, a considerable amount of people who reach out already own solar PV facilities and are experiencing complications with their systems. These individuals hope to receive aid from an independent party (in contrast to the supplier who installed their system). As will be explained when detailing the company's value capture, Solcellskollen are not positioned to generate any revenue this latter part of solicitors. Despite this, the company obliges in answering their questions, reasoning that want to help people and view it as a form of goodwill.

Network

The primary partners which the company has is the network of suppliers who they have agreed to collaborate with, consisting of around thirty-five actors spread across the country and covering a large share of the solar cell market. Solcellskollen are selective in who they chose to include in their network of suppliers, only want to suppliers who have a track record of providing high quality work and being economically stable. The goal is that potential adopters should be able trust the suppliers which are shown on their website. In addition to these partners, they are also active in two industry associations and view these channels as a way to enhance their own knowledge further, keep themselves on up to date on current consumer issues and contribute to the solar cell industry in on a broader scale.

Resources and capabilities

The company started operations in 2017 and is solely run by the two co-founders and as stated, their limited personnel size does constrain them in the amount of site users they can service on an individual basis. They consider the factors for their success to be providing high quality information that answers concerns of potential adopters. Therefore they have designed their website so that that these answers are easily found by visitors of their site. Moreover, being able to rate suppliers and view these as a user is also considered an important part to create more transparent and building credibility as an independent intermediary. Although they are working specifically on improving search engine optimization to attract more visitors, they believe that the aforementioned provision of high quality information will in the long term lead to being the website which is premiered on search engines such as Google.

Value capture

Revenue sources
Solcellskollen's primary mode of generating revenue is by extracting a commission fee for every user who contacts a supplier through their website and ultimately decides to purchase a solar PV system. This fee is paid by the suppliers, formally making them the revenue generating customer of Solcellskollen.

Economics of the business
Solcellskollen functions as a sales channel for suppliers, who pay them for every successful user which is converted to an adopter, i.e. that both parties are monetarily compensated only when one of their users chose to invest in a solar cell facility. Contrasting this to a leads structure where suppliers pay for every interest in a quote provided. In this way, their revenue model aligns the incentives of Solcellskollen with the suppliers which creates more trust between them and allows the suppliers to spend less time on customer acquisition. This is important since their payment system is trust-based, meaning that every supplier reports when a user has successfully been converted into a paying customer, which enables Solcellkollen to collect their fee. Additionally, their chosen way to create and deliver value has resulted in their primary cost driver being the salary that both co-founders posses. Their chosen economic model has led to the company being profitable for the last three reported financial years as can be seen in Figure 7.

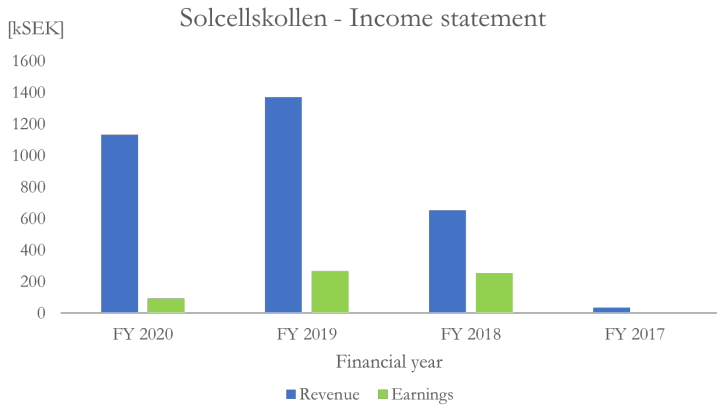

Figure 7: *Solcellskollen's income statement since its founding.*

4.4 Solenergikvalitet

Value proposition

Offering
Institutet för solenergikvalitet (IFSEK) is a third party company that offers inspection and advisory services to adopters, as well as companies active in the solar PV industry to a small extent. Their value offering can be summarized as:

- Consultation with adopters in the process of purchasing a solar PV facility
- A physical inspection of solar PV facility
- An online supplier assessment tool
- A digital inspection protocol

Target customers
As stated, the majority of the customers they cater to are residential households, in addition they also provide their services to companies (i.e. solar PV suppliers) on occasion.

Basic strategy
Their business model relies on providing physical inspections of solar PV systems, as well as related advisory services. However, they also offer various digital services on their website, free of charge. They started the company because they considered the solar PV market to be filled with suppliers who do a poor job of installing solar PV systems, taking advantage of consumers' lack of knowledge in the area. Together with a software developer and an investor, they founded to company to not only focus on performing inspections of solar PV systems, but also to develop software which allow users (visitors of the site) to gain insight into the quality of the inspected systems, and who installed them. In addition, they also wanted to provide users with more knowledge in the adoption process, or as the founder said:

"The basic idea is to give private individuals an honest chance when they procure the solar cells, so that you do not feel betrayed and cheated in the end and actually know that what you have bought lives up to the agreement but also lives up to the guarantee terms you have been promised and got something on the roof that sits for another 30-40 years."

Value creation and delivery

Organization: activity system and value chain
IFSEK aids their clients with considerations before purchasing a solar system, as well as support after it has been purchased. These constitute their paid services which either entail inspection of solar facilities or advisor support. At the time of the interview, their largest focus had been on the inspection services, however their advisory services were growing in relation and they commented that since purchasing a solar PV system involves many complexities and investment costs, adopters are eager to find an independent party that can guide them through the process.

Their advisory services are either done in-person or through phone calls, with clients being those looking to install a solar PV system, or has already done so and need aid with their existing facility. In the former scenario, aid may entail helping to translate the clients' requirements and house specifications into list of eligible products and helping them to review quotes from suppliers that the client has chosen to contact. They also urge these clients to sign a quality assurance agreement that with their chosen supplier to hold them accountable for any errors caused during the installation process. Such an agreement is offered in a boilerplate format on IFSEK's website for free. Moreover, they also share information on their website such as what consider when comparing quotes from different suppliers. The aid they provide to clients who already own a solar facility is commonly technical in nature, often when the supplier which they purchased the system from has gone out of business or when they feel the need to hire someone with an independent view.

Their inspection services entail a third party examination of an installed solar PV system to ensure that it is properly installed in accordance with Swedish electrical standards and the product manufacturer's directions. Each inspection has a protocol with different checkpoints such as electrical outfitting, placement of solar panels and cable management. This protocol has been digitally constructed by IFSEK's software developer in a modular nature so that each protocol conforms to the specific PV system being inspected. Each checkpoint in the protocol is worth 1 point, if there are any errors found the checkpoint in question gets penalized, depending on the severity of the error this ranges from -1 to -10 points. The overall score of the protocol is summarized in a score between 0 - 10. A score

of 10 indicates that all checkpoints passed the inspection, conversely a score 0 indicates that all or a majority of checkpoints harbor critical errors.

Besides the espoused thoroughness of their protocol, a major value creating aspect in this service is that all performed inspections conducted by the firm are publicized on their website into an online supplier assessment tool. This allows anyone who visits their website to read the inspection of checkpoints conducted, which contains documentation, comments on what errors are found with relevant images of the system. Each protocol is aggregated in a review tool, which allows users to evaluate the quality of the installed PV systems and can be filtered by supplier name and geographic location. When asked why they have chosen to develop a platform to publicize protocols, the interviewee states that it is because they found that that review sources for solar PV suppliers on other sites were too simplistic, rating the company from a scale between 1-5, and that the ratings are often based on interpersonal or short-term factors, such as receiving a pleasant customer experience. This makes it hard for adopters to assess the technical expertise of any single supplier. This perspective, they argue, is of paramount importance when the system is expected to last for 30 years. Furthermore, they emphasize that this knowledge is important since the market is growing rapidly, and that firms, both large and small, are having difficulties in consistently providing high quality installations. So far, they have received positive response from solar PV adopters who have used their review tool and contacted them, wishing to be a part of the statistic. There have also been instances where supplier companies have paid them to re-inspect low scoring installations which have been revised in order to gain higher scores on their website, but others (suppliers) who have a scored lowly have elicited negative reactions from these actors. Visitors to their site can also fill in a digital inspection protocol, containing the most common areas which are found faulty by IFSEK. Users are prompted to answer each question with a "Yes", "No" or "I don't know" answer, and are thereafter provided with a form that they can fill in if they are interested in a physical inspection to be done by the company.

Furthermore, they are continuing to develop more digital tools other than those hosted on their website. One such is the creation of a education portal to host different type of courses related to solar PV. The aim is to help them educate their own personnel. In addition, they also want to offers courses that can be sold to suppliers to proliferate proper installation procedures and to adopters of solar PV systems.

Network
Regarding establishing partnerships, they are hesitant to collaborate with other inspection firms or subcontractors because they want full control over the quality of the inspections performed. Elaborating on the topic, they place a high priority on being a independent and trusted actor and are thus not interested in forming any alliances with suppliers and also reasoning that the negative response from some solar PV suppliers have also made collaborations unlikely. They also mentioned that this strenuous relationship with some suppliers have resulted in these firms discouraging their customers to hire the inspection company.

Resources and capabilities
The firm has been operating since 2021, and is a small firm consisting of one inspector and one developer, both founders of the company. The developer manages the software which they company uses in their digital offering while the inspector is the one performing the inspections which generate the company's revenue.
In terms of marketing their business, they have used Google ads and put in initial efforts to work with SEO in order to rank higher on search engines. Additionally, they have also heavily relied word-of-mouth that is spread in Facebook-groups that focus on solar adoption.

Value capture

Revenue sources
At the time of the interview, IFSEK solely generated revenue through their advisory and inspection services done off-line, with the primary revenue stream being constituted of the latter service. The cost of their advisory appointments are subtracted entirely if a client chooses to purchase a full inspection of their solar PV system. They argue that this encourages their clients hire them for additional services while only incrementally increasing the workload for IFSEK.

Economics of the business
Their cost structure is variable in nature and that what would otherwise be their biggest cost, software development, is kept low since it the duty one of the co-founders, meaning that wage costs can be held low. This has resulted them reaching a profitable state in their first year of operating as can be seen in Figure 8. However, they elaborated that growing the business in terms of revenue and employees is challenging. At the time of the interview, the company only had one inspector, although they were in the process of hiring one additional inspector. They did note that the services they offer requires inspectors to possess knowledge in multiple areas such as constriction and electricity expertise and contractual knowledge. They claimed that it is difficult to find people with such knowledge, thus hiring requires the company to allocate considerable resources in order to provide sufficient education to new employees.

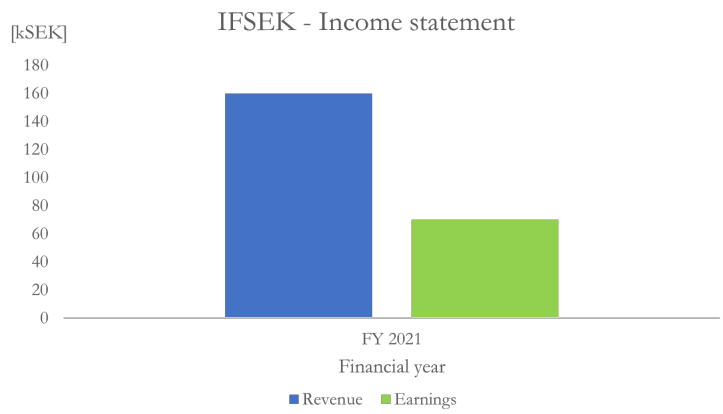

Figure 8: *IFSEK's income statement since its founding.*

4.5 Bengts Villablogg

Value proposition

Offering
Bengts villablogg is a blog cantered around solar cell technology, historically with a focus on providing information to individuals interested in adopting the technology. The value proposition can be summarized as:

- An blog centered around solar PV technology
- Various types of informative texts (separate from the blog)
- A collection of other digital information sources centered around solar PV

- An internet forum to discuss solar PV

Target customers
The blog has primarily targeted residential adopters of solar PV. However, some content that is written in recent time can be said be catered towards decision makers related to solar PV policy.

Basic strategy
Bengts villablogg is run as a non-profit operation solely driven by its creator, Bengt Stridh, who has a background of working with solar technology both in an industry and academic setting. The blog started in 2010 as an affiliate to a Swedish magazine directed towards homeowners. During the time, Bengt had recently installed a solar PV system on his house, and therefore chose to write about the experiences to shed insight to others who might be interested in the subject, i.e. potential and post adopters. Recently, the blog posts have also been directed towards discussing developments within the solar PV field and advocating for policy changes that might facilitate its continued proliferation. In addition of hosting their own solar cell information, the website also aggregates other sources of information which the user can be redirected to, such as a list of actors from which a user can solicit quotes. Lastly, the blog also has a forum in which registered users can post and discuss topics related to solar technology.

Value creation and delivery

Organization: activity system and value chain
The blog was the original vehicle for value provision and centers around the topic of solar energy. Here, Bengt stated that the content he posted in the first years detailed the production and general upkeep of his own solar facility, as well as some educational posts of how the solar PV panels work and its potential as a source of energy in Sweden. In later years, the frequency which he has posted has lessened over time and the content which he currently produces has shifted focus. Recent posts have a larger scope, such as highlighting regulatory issues or news. As an example, a recent posts discusses recent changes in policy which has led to certain small-scale producers (e.g. home-owners) not having to pay input fees to connect to an electrical grid. Additionally, Bengt said that it is likely that he will create content surrounding new frontiers within solar energy. As an example, he has already started to discuss new concepts such agrivoltaics and its potential in his posts (using a land area for both agricultural and solar energy production purposes). As Bengt himself explains: *... it (the blog) has slightly shifted focus. I get a lot of requests to lecture externally, so that has also affected the content. Especially this new area we are working on, agrivoltaics, combining farming and solar cells on the same agricultural land to reduce conflict.* Thus far, the blog has around 1000 posts and garnered over two million page views.

In addition to the blog module of the website there exists various articles which are also related to solar energy. These are similar to the educational blog posts which were posted earlier in the site's life-cycle, such as providing general facts about solar cells and their potential in Sweden, explaining what production costs a small-scale producer will have to cover when adopting a solar PV facility, how to calculate the economic value of solar energy as a producer, relevant subsidies a potential adopter can apply for.

Lastly, the website does host a forum where users who register an account can discuss topics related to solar technology. Posts in this forum have often been users who are in the process of purchasing and installing a solar PV facility, and are looking for advice from the Bengt or other visitors of the site. However, the forum was largely inactive during the time of the interview, having been entirely

replaced by dedicated groups on social media.

Network
Bengt, through his website, does not have any partnerships. The independent nature of the blog allows him to choose what content he posts also results in users perceiving him as a neutral party with no vested interest in any other actor within the solar energy industry. However, the site does forward the user to other informational sites by providing links to various types of actors within the solar energy industry. For example, knowledge of quote comparison and quote offer websites are provided, as well as a list of suppliers, consultancies and providers of calculation software are also detailed. In general, these are provided without any commentary of the referenced actors other than a brief description of their business. Other, non-commercial actors are also communicated, such as various government agencies, website pertaining research in solar technology as well as other blogs.

Resources and capabilities
Operating the website is a hobby for the blog's creator, and therefore he cannot cover all topics within solar technology in the same capacity as full-scale business' are able. Therefore, Bengt has chosen to align the blog's direction with his interest and the blog only attends to matters which Bengt himself is knowledgeable in, or else, he refers site visitors to other sources with information. Having worked with research and development (R&D) within solar energy and as a lecturer in the subject on a university level, Bengt possess' considerable knowledge in the field which serves as one of the distinguishing resources the blog relies on.

Value capture

Revenue sources
No stable revenue source has been established by Bengt. He has set up an option for site users to donate a sum of their choosing and has in the past sporadically urged those who find the website useful to donate, but has abstained from doing for a long time. He has previously been solicited to post advertisements on his platform, but has declined the offer, saying:

There are people who have asked to be allowed to advertise on the site, but then I thought "you might be a little more bound to someone", and people can question if I am still neutral, so I have declined to do it. Otherwise, it would probably have been quite easy to get ads in if I had wanted to.

Economics of the business
Since the blog is run as a hobby rather than a full-time operation, time spent on its development as well as creating a plan for value capture has been a low priority. Work into the website when time and interest allows and is partially financed through the aforementioned donations. The interviewee states that being profitable has never been a goal with running the website, and that it in fact costs him money instead of generating a profit. The choice of value capture has resulted in the blog being consistently being operated on a loss and an enterprise which costs him money instead of a profit generator.

4.6 Energimyndigheten

Value proposition

Offering
Energimyndigheten is the agency that handles energy usage and supply issues on behalf of the Swedish government, including everything from transportation to energy use in homes, electricity

producers and electricity users in general, and various types of activities that connect to different parts. Energimyndigheten provides an incentive for Sweden to transition to a more sustainable society in terms of energy usage. They offer a wide range of services, including:

- Counseling to private clients on how to improve the efficiency of their energy use.
- Testing of various energy sources such as heating, solar power, appliances, and so on.
- Energy supply and demand statistics, energy balances, and price development.
- Research and development, where they fund more large-scale solar power projects.
- Training for energy and climate advisers.
- Solelportalen, which assists clients in their search for solar panel information.

Of these services, only the latter, Solelportalen, is offered digitally and was the focus of study for this case subject.

Target customers
Solelportalen primarily targets residential and commercial property owners, such as farmers and tenant-owner organizations.

Basic strategy
Solelportalen is their primary digital offering in the solar power industry. It is a digital platform which gives customers information and unbiased advice before deciding whether or not to invest in solar power. The interviewee reaffirmed this notion, and stated: *Solelportalen can be said to be a main channel for much of what we do in the area of solar power, and it is intended that it should help in the process when someone want to invest in the technology. I think customers turn to an authority if they are searching for independent information and the main purpose with Solelportalen is to give that information.*

Value creation and delivery

Organization: activity system and value chain
Solelportalen assists in detailing the rules and regulations for obtaining financial assistance when installing solar panels. Through their website they offer site visitors help in the following nine subcategories:

- *Determining whether the building's roof is appropriate for solar panels.* This section briefly outlines what circumstances are ideal and sufficient for solar panels, as well as the factors that influence the efficiency of a solar power installation.
- *Comprehending what factors must be considered in terms of panel size.* This section considers the size of the solar system in relation to the customer's own electricity use and outlines limit values and restrictions to be aware of.
- *Calculate the investment required for the panels.* This model assists clients in determining payback time and average power price based on criteria such as investment cost per kW, yearly production, interest rate, number of years of tax reduction for delivered electricity, and proportion of own consumption. Each section has an explication to help clients understand what inputs are required. They also offer the option of advanced inputs such as economic lifespan, building permit per kWh, and origin value guarantees.
- *Learning what financial assistance is available for installing solar power.* This provides access to resources regarding state investment assistance or a root deduction on installation work. They also detail potential revenue streams from solar panels by stating that any electricity that clients do not need is put into the grid, where there is a possibility to receive a tax reduction and can sell it to an electricity trader.

- *Guidance on what to look for when selecting a solar power provider.* This section assists clients who have progressed to the point where they need to contact a solar power supplier. They offer advice on what to consider when making the first contact and when selecting a supplier, and they highlight the need for a procurement if the property is commercial.
- *The obligations and rights that come with acquiring solar power.* This section gives an overview of significant regulations that comes from the property change needed when establishing a solar power plant, as the client then becomes the owner of an electricity producing facility. They emphasize that the client has rights and obligations to numerous parties such as your municipality, the energy network owner, and electricity trader before, during, and after installation.
- *The operational aspect associated with a solar power facility.* This section explains what the client must consider in order to ensure uninterrupted electricity generation for as long as possible. They describe that the maintenance is fairly self-sufficient, but there are some operating and maintenance instructions from the installation that must be followed.
- *How to liquidate a solar power plant and what to consider.* The section discusses the requirement to transfer any electricity certificates when liquidating or moving a solar power system, as well as origin guarantees and canceling any electricity trade agreement.

Each of the nine sections has a quick description of frequently asked questions, as well as several sections to assist site visitors in answering these. They also include a brief video with additional explanations on the respective topic, and links to further explanations and resources available, such as energy adviser's. The nine subcategories follow a pattern in which the client can delve deeper into the solar panel adoption process by clicking through to the next category. Solelportalen also provides two calculators that allow clients to assess the payback time of a solar project as well as the cost of the electricity it generates.
A customer can contact Solelportalen via the designated digital mailbox or through ordinary emails or phone calls. Most information can be obtained on the web, but if clients have general questions, they can be answered in person. For more precise questions, customers are usually referred to energy and climate adviser's, who may address questions like installing solar panels on a person's roof, among other things.

Network
In terms of their network, Energimyndigheten has a number of partners with whom it collaborates with. They partnered with other authorities when developing Solelportalen, as will be explained in the following business model element. Their major partners in terms of research or funding are other authorities, although they also collaborate with other schools, universities, and industrial organizations. They are responsible for supporting municipalities and regions specifically around sustainable cities and similar issue.

Resources and capabilities
In the context of solar technology, the human capital Energimyndigheten employs has historically varied. At the time of the interview, they employed ten to fifteen employees who worked with solar energy in some capacity. Besides utilizing internal competencies, the website Solelportalen was designed in collaboration with other other Swedish government authorities, namely Boverket (the Swedish National Board of Housing, Building and Planning), Elsäkerhetsverket (the National Electrical Safety Board), Energimarknadsinspektionen (the Swedish Energy Markets Inspectorate) and Skatteverket (the Swedish Tax Agency). However, they have also consulted other institutions in some matters. For instance, the calculator previously mentioned is based on a project for solar cells carried out by Mälardalen University. Currently, ongoing management of the website was handled solely by the interviewee.

Value capture

Revenue sources and Economics of the business
Energimyndigheten is a government agency, and as such, it is funded by the government. They acquire their money from appropriation directions that includes a grant for renewable energy production initiatives, as well as a framework grant that includes the annual funds. The total amount they have been given in recent years can be seen in Figure 9. It should be noted that only a portion of each year's budget is directed towards their activities related to the solar PV field.

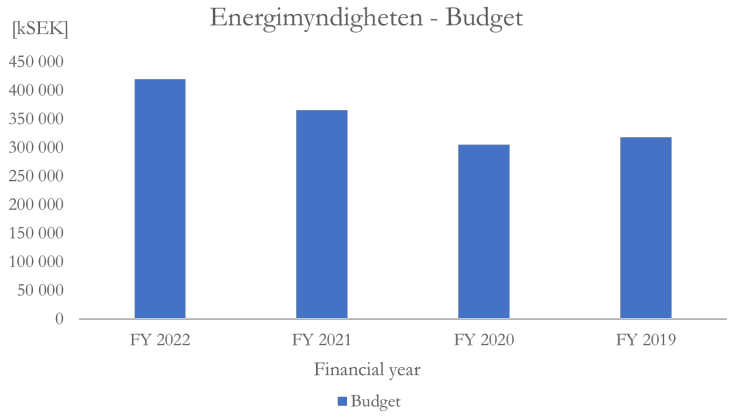

Figure 9: *Energimyndigheten's budget during the period 2022 - 2019.*

4.7 Elsäkerhetsverket

Value proposition

Offering
Elsäkerhetsverket (the National Electrical Safety Board) is a Swedish government agency and are responsible for electrical safety issues. From an intermediary perspective, Elsäkerhetsverket provides potential adopters who visit their site with the following service:

- Information on solar PV such as responsibilities of a solar PV owner and current regulations
- An index of all authorized solar PV installers

These services are found on their website. On this site, they provide information to those who are interested in investing in a solar PV system.

Target customers
In the context of solar PV technology, their digital presence is directed towards adopters, primarily residential households.

Basic strategy
Elsäkerhetsverket's mission is to prevent damage caused by electricity as well as interference which can be caused by electrical products, which has led them to concern themselves with the safety aspects of solar PV systems. Their primary mode to carry out this vision is to supervise the market for all electrical products and impose regulations as necessary as well as being the body which processes and authorizes certificates to work with electrical installations. Though the former areas are the dominating focus of the organization, they have also established a dedicated platform to diffuse

information regarding electrical products into society which is manifested as the aforementioned website.

Value creation and delivery

Organization: activity system and value chain
The focus of their their information platform lies in issues related to regulatory requirements, the responsibilities of the owner of a solar PV system in addition to some other non-authority issues. Examples of these are conditions for optimal intake of solar energy, what to think about when comparing quotes and considerations for including a battery storage unit in the PV system. The information is centered around preparatory aspects of installing a solar PV system, and as previously described entails describing the responsibilities an owner of a solar facility has, and in line with this, also provides advice on what to ask and look for in suppliers and installers of solar PV. Furthermore, questions such what authorities need to be contacted are detailed and they also provide a register of all authorized electrical installers in the nation. They also provide some information surrounding the maintenance of a solar PV system and what owners of such facilities should look for to ensure that they are kept safe. Lastly, they also provide a digital search index, which contains all authorized companies that are allowed to perform electrical installations, including all suppliers and installers who help adopters of solar PV systems install their facility.

Additionally, they also operate a phone line where individuals or professionals may contact them for help. Individuals often reach out to them via this method when they have encountered problems with their solar PV systems or supplier, and hope that the agency arbitrate their matters, which they decline to do. As the representative explained in regards to electrical safety and interference:

Once you have had your photovoltaic system installed and finished, you are responsible for it. It is not the person who has installed the person who is responsible, it is you.

Network
For matters that they do not cover on solar PV, they defer to other agencies such as Energimyndigheten. Considering their shared status as government agencies, they could be considered partners in the context of spreading solar PV knowledge. Regarding their non-digital activities, Elsäkerhetsverket does collaborate with local energy advisers (a municipal-affiliated role) so that they may provide adopters with information of what to consider when installing a solar PV system, similar to what is found on Elsäkerhetsverket's website.

Resources and capabilities
Approximately 90-95% of the agency's resources is estimated to be allocated to electrical safety issues and ensuring that actors selling and performing electrical work follow regulations imposed, this work also includes spreading information regarding electrical safety. Thus, services and information that does not concern electrical safety is of less priority to the organization. Since the offering provided in a solar PV context is related to informing adopters of regulations and responsibilities, these are the competencies the organization relies on in order to deliver their value proposition.
As the interviewee put it:
Our role is not to promote and develop the (solar PV) market, but rather to ensure that the rules of the game are so good that the market has the opportunity to develop so that we do not hinder it. From that perspective, (aiding in the diffusion of solar PV) it is a bit secondary, but can also be important even if we are a bit in the second rank.

Value capture

Revenue sources and Economics of the business
Like Energimyndigheten, Elsäkerhetsverket is a governmental agency and are funded through public means. However, these means are not funded through taxes and are instead generated through an electrical safety fee that all who use electricity in the country pay and put in the state treasury. The budget is set through appropriation directions, which a part of the government budget and is set by the Riksdag. These directions dictate how the funding should be spent by the agency in a general sense. However, they agency does have autonomy how to best distribute the funds on a detail level. The amount they have been given in recent years can be seen in Figure 10. As stated, Elsäkerhetsverket only spends a small portion of this funding on services and information related to solar PV technology.

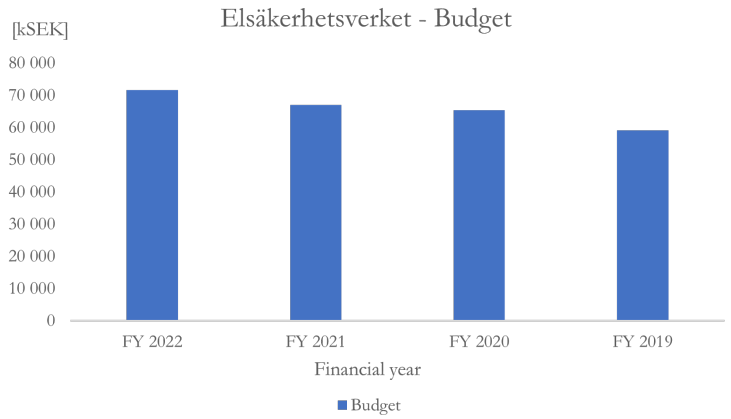

Figure 10: *Elsäkerhetsverket's budget during the period 2022 - 2019.*

5 Cross-case analysis

In this section we analyze the data collected from the case subjects to answer the research questions posed in this thesis. The analysis is performed by comparing the case subjects against each other to highlight similarities and differences exhibited as well as evaluate them against the literature reviewed. The section is divided into subsections, with each corresponding to one of the three research questions.

5.1 How do digital intermediaries support the adoption of solar PV and what roles do they serve?

Based on the selection of case subjects, we identified six digital intermediaries that supported solar PV adopters in various ways.
The support each intermediary provides is presented in Figure 11 and is based on the same framework used by Glaa and Mignon (2020) to illustrate the different types of support RET intermediaries are able to provide adopters. As seen in the figure, most intermediaries provide pre-decision and decision support, while only two of the intermediaries - the regulators - provide post-decision support.
Regarding the roles these intermediaries serve, a condensed summary of the supportive role they each serve can be seen in Table 7. This synthesis is partly based on the findings of commonly found business model types presented in section 2.3.1, and was also supplemented by the regulatory role we identified in two of the examined intermediaries. In essence, we find that all intermediaries act as a type of content provider by sharing information to potential adopters regarding different aspects in the adoption process of embracing solar PV technology. Additionally, a majority of intermediaries (five out of six), were found to exhibit an additional support role, either as a form of match maker, regulator or community platform.

Support given in the adoption process

Diving deeper into the specific type of support the intermediaries provide in the adoption process, we examine the aid given by the different intermediaries in each phase, highlighting the similarities and differences they exhibit. A summary of the support given by the studied intermediaries is shown in Figure 11.

Intermediary	Pre-decision	Decision	Post-decision
Hemsol	• Identify or create adoption opportunities • Market and advocate for the innovation • Provide information	• Facilitate networks and collaboration. • Provide business and investment advice. • Support supplier evaluation and selection.	
Solcellskollen	• Identify or create adoption opportunities • Market and advocate for the innovation • Provide information	• Facilitate networks and collaboration. • Provide business and investment advice. • Support supplier evaluation and selection.	
IFSEK		• Support supplier evaluation and selection.	• Provide implementation expertise and services.
Bengts villablogg	• Facilitate networking and collaboration prior to decision • Identify or create adoption opportunities • Market and advocate for the innovation • Provide information	• Facilitate networks and collaboration.	
Energimyndigheten	• Identify or create adoption opportunities • Market and advocate for the innovation • Provide information	• Provide business and investment advice.	
Elsäkerhetsverket	• Provide information	• Support supplier evaluation and selection.	

Figure 11: *Intermediary support offered to solar PV adopters during the decision process.*

Pre-decision phase
Regarding the support given to adopters in the pre-decision phase, we note from the data gathered that all except one (IFSEK) of the studied intermediaries provided some type of *information* that intended to help site visitors to adopt solar PV technology. As an example, four of the intermediaries, Solcellskollen, Hemsol, Bengts villablogg and Energimyndigheten hosted informational texts also focusing on issues related to the pre-decision stage, assisting customers in bridging any potential knowledge gap when it comes to solar PV technology. Elsäkerhetsverket also provided information, but had a focus on safety and responsibilities that adopters and solar PV suppliers have in during the adoption process. As an example, they provide information of what requirements an adopter's house roof must possess to be eligible for installation. In contrast to the previously mentioned intermediaries, IFSEK did not offer any information that explicitly help adopters in the pre-decision phase. This is explained by their value proposition which is directed towards helping adopters that are either in the decision or post-decision phase.

The previously four mentioned intermediaries (Solcellskollen, Hemsol, Bengts villablogg and Energimyndigheten) also shared information which *advocated* the use of the innovation and created *opportunities* for site visitors to realize the benefit of adopting solar PV technology. In their support, they offered some type of text explaining the viability of solar PV systems in Sweden, contending that many may benefit economically long-term if their housing situation is favorably situated to absorb

sufficient quantities of solar radiation. These intermediaries also offered some type of tool for adopters to perform this assessment of their houses, which will be explained in the detailing of the support given in the decision phase.

Lastly, Bengts villablogg also offered a forum where adopters in the pre-decision phase can *collaborate and create a network* with their peers, although the most of the topics were primarily directed towards those in the decision phase.

Decision phase
From the data, we see that the support given to adopters occasionally blurred the lines between the pre-decision and decision phase. For example, we noted that one type of information intermediaries facilitated in the pre-decision phase was explaining to potential adopters the viability of solar PV technology in Sweden. In this instance, the point was further emphasized by the intermediaries which offered solar production calculators (Hemsol, Solcellskollen and Energimyndigheten), as these allowed adopters were able to assess whether solar PV technology would be a worthwhile investment in their specific circumstance. The benefit of this type of interactive tool allowed adopters to simply input a few variables that they are likely to already know such as their yearly energy consumption and home address, instead of having to investigate how much solar radiation an adopters living area receives as well as the average cost and energy production of a solar panel. In turn, this feedback helped adopters to make a decision whether or not invest in a solar PV system and served as a type of *business and investment advice*.

Many intermediaries also supported adopters in *evaluation and selection* of suppliers (this is similar to the type of support mentioned by Glaa and Mignon (2020), but supplier has replaced technology as the subject being evaluated and selected). Solcellskollen and Hemsol did this through their quote comparison service, offering adopters a list of suppliers to choose from (referring to suppliers which are partnered to each intermediary). In Solcellskollen's case, this evaluation is done by the adopter themselves and are guided by the intermediary's rating system which judges the track-record of the suppliers performance. For Hemsol, evaluation is done by the intermediary as previously mentioned, offering the adopter utilizing their quote service up to four different suppliers to choose from. Through this service, they also *facilitated networks and collaboration* opportunities to adopters.
Both Elsäkerhetsverket and IFSEK also offered adopters in the decision phase the ability to evaluate solar PV suppliers, but in different contexts. For Elsäkerhetsverket, their provision of of all registered solar PV installers in Sweden, helped adopters determine whether suppliers were authorized to perform solar PV installations and thus aid them in eliminating unqualified actors. In IFSEK's case, evaluation was done in two different ways. The first was aiding adopters on an individual level by providing them with guidance of which supplier they should choose for their solar PV through their advisory services. The second mode was through their online supplier assessment tool, which allowed adopters to compare the performance of previous installations performed by suppliers which IFSEK had inspected.

Post-decision phase
In contrast to the support offered in the pre-decision and decision phase, most digital intermediaries offered little to support those who had already installed a solar PV system when strictly examining their online activities. In this respect, IFSEK was the only intermediary to offer digital aid through their digital inspection form by sharing their *expertise of implementing* and serving installed PV systems. This enabled adopters to perform a cursory assessment whether their solar facility was properly installed. The support was further enhanced by their physical inspections if adopters chose to have them inspected by the firm.

The state-funded intermediaries also offered some post-decision support, although this was not manifested in their digital presence. For example, Energimyndigheten helped facilitate the continued use of solar by offering counseling to private clients on how to improve the efficiency of their energy use. Elsäkerhetsverket did so by defending adopters' interest through setting industry standards.

Lastly, though both Solcellskollen and Hemsol did not offer post-decision support, the latter intermediary intended to do so in the future by offering a similar quote service to solar PV adopters but instead focusing on electricity contracts which they are required to sign with a utility company.

Support roles

By identifying the different types of support each digital intermediary provides, we could categorize them in different roles to compare the similarities and differences they share. A summary of these roles can be seen in Table 7.

Table 7: *Condensed summary of the support role that each intermediary serves.*

Intermediary	**Support role**
Hemsol	Content provider and match maker
Solcellskollen	Content provider and match maker
IFSEK	Content provider and (informal) regulator
Bengts villablogg	Content provider and community platform
Elsäkerhetsverket	Content provider and (formal) regulator
Energimyndigheten	Content provider

Firstly, we note that all studied intermediaries act as some type of *content provider* (discussed earlier when synthesizing the different type of digital business model types in the Theory section). By content provider, we mean that the intermediary's primarily facilitated knowledge surrounding solar PV in their intermediary services. For example, by providing informative articles or interactive tools which guide adopters.

Secondly, most also provided an additional role in their intermediary services (with the exception of Energimyndigheten). Both Hemsol and Solcellskollen exhibited similar types of roles, that of *match makers*, where they helped facilitate a connection between adopters and solar PV suppliers. Bengts villablogg hosted a discussion forum where registered members can congregate and exchange information regarding solar PV systems and thus also serves as a *community platform*.

Thirdly, regarding the last additional role exhibited, both IFSEK and Elsäkerhetsverket filled a type of *regulatory* role in different ways worth elaborating upon. For the latter intermediary, regulation was done by official decree as authority of the Swedish government, deciding who is allowed to perform solar PV installations or not and providing this information through their website via their index registry. For IFSEK however, their regulatory role has carried no official mandate, however, by creating transparency in the quality of solar PV installations they allowed adopters to understand and compare the quality in installations provided by different solution providers.
While it from an adopter perspective can be argued that these regulators are merely an additional facet of information to absorb (i.e. viewing the intermediary as a content provider), we contend that there is a distinction in the role worth accentuating. To explain why, we argue that the information conveyed in this context differs as its intent is not to facilitate knowledge surrounding solar PV technology

and its viability in the adopters context. Rather, its seeks to discern which solution providers are qualified to help adopters become solar PV owners. As stated in the case of Elsäkerhetsverket, this is an official role, as they control who are allowed to perform solar PV installations or not in the country and this information is accessible to the public via their website. Their content is also geared towards instructing site visitors of what they need to consider to successfully adopt and operate a solar PV facility.
Comparatively, the value IFSEK creates is tangential to Elsäkerhetsverkets, as each inspected facility is evaluated according to the standards set by the product manufacturer and Swedish electrical standards and then posted on their website. However, IFSEK does not have any official authority to force PV installers to improve facilities with poor scores, they give the owners of the installation a basis to argue for improvement if assurances provided by the supplier have been broken. In IFSEK's case, adopters in the decision-making process can use the information to assess which solution provider to select. Thus, the intermediary's provision of information is also less focused on highlighting the benefits of solar PV technology and its viability in Sweden and more directed towards informing potential adopters of considerations when making choices related to the installation process itself, such as how to chose the right supplier.

Scope of action and its effect on support

The intermediaries' scope of action, as discussed by Mignon and Kanda (2018) also influences the role they serve. We argue that among the studied intermediaries, those that have a for-profit motive (Solcellskollen, Hemsol and IFSEK) have a singular focus on the actor level while the non-profit intermediaries (i.e. Elsäkerhetsverket, Energimyndigheten and Bengts villablogg) - in addition to engaging on an actor level - act on a systemic level in some capacity.

For some of the non-profit intermediaries, such as Elsäkerhetsverket, acting on systemic level is self-evident, as their primary mission in a solar PV context is to regulate the market and shape regulations that allow for it to flourish in accordance with their rules. The same can be said of Energimyndigheten who collaborate with various research organizations and municipalities. However, their influence asserted on a systemic level does not manifest in the digital medium, instead occurring in an off-line environment. In the case of Bengts villablogg the visibility of their influence is less apparent, nonetheless their blog posts are intended to affect change on a systemic level in some capacity. An example of this is Bengts' discussion regarding agrivolatics and advocating its benefit in society on the blog. It should be noted that this is also supplemented by in-person lectures he holds. Therefore, the systemic presence he asserts is not solely contingent on his digital intermediary activities.
Regarding the actor level focus these non-profit intermediaries possess, this is directly manifested through their digital activities which is evidenced in their value proposition (further discussed in section 5.2), which is aimed at adopters of solar PV.

In the case of the for-profit intermediaries, we see that their scope of actions is directed towards the actor-level. For Hemsol and Solcellskollen, intermediation is facilitated towards both adopters and solar PV suppliers. In the case of IFSEK, their aid is primarily directed towards adopters.
We contend that the focus on the actor level is stronger for the for-profit intermediaries than their non-profit counterparts and that they invest more time in each adopter because this is aligned with the design of their business model. To elaborate, while all six intermediaries provide information relevant to potential adopters, the for-profit actors also provide some additional service which is also tied to their value capture model and creates additional value for adopters. This is exemplified by the match makers, which help connect adopters with solution providers, and IFSEK, who helps adopters

chose among a set of self-selected list of suppliers. Previously, Bengts villablogg has shared the same actor-specific focus, having provided a forum which acted as a network for adopters to congregate to exchange information. However, as noted by the blog creator, its role has been superseded by dedicated social media forums and he considers the activity on these forums to be low.

5.2 How are the business models of digital intermediaries within the solar PV market structured to create, deliver and capture value?

We begin the analysis of the case subjects' business models with a brief reiteration that the concept reflects a company's interpretation of who their customer is, what the customer wants and what they are willing to pay for it (Teece, 2010). To interpret these aspects we have used Richardson's (2005) business model framework and evaluate the intermediaries for each component in the framework. A condensed summary of each intermediary's business model component can be seen in Figure 12 which is based on the data collection divulged in section 4.

Business model Aspects	*Business model component*	Hemsol	Solcellskollen	IFSEK	Bengts villablogg	Energimyndigheten	Elsäkerhetsverket
Value proposition	*Offering*	• Quote comparison service • Informative texts • Solar PV calculator	• Quote soliciting service • Informative texts • Solar PV calculator	• Advisory services • Physical inspection of PV systems • Digital inspection protocol • Online supplier assessment tool	• Solar PV blog • Informative texts • Discussion forum • Repository of other digital information sources	• Solelportalen (focus of the data collection) • Education and advice in energy matters • Providing energy-related data • R&D	• Regulatory solar PV information • Index of authorized solar PV installers
	Target customer	• Residential households • Solar PV suppliers	• Residential households • Solar PV suppliers	• Residential households • Solar PV suppliers	• Residential households • Policy makers	• Residential households	• Residential households
	Basic strategy	To link adopters and solar PV suppliers	To act as a marketplace for adopters and solar PV suppliers	Providing advisory and inspection services to solar PV adopters	To provide information to adopters and decision makers	Solelportalen aims to help citizens to decide whether to adopter solar PV technology	To ensure that solar PV products are safely installed and managed
Value creation and delivery	*Organization*	• Adopters engage in with services through their website; and • Direct contact is also made with adopters and suppliers	• Adopters engage with their services through their website	• Adopters engage with their services through their website; and • Services area also rendered in person	• Adopters engage with their services through their website	• Adopters engage with their services through their website	• Adopters engage with their services through their website; and • Direct contact with adopters is also possible
	Network	• Solar PV suppliers	• Solar PV suppliers	• No partnerships	• No partnerships but does refer users to other actors	• Other government agencies	• Energimyndigheten
	Resources & capabilities	• Marketing competencies • Company representatives	• Competencies to provide high-quality information and information about partnered suppliers	• Competencies related to inspecting PV systems • Software development	• Solar energy expertise	• Solar energy expertise	• Electrical safety expertise.
Value capture	*Revenue sources*	• Referral fee or commission fee	• Commission fee	• Client fees	• Self-funded • Voluntary donations	Funded by public means	Funded by public means
	Economics of business	Yet to reach profitability	Profitable multiple years in a row	Profitable since start (one year)	Run as a non-profit	Survival not dependent on being profitable	Survival not dependent on being profitable

Figure 12: *Condensed summary of studied case subjects business model.*

Value proposition

Target customers

Looking at the targeted segments on the solar PV market, we see in Table 12 that all intermediaries target the residential household segment, i.e. adopters of solar PV systems (as opposed to e.g. utilities). With the exception of the two government agencies, most intermediaries did also target additional segments on the solar PV market besides residential households. As an example both match makers provided value to solar PV suppliers by connecting them to interested buyers, while IFSEK were

sometimes hired by solar PV suppliers when their installations had garnered low inspection scores in attempt to raise their score. For Bengts villablogg, we argue that his intended audience also included policy makers to some extent.

Offering and basic strategy
First, regarding the offering, we iterate that with the exception of IFSEK, all intermediaries provided information regarding adopting solar PV technology through their digital presence as discussed when relaying the support roles they possessed. This type of value offering was expected due to previous research's emphasis on its importance. To elaborate, in the context of solar PV diffusion it was highlighted that adopters need to overcome a lack of information before committing to purchasing a solar PV system (Jager, 2006, Rai, 2013). Moreover, it was also established that consumers have a penchant for the Internet as a source of information (del Águila-Obra et al., 2007) and that internet intermediaries help consumers filter forth the relevant information (Yacouel and Fleischer, 2012). Cumulatively, these reasons help explain why all the studied intermediaries have chosen to present a curated repository of information aimed at solar PV adopters, albeit with slightly different focus. In IFSEK's case, we posit that the absence of informative texts can be explained by the fact that they are mainly targeting those who have already adopted solar PV technology, and thus have no incentive to explain the benefits of the innovation.

Second, specifically examining the offering and basic strategy for the non-profit intermediaries we initially argue that provision of information can be said to be their main value offering. Since they are not concerned with generating revenue, their primary concern is to proposition adopters with information which is neutral and can be considered trustworthy. Since they are free from profiting of providing value to adopters, this fact can be said to be a pillar in their basic strategy. Even here, differences exist in what type of information is offered and the strength in their value proposition. For example, Bengts villablogg and Energimyndigheten's Solelportalen share similarities in the manner information was delivered to site visitors, both are geared towards highlighting the benefits and fit of adopting a solar facility for an individual without having any additional value proposition tied to any other actors. Conversely, Elsäkerhetsverkets intent in contrast is to ensure that solar PV systems are diffused safely into society which is reflected in the type of information they provide. Regarding their index of authorized installers (one of their offerings), this tool helps users control that their chosen contractor has the proper accreditation to install solar PV systems and protect them from rogue actors. Despite the latter tool, Elsäkerhetsverket's digital presence is relatively modest and aligns with Winkel's Winkel [2005] description of public organization's who had chosen not to significantly invest in their digital transformation. Considering the agency's larger mission and main allocation of resources, this fact is not unexpected. Moreover, their value proposition can also be said to mostly align with the traditional view described by Ranerup et al. Ranerup et al. [2016], as most of the information provided is delivered in a neutral tone. However, there are nuances of a more emerging view espoused by the authors, as the intermediary's content does facilitate user judgment.
Lastly, regarding the value offering of the non-profit intermediaries, we noted that while Bengts villablogg did offer an online forum singularly focused on solar PV technology, platforms such as Facebook have the advantage of being more accessible to a larger audience, and has the capability to form groups for specific topics as well. Thus, the value Bengt's forum holds for adopters is considerably weaker than it historically has been.

Third, reviewing the the for-profit intermediaries separately. The offering these actors provide is influenced by their basic strategy relies on nudging site visitors to use their revenue generating services. To illustrate this, we see in the case of IFSEK that this is reflected by portraying their competencies within solar PV installations though their digital inspection and online supplier assessment tool, which

in turn may convince site visitors to book them for advisory or inspection services. Comparatively in the case of Hemsol and Solcellskollen, both ultimately want users to use their quote comparison or solicitation services and urge users to do so by providing various types of information. Additionally for the two match makers, the differences in how these two intermediaries have structured their revenue-generating services are also worth accentuating. To elaborate, Solcellskollen's strategy is to offer site users transparency in who they are partnered with and puts the onus of supplier choice (referring to the suppliers partnered with the intermediary) and quote evaluation on the user. In contrast, Hemsol manages this process entirely for users are part of their operations, sacrificing evaluation transparency in the process.
Lastly, we also saw that two of the for-profit intermediaries had ambitions to expand their value offering. The first of these was Hemsol, who had plans to differentiate their value proposition by expanding their offering to encompass more areas than just matching adopters with solar PV suppliers. This was evidenced by their plan to offer the same type of services for electricity contracts, which would allow them to both enter a new market and serves as a natural next-step for those who previously used their quote service for PV systems. The second intermediary who exhibited plans for expansion was IFSEK, their intent was instead to widen their value proposition within the solar PV market by offering educational content aimed both at solar PV installers and adopters alike.

Value creation and delivery

Organization: activity system and value chain
In Figure 12 when highlighting the organizational activities and value chain, we mainly refer to how intermediaries engage with adopters. Here we discuss more in-depth the activities intermediaries engage in and the value chain they find themselves in to facilitate the support the offer and value being provisioned.
Using the support roles discussed in section 5.1, we first examine those fulfilling the content provider role. The most rudimentary form this type of support is delivered is through various types of texts hosted on each intermediary's website. Some also have additional ways to deliver information to site visitors such as the interactive tools (investment and production calculators) possessed by Hemsol, Solcellskollen and Energimyndigheten. Similarly, IFSEK allowed their site visitors to fill in a digital inspection form to understand the most important elements for a correctly installed PV system.
These services were delivered through in a one-way communicative channel, however, some such as Hemsol and IFSEK also chose to interact with adopters in a more direct manner. In Hemsol's case, this entailed contacting adopters via telephone when using the company's quote service. For IFSEK, interaction meant providing advisory or inspection service face-to-face.

Secondly, viewing the activities performed by the match makers, we see that Solcellskollen and Hemsol exhibited some differences which are noteworthy when it comes to how the companies chose to structure their quote services. As already mentioned, in contrast to Solcellskollen's laissez-faire disposition in match making, Hemsol took an active role in curating a list of suppliers for each of their users and also invest time by speaking with each user individually, resulting in a need for a larger degree of human capital. It can be argued that this requires less expertise on the part of the consumer, who entrusts Hemsol to translate and articulate their needs to suppliers on their behalf, although this is done at the expense of a lack of transparency in the selection process. In contrast, Solcellskollen's approach puts the burden on the user to reach out to each supplier they wish to solicit a quote from. Dialogue between a user and Solcellskollen is only exchanged in the event that they are contacted by users directly. Their service however, allow users to see how each supplier have been judged by previous customers and are thus able to form an independent assessment of of their suitability.

Third, diverging from using the support roles as a source of examination we instead specifically review how the supplier assessment between Solcellskollen and IFSEK differs (though this will in part also explain how one of the regulators choose to deliver value to adopters). While the service itself is somewhat similar to each other, how they assess suppliers is different in several ways. For one, Solcellskollen defers all assessment to the adopter instead of the intermediary themselves. This means that from a solution provider's perspective, they are incentivised to prioritize a provide a positive experience during the installation process as they are not evaluated on the long-term effects of their service. Second, the criteria which they are evaluated upon differs. Whereas Solcellkollen's assessment lies on a scale of 1-5 on customer reception and installation, IFSEK's assessment is more granular and singularly focuses on the quality of the installed facility. In the case of Solcellskollen, the assessment is one feature in the complete service offering they provide, while IFSEK's main service are the inspections. This factor may help explain the differences in how solution providers are assessed.

Network
Regarding the network each intermediary has chosen to establish, we examine the for-profit and non-profit intermediaries separately.

Starting with the for-profit intermediaries and the match makers in particular, we see that Solcellskollen and Hemsol share similarities in the network that they have chosen to curate. Both rely heavily on their network of supplier partners who pay them a fee for the transaction services they. Moreover, the selection of who to partner with entails assessing the financial standing of each supplier as well as their track-record of performing installations for both intermediaries. Because adopters are likely to associate the quality of service of Solcellskollen or Hemsol with who they chose to collaborate, these criteria are not surprising. Moreover, both these intermediaries argue that their activities allow suppliers to lower their marketing cost, as the process is effectively outsourced to them. This does lend credence to Teece and Linden's (2017) assertion that markets have shifted to become more ecosystem oriented, fostering collaboration among companies that may compete with each other on paper. It also aligns with Anderson and Anderson's discussing regarding e-commerce intermediaries needing to focus more on establishing a network of partners (Anderson and Anderson, 2002). Because solar PV suppliers generate customers organically, it may lead one to think that they would view these match makers as actors who compete for customer's attention. However, their willingness to collaborate with these intermediaries supports the notion that the solar PV market is in some capacity oriented towards working across company borders despite conflicting interests.
In contrast with the match makers, the other remaining for-profit intermediary IFSEK has chosen to not collaborate with any solar PV supplier. This is explained by the fact that a lack for ties to suppliers enhances their credibility as inspectors, meaning that they are free to assess installed solar systems free of any bias to any single solar PV supplier. However, the company is nonetheless apart of a ecosystem of solar PV actors, as their existence is dependent on inspecting systems installed by suppliers.

Similar to IFSEK, the non-profit intermediaries were also less pronounced in the network of partnerships they possessed. For the government agencies, ties among each other existed to strengthen the value provision to solar PV adopters. For instance, Elsäkerhetsverket does defer to Solelportalen on their website for those looking for more information. In the case of Bengt's villablogg, no partnerships had been established either, but he referred site users to other actors within the solar PV industry that had more information and that could help adopters. However, none of the three actors can be said to depend on any other entity to ensure the continuation of their digital intermediation.

Resources and capabilities
Relating the intermediaries' resources and capabilities, we first examine their source of funding

(as discussed by Mignon and Kanda (2018)) to draw inferences on how this may affect their ability to operate. Contrasting the non-profit intermediaries with the for-profit intermediaries, we first note that the for-profit intermediaries studied are recently established when compared to the non-profit intermediaries. For example, the oldest for-profit intermediary, Solcellskollen, is only 5 years compared to the youngest non-profit intermediary, Bengts villablogg, which is 13 years. Looking at Figure 1 presented earlier, we see that Sweden experienced an exponential growth in solar PV capacity the previous decade (Lindahl et al., 2020. This may help explain why privately funded - i.e. for profit - intermediaries are younger when compared to their non-profit counterparts. This also resonate with Mignon and Kandas (2018) assertion that public intermediaries are able to operate on a longer time-frame as their funding is more secured when compared to those who rely on generating their livelihood on market developments, and can afford to engage in markets that have yet to accelerate. Thus, we assert that it is likely that for-profit intermediaries are beholden to a sizable market growth before then can establish themselves and be financially stable.
One caveat in this regard, is that neither government agencies - the two oldest intermediaries by a 10 year margin - have solar PV as their sole focus in terms of organizational activities. Moreover, this also means that compared to the non-government intermediaries, they are take a more technologically neutral stance, opting to engage in the advocacy of other technologies as well (e.g. Energimyndigheten testing of various energy sources). Conversely, all the non-government digital intermediaries studied solely engaged in solar PV as the focal point of their activities, regardless whether they had a for-profit motive or not. Thus, they have a clear vested interest in the proliferation of solar PV as a technology.

Second, we evaluate the competencies exhibited by the intermediaries. We see that each intermediary has positioned to emphasize different ones, even when serving the same type of role. For example, while Solcellskollen and Hemsol both are a type of match maker, their priorities in terms of competencies can be argued to be different. Solcellskollen had developed their competencies to be able to relay high-quality information, both regarding solar PV technology and the suppliers they are partnered with (i.e. being able to assess supplier performance). The reason for this is that they believed that provision of this information would lead to organic growth and attracting new potential adopters. Conversely, Hemsol favored using their marketing competencies to grow their business and attracting adopters and also relied on developing company representatives that could process individual quote requests. If viewed through the same perspective espoused by Timmers' (1998) (and tangentially by Teece (2010), this suggests that the company is not only diverting their attention to adopting a business model congruent with the market dynamics, but consider their marketing strategy paramount in their success.
An exception to the disparate focus on competencies are Bengts villablogg and Energimyndigheten, who can both be said to chiefly rely on their own solar energy expertise. However, here the scope of utilizing this competence is different as Bengt uses his own knowledge to develop the blog according to his own interests. Conversely, Energimyndigheten is an organization consisting of 400 employees with ten to fifteen of these directly work with solar energy matters full-time with an expressed mandate delivered from the Swedish government. Lastly, relaying the competencies of the remaining intermediaries, Elsäkerhetsverket's primary competencies were their knowledge within electrical safety and its application in regards to solar PV systems. IFSEK also relied on competencies related to proper solar PV installations, using this to be able to perform their inspections. Additionally, their business model relies on software development to enable their digital offerings.

Value capture

Revenue sources
Looking at the intermediaries method to sustain their respective business', we note both similarities

and differences among them. To short summarize the findings, the two government agencies generate funding through public means, IFSEK generates revenues off-line through client fees, Bengts villablog is mainly self-funded. Lastly, the two match makers are the two remaining intermediaries which have revenue sources based on their digital offerings.

In the case of the two government intermediaries, Elsäkerhetsverket and Energimyndigheten, their financing through government budgets can be said to be more predictable as they do not rely on any actor or customer in the solar PV market for their sustenance. Instead, they are influenced by changes in the political landscape, as their budget is set by the Swedish government and they stance on solar PV's place in society.

IFSEK's revenue streams are derived entirely from their non-digital activities, soliciting fees from consultation fees which includes advisory and inspection services. Although all of the digital services they provide are free for users, they have structured them to complement their offline revenue generating streams. The most notable example of this is their supplier assessment tool, which they consider one of their core assets in creating value for site users. Since more inspections leads to a greater quantity for site users to evaluate, the company synergies the two mediums to their benefit. Thus, their digital raison d'être can be said to persuade potential and post-adopters of the benefit of purchasing their off-line services, which solicits payment for each consultation/inspection performed. Their limiting factor lies in the number of inspections they can effectively execute, which is both time and resource intense.

Bengts villablog can be said to not having a fully developed value capture model. The site relies primarily on self-funding and is supplemented by voluntary donations by site visitors. Although they have had the opportunity to generate revenue through advertisement, this option has never been chosen due to a concern of wanting to be a neutral actor, not wanting to favor any specific technology provider on the market. It can thus be surmised that the blog will be operational so long as the creator has a continued time, interest and financial means to sustain it.

In the case of the match makers, we once again see similarities and differences worth highlighting. Both rely on a revenue model which is based on their solicitation of commission fees to suppliers for every quote forwarded to them (with Hemsol also providing their partners to instead opt for a referral fee). While this entails a low barrier to engage with these firms' services from an adopter perspective, it is reliant on the fact that suppliers - the party that incurs a cost in the transaction - finds the arrangement attractive where two possible complications may arise. To elaborate, it firstly presupposes that the supply for any solar PV supplier is greater than the demand they receive, or else there is no reason for the intermediaries' suppliers to pay them for interested adopters they cannot service. This is not always the case, as the findings illustrated for Hemsol. In this scenario, the company's network of solar PV suppliers prioritized managing their own organic inflow of prospects instead of paying the fee and receiving the customers Hemsol provided. Comparing the match makers' revenue models further, we do note that they once again have differences between them. For example, the nature of Hemsol's service allows them to direct the flow of interested users to a particular supplier in theory if the supplier has expressed an interest in receiving a certain quantity of potential customers, although this practice could question their perception as a neutral intermediary. Conversely, Solcellskollen has no influence in linking a user to a particular supplier.

Economics of the business

Assessing the profitability for the three for-profit intermediaries (Hemsol, Solcellskollen, IFSEK), we note that both Solcellskollen and IFSEK have been profitable for the entirety of their duration. Both

of these intermediaries have low costs such as few employees (if more employees are hired as in the case if IFSEK, this directly leads to increases in revenue if the demand for inspections can be met). In contrast, Hemsol, who have yet to be profitable, and spend more resources on each potential adopter (i.e. those who fill in their quote form) through the company representatives which they have chosen to manage quote requests. This may explain why they have not seen the same profit margin as other either Solcellskollen or IFSEK.

Because the two match makers bear many similarities, a comparison of their business model in relation to their profitability is also analyzed. We see that Solcellskollen has experienced a more favorable outcome in this regard, consistently being profitable since their start in 2017 in contrast to Hemsol. It should be noted that Hemsol had only been operating for two years compared to Solcellskollen's five years during the time of the interviews. Also, in Hemsol's case it is uncertain whether balancing the fee so that suppliers find it attractive to sacrifice part of their margin while simultaneously allowing Hemsol to their profit targets can be achieved in the long-term. Compared to Solcellskollen, Hemsol has allocated more resources to increase their human capital as evidenced by the nature in which they chose to interact with users who chose to user their quote service. In Solcellskollen's case we see that since site visitors freely select which suppliers to contact, the intermediary lacks control in the interaction between user and supplier and determining who will receive a quote request. This means that the they cannot provide a desired quantity of leads to any individual supplier. Conversely, this also incentives suppliers to engage in activities that lead to higher ratings on the intermediaries' website.

Lastly, regarding the external contingencies for all for-profit intermediaries. We note that at the time, all for-profit intermediaries relied on a continued interest from consumers wanting to adopt solar PV technology. It is uncertain how adversely reduced subsidies or higher feed-in tariffs would affect these intermediaries. However, considering that the investment size and pay-back time is a prominent part of the information conveyed for both match makers (as well as Energimyndigheten) and that research has shown it to be a large concern (Girardeau et al., 2021), we presume it would deteriorate the for-profits intermediaries' ability to operate their business' sustainably.

5.3 What are the trade-offs that exist in digital intermediaries' business models?

When discussing trade-offs, we utilize three aspects which are either strengthened or serve as a trade-off as a consequence of the business model chosen by the intermediaries. These three aspects we have chosen to highlight are *value provision* which concerns the value which the intermediary provides to adopters through their services, *revenue generation* which is the method the intermediary has chosen generate profit, and *neutrality* which is the degree to which the intermediary can render impartial advice to adopters.

Trade-offs manifested in value provision versus revenue generation
We iterate that all intermediaries offer some type content through their website that facilitates knowledge (i.e. information in various forms). As explained, this is crucial in the context of both solar diffusion and as a digital intermediary (Rai, 2013, Chircu et al., 2000). However, this must be offered free of charge as hypothesized by Anderson and Anderson (2002). Thus, digital intermediaries that are privately funded (Hemsol, Solcellskollen, IFSEK) need some other way to capture value while still incorporating free services in their business model. Instead, their revenue comes from serving a problem solving role (i.e. as a match maker) also discussed by Anderson and Anderson (2002).

To clarify, these for-profit intermediaries offer content in order to encourage site visitors to utilize their paid services which allow them to capture value. For the match makers, this is the the quote comparison services, for IFSEK, this is their offline inspections.

Trade-offs manifested in neutrality versus revenue generation

First, in terms of the information provided, we note all of the intermediaries had taken care to present them in a neutral manner (regardless of having a for-profit motive or not), albeit all promoting the use of solar PV technology. I.e., no intermediary promoted the specific use of a single product or supplier. While it may be evident why the government agencies would not promote a particular private enterprise (thus, corresponding to the traditional view ascertained by Ranerup et al. (Ranerup et al., 2016), it is interesting to note that none of the privately funded intermediaries encouraged the use of any specific product or supplier in their informative texts either. For instance, the privately funded intermediaries could possibly generate advertisement revenues by directly promoting the use of a specific solar PV product but chose not to. This may be explained by the fact that adopters of solar PV prioritize information that they deem credible and trustworthy as research has shown (Jager, 2006, Rai, 2013). This fact is also exacerbated in the case when interacting with digital intermediaries, where these actors must further establish a sense of trust and expertise to gain influence over consumers (Chircu et al., 2000).

However, when assessing the neutrality of the match makers' (Hemsol and Solcellskollen) revenue generating services, we note that they are not neutral to the same extent when compared to the four remaining intermediaries. Both intermediaries are financially dependent on the suppliers, as they are their actual - paying - customers. Thus, they are forced to balance the interest of solar PV suppliers with adopters to create a service where they are able to capture value and as stated by Klerkx and Leeuwis (2008), finding an acceptable balance is what allows brokers to be effective. In Solcellskollen's case it can be argued that their chosen business model and level of balance has been achieved, as they have been able to operate on a profitable level. Conversely, Hemsol has yet to reach a profitable state with their chosen method which may be due to a poor balance between supplier and adopter interest. However, other factors such as investing more resources in developing human capital (thus having to scale up the volume of quote inquiries compared to Solcellskollen) may also explain why this is the case. Although the counterargument can be made that both match maker intermediaries have structured their respective business' so that site users are not directed towards choosing any particular supplier, they have consciously curated a network of suppliers that they chose to work with and have thus made some choice in who their site users should opt for when choosing a PV supplier. In the case of Hemsol, this is particularly evident as they are the ones who determine which suppliers adopters are given as matches. In contrast, Solcellskollen's users chooses freely who to contact among their partnered suppliers. Here, we argue that both intermediaries have imposed a degree of standardization in their business models, allowing them to streamline the match making they offer each adopter using the service. As a contrasting example, the match makers could offer a larger degree of customization to adopters if they had reviewed all available solar PV suppliers in the country for every inquiry. However, this would likely require too much resource investment from the intermediaries' perspective and lead to a business model which is economically infeasible. Moreover, this list of curated suppliers can be argued to be a form of quality assurance, as both match makers argue that their selection process filters out solar PV suppliers that are in poor financial standing or have a poor reputation. Therefore, the intermediaries' bias in supplier availability from an adopter perspective can be said to both posses benefits and limitations.

Trade-offs manifested in value provision versus neutrality

Regarding the non-profit intermediaries (Energimyndigheten, Elsäkerhetsverket, Bengts villablogg),

their strongest value proposition lies in the fact that the content they provide is offered from a neutral point of view. Since their funding does not rely on the financing of any other actor in the solar PV market, they have no bias to push adopters in selecting any specific supplier. Thus, their credibility as neutral intermediaries is enhanced due to not having to balance the interests between other solar PV actors and adopters in order to sustain their organizations. However, this also means that they do not offer help to intermediaries who need aid in selecting who to aid them in the installation of a solar PV system once they have made the decision to invest in the innovation.

6 Discussion

In this section, we discuss the key findings in this thesis. Each finding is divided in a subsection where we first discuss what has been seen and its following implications for either adopters, policy makers or those on the business side. Thereafter, we provide suggestions for new areas of research related to the particular finding discussed.

6.1 The significance of content provision and differences among for-profit and non-profit intermediaries

Implications

Examining the business models of the digital intermediaries, we see that all offer some type of informative content in their value proposition. This was the main offering for the non-profit intermediaries, while the for-profit intermediaries had some additional value offering that was tied to how they chose to generate revenue. For the former group (Bengts villablogg, Energimyndigheten, Elsäkerhetsverket), conveying information without have bias to any other commercial actor is of importance and a part of their strategic intent. For the for-profit intermediaries, the business was designed to encourage site visitors to utilize their revenue generating services and providing information was a way for them to gain the trust of site users. A last observation regarding the provision of information is that four out of the six intermediaries (Hemsol, Solcellskollen, Energimyndigheten, IFSEK) provided some type of interactive content. E.g. by allowing adopters to use a solar and investment calculator or digital inspection assessment tool. Here, we note the benefits of such an approach in content provision, as it allows intermediaries to better tailor the provision of knowledge to an individual adopter's specific circumstance.

We conclude that providing information surrounding the solar PV technology which is considered neutral is important to convey expertise and establish trust. If they are a non-profit intermediary, this is the focal point of their value proposition. For the for-profit intermediaries, some other way to ensure their financial sustainability must be found and may be generated by linking adopters to other solar PV actors or by helping adopters that have already installed a PV facility. For this reason, we argue that both the non-profit and for-profit intermediaries serve useful and complementary support to adopters. In general, we suggest that non-profit intermediaries are better at providing information which adopters will interpret as neutral and credible (although the for-profit intermediaries are also to provide this to a large extent). While for-profit intermediaries are better served at helping adopters choose specific solution providers in the adoption process.
We believe that both types of intermediaries (non-profit and for-profit) that have been studied provide value to adopters. In the case of non-profit intermediaries, we posit that their neutrality in the provision of all services means that adopters are more likely to trust the information they provide. In the case of for-profit intermediaries, these are able to help adopters with installation and post-installation process by recommending specific solution providers which non-profit intermediaries elect not to due to their stance as independent advisers.

Future research

Regarding further research, we believe it would be relevant to assess adopters' perception regarding the content provided by different intermediaries. For one, while we asserted that non-profit intermediaries

are better suited at providing information that is neutral, both for-profit and non-profit intermediaries share an overlap in the type of information conveyed and adopters' preference in regards to consuming this type of content and how they choose to engage with it has not been validated. For instance, a scenario could exist where adopters cross-validate the knowledge provided by for-profit intermediaries with non-profit intermediaries to assess the expertise they hold to determine whether to use their services. A second point of interest in adopter's perception of content offered would be to study the significance of providing information which is interactive in nature, its benefits and shortcoming and whether it is beneficial to design more type of content in this fashion.

6.2 Absence of post-decision support in digital intermediation

Implications

The digital intermediaries examined are not equally active in all phases of the decision-making process. To some extent, all intermediaries are active in the pre-decision and decision phases of adoption, informing adopters about the benefits and requirements of solar PV. This contributes to solar PV diffusion by addressing the current information gap, where currently 46 percent of people who want to invest in the technology do not feel well informed enough to do so (Svensk Solenergi, 2020). Digital intermediaries thereby assist adopters in deciding whether or not to invest in solar PV, but our findings suggest that they may be less suitable for post-decision support. Their online presence enables them to be resource efficient when providing easily accessible information on benefits and requirements of solar PV. However, it can also can also be a hinder for post-decision support where other types of intermediaries might be more suitable. As an example, facilitating the use of innovation after implementation is part of the post-decision phase, where we have seen a lack of digital intermediaries (Glaa and Mignon, 2020). Only one intermediary (IFSEK) provided support, through maintenance and quality assurance services. In this instance, support was accomplished through a combination of digital and physical services, which further implies that post-decision support though entirely digital efforts is challenging to provide. However, it should be noted that some intermediaries were planning on expanding their value provision which included offering more post-decision support. This was exemplified by Hemsol, who planned on extending their quote provision services to include the evaluation of utility companies in regards to signing an electricity contract.

To conclude this point, we argue that our findings imply that while digital intermediaries can contribute to solar PV diffusion, there exist caps in the post-decision phase where these intermediaries are less equipped to facilitate aid and should be supplemented by non-digital support as well in order to effectively provide aid in all stages of adopters decision-making process. For policymakers, this knowledge is relevant when determining how to best support solar PV proliferation. To elaborate, solar PV systems are often expected to last between two or three decades. However, this is contingent on that facilities are installed and properly maintained. If it becomes necessary for society to divert more resources in ensuring that issues such as these are handled, we argue that this type of support will likely not be able to be offered in a purely digital setting. We also suggest that it is of interest for decision makers on the business side to be aware of the insights derived of the post-decision support. Conversely from their point of view, we first argue that the digital setting can be used as an initial tool to generate interest for their off-line services and legitimacy (as we argue that IFSEK uses their digital presence), but that it alone is unlikely to lead to a sustainable business model. Second, while we contend that much of the gaps in the post-decision support seem unable to be provided in a digital setting, some of the currently existing gaps not related to a solar facilities continued operation can be

served by digital intermediaries. Once again, we refer to Hemsol's plan to expand their quote service as an example of how this.

Future research

Looking forward, we believe it there are several avenues related to solar PV support that are worth exploring. First, while we have examined what type of support digital intermediaries provide, the efficacy of this help has not been assessed. This type of study could be interesting to determine how well the intermediaries intended support given is perceived by adopters. Second, while one intermediary (Bengts villablogg) did provide a community platform its role in the value provision was deemed to be of low significance. It was indicated that social media groups served as the primary platform for community interaction. Therefore, it would be interesting to study the support an active and widely used solar PV forum on such a provides to understand what type of support is given and whether it correlates to the findings by Hyysalo et al. (Hyysalo et al., 2018).

6.3 Match maker transparency and their evaluation criteria in supplier selection

Implications

Discussing match makers, based on our findings it has become clear that one of their primary tasks on the Swedish solar PV market is to recommend a solar PV supplier to adopters and facilitate the initial connection between them. These intermediaries take on a role of curating a network of suppliers and some match makers also choose filter information between the adopter and supplier. In both cases, an argument can be made that the match makers act as form of quality assurance, who are better equipped to assess which PV suppliers are better suited to cater to adopters' needs. Nonetheless, this selection process of suppliers is for adopters is in some respects obscured, and it is unclear whether suppliers are chosen strictly with the adopter's best interest in mind. The data shows that some adopters question how these intermediaries earn a profit (to which the intermediaries give a transparent answer, also going so far as to explicitly stating on their website how they generate revenue), thus a sign that at least some adopters critically assess the interest of match makers. Despite this, we think it pertinent reiterate that these intermediaries, while they may be earnest in their intention to help adopters and may act in good-faith, ultimately have their own interests to look after which are not completely aligned with adopters. Part of the match makers' value proposition is being perceived as neutral actors who have no vested interest in adopters choosing a particular solar PV suppliers, they leverage this perception to gain adopters' trust in their service. However, this perception may only hold true to the extent that concerns the solar PV suppliers who included in the match maker's network. Because match makers rely on their network of partnered suppliers to generate revenue, there is no reason to believe that they will recommend suppliers who are not partnered with them, even if a supplier outside the network should offer superior products and services.

Moreover, we see that price has been a widely documented factor for adopters when determining which supplier to choose (Girardeau et al., 2021, Rai, 2013). The emphasis on this is also evidenced by the solar production and investment calculators that these match makers provide, which give an estimate of energy produced, pay-back period and investment cost. However, other factors such as product and roof compatibility, product warranties and origin of product manufacturing are - from the data we gathered - not pronounced in the quote process. As previously stated, due to the expectation that solar PV systems are expected to last for several decades we assert that adopters

would benefit from being able to make an informed decision based on more factors. In this way, digital intermediaries could provide more than just pricing knowledge to adapters.

Future research

On the basis of the two previous paragraphs, we see multiple areas for future research. One aspect worth studying is to what degree adopters value transparency. For instance, do adopters value knowing how suppliers are selected, being able to choose which suppliers they are offered, or do they prefer being given pre-defined list of suppliers? This knowledge could be useful to both understand how adopters want to receive supplier recommendations and also to evaluate whether adopters on an aggregate level are prone to be exploited should they prefer options which are less transparent. Another similar area worth exploring would be what factors besides price are important for adopters when choosing a supplier and their products. Our data and previous research suggests a large emphasis on this factor, however we believe it is merited to compare it to other factors and if possible quantify its significance (i.e. through a discrete choice model experiment).

7 Conclusion

7.1 Aim of thesis and answers to research questions

The aim of this thesis was to understand how digital intermediaries support solar PV diffusion. By examining their business models, we strove to ascertain what type of support (i.e. value) they provided adopters with, how this value was delivered and how the intermediaries chose to ensure their survival by a chosen method to capture value from their value creation. Lastly, we sought to understand what trade-offs these digital intermediaries had to contend with in balancing the provision of value while ensuring that they made a profit. The following research questions and their corresponding answers is how the thesis attempts reach its aim.

How do digital intermediaries support the adoption of solar PV and what roles do they serve?

Digital intermediaries who help solar PV adopters do so by primarily by providing them with information regarding solar PV technology and advocating for its use in Sweden, helping adopters assess the viability of adopting a solar PV facility in their specific circumstance and facilitating a connection between a potential adopter and solar PV supplier. This type of support is characterized by intermediaries exhibiting a content provider role and match maker role (the latter specifically addressing the brokering between adopters and solar PV suppliers). To a lesser extent, digital intermediaries also help adopters the discern which solution providers are allowed or best qualified to help them install solar PV systems and do this through a regulatory support role. Lastly, digital intermediaries tend to provide support by providing it on an actor level, helping individuals directly instead of facilitating systemic aid.

How are the business models of digital intermediaries within the solar PV market structured to create, deliver and capture value?

Answering how digital intermediaries have designed their business models to create, deliver and capture value, we first address that they primarily cater to residential households looking to adopt solar PV systems, with some also helping solar PV suppliers finding customers (adopters).

Value is created in different ways depending on the type of support offered by the intermediaries. Regardless of role, most intermediaries create value by providing informative texts surrounding solar PV technology and the provision of interactive tools such as solar production and investment calculators in order to better cater to individual adopter's specific needs. Moreover, match makers create value by linking adopters with solar PV suppliers who the match makers have chosen to partner with. Information is delivered by adopters interaction with the intermediaries' website, some also chose more direct and communicative methods such as through phone conversations. In order to create and deliver this value, intermediaries have chosen different competencies to emphasize, some value their expertise in solar energy foremost, while others prioritize their marketing capabilities or ability to provide high-quality information.

To ensure their continued survival, for-profit intermediaries either choose to solicit commission fees from the solar PV suppliers in their network when providing them with adopters, as in the case for match makers. Alternatively, client fees are extracted when directly helping adopters in scenarios

where no other stakeholder is directly involved with the intermediary's value provision. For the non-profit intermediaries, value is either captured through public funding as in the case with government agencies, or through self-funding or donations as the case of a private non-profit actor.

What are the trade-offs that exist in digital intermediaries' business models?

Regarding trade-offs that digital intermediaries must contend with, we see that regardless of role provided, intermediaries must provide adopters with content to engage with, free of charge. This means that for-profit intermediaries must find some other service to serve as their source of revenue generation.

In terms of providing support from a neutral stance, we have seen that all intermediaries take care to provide neutral information regarding the solar PV technology, regardless whether their source of funding comes from public or private means. However, since some intermediaries - specifically those acting as match makers - depend on their established partnership of solar PV suppliers to make a profit, their neutrality in in their brokering services cannot be guaranteed from an adopter's point of view.

Lastly, the neutral stance that government-affiliated intermediaries possess limits the type of value provision they can offer adopters. For example, they are unable to give them advice on choosing specific solution providers.

7.2 Implications and recommendations for future research

In analyzing the data and answering the thesis' research questions, implications for adopters, business actors and researchers were yielded. Furthermore, recommendations for future research were also manifested which are relayed.

Implications

First, as we previously noted, facilitating support to solar PV adopters entails the provision of free content which to some extent must be conveyed in a neutral manner. Even if an intermediary intents be operate on a for-profit model, this type of service must be rendered to adopters in order to nudge them to use utilize revenue generating resources. We believe that that both non-profit intermediaries and for-profit intermediaries complement each other, with the former being better positioned to render neutral and credible information and the latter better suited to guide adopters towards specific solution providers.

Second, while we have seen that digital intermediaries provide ample support in the pre-decision and decision phases of adoption, they are less equipped to facilitate post-decision aid. Particularly, we contend that this type of help is absent regarding post-implementation and maintenance help. We therefore suggest that post-decision support may be better given in a non-digital setting or alternatively, that non-digital intermediaries may offer some (likely free) digital services to adopters to encourage the use of their non-digital ones.

Lastly, regarding match maker intermediaries, we have seen that how they choose their network of solar PV suppliers are to adopters partially obscured. This is also true for one of the match makers when it comes to the process of linking adopters with a selection of their solar PV suppliers. While this

type of intermediary position themselves as being a neutral actor in the eyes of adopters, their chosen value capture model means that their own interests are not entirely aligned with them. Moreover, price as a deciding factor in the brokering services are predominantly emphasized and other factors such as product quality are less pronounced.

Recommendations for future research

Regarding avenues for future research, we see multiple areas worth examining based on the implications highlighted. For one, we believe it is relevant to assess adopter's perception regarding the content provided and if they have any preferences in how this content is communicated and by whom (e.g. whether it is offered by a for-profit or non-profit intermediary). Moreover, assessing the efficacy of support provided by intermediaries from an adopters point of view would could further help to determine how to best support diffusion of solar PV technology. Regarding support roles, it would be of interest to study a widely used community platform that were suggested to exist on social media platforms to determine what support they are able to render. Lastly, we also suggest that it would be pertinent to understand how highly transparency in intermediaries is valued by adopters, and similarly to what degree they factors other than price would influence their decision during the adoption process.

References

Raphael Amit and Christoph Zott. Value creation in e-business. *Strategic management journal*, 22 (6-7):493–520, 2001.

Philip Anderson and Erin Anderson. The new e-commerce intermediaries. *MIT Sloan Management Review*, 43(4):53, 2002.

Joakim Aspeteg and Anna Bergek. The value creation of diffusion intermediaries: Brokering mechanisms and trade-offs in solar and wind power in sweden. *Journal of Cleaner Production*, 251: 119640, 2020.

Charles Baden-Fuller and Stefan Haefliger. Business models and technological innovation. *Long range planning*, 46(6):419–426, 2013.

David Barnes and Matthew Hinton. Developing a framework to analyse the roles and relationships of online intermediaries. *International Journal of Information Management*, 27(2):63–74, 2007.

Emma Bell, Alan Bryman, and Bill Harley. *Business research methods*. Oxford university press, 2018.

Anna Bergek. Diffusion intermediaries: A taxonomy based on renewable electricity technology in sweden. *Environmental Innovation and Societal Transitions*, 36:378–392, 2020.

John Bessant and Howard Rush. Building bridges for innovation: the role of consultants in technology transfer. *Research policy*, 24(1):97–114, 1995.

Christian Bessy and Pierre-Marie Chauvin. The power of market intermediaries: From information to valuation processes. *Valuation studies*, 1(1):83–117, 2013.

BMWK. Erneuerbare energien in zahlen. In *Nationale und internationale Entwicklung im Jahr 2019*, page 12. Bundesministerium für Wirtschaft und Klimaschutz, 2020.

Eric Brousseau. The governance of transactions by commercial intermediaries: An analysis of the re-engineering of intermediation by electronic commerce. *International Journal of the Economics of Business*, 9(3):353–374, 2002.

Donal Brown, Paula Kivimaa, and Steven Sorrell. An energy leap? business model innovation and intermediation in the 'energiesprong'retrofit initiative. *Energy Research & Social Science*, 58:101253, 2019.

Debra Cash et al. The invisible world of intermediaries: A cautionary tale. *Computer Supported Cooperative Work (CSCW)*, 8(1):147–167, 1999.

Henry W Chesbrough. Why companies should have open business models. *MIT Sloan management review*, 48(2):22, 2007.

Alina M Chircu, Gordon B Davis, and Robert J Kauffman. Trust, expertise, and e-commerce intermediary adoption. 2000.

Fariborz Damanpour and Marguerite Schneider. Phases of the adoption of innovation in organizations: effects of environment, organization and top managers 1. *British journal of Management*, 17(3):215–236, 2006.

Ana Rosa del Águila-Obra, Antonio Padilla-Meléndez, and Christian Serarols-Tarres. Value creation and new intermediaries on internet. an exploratory analysis of the online news industry and the web content aggregators. *International journal of information management*, 27(3):187–199, 2007.

Ulrich Dewald and Bernhard Truffer. The local sources of market formation: explaining regional growth differentials in german photovoltaic markets. *European Planning Studies*, 20(3):397–420, 2012.

Klaus Fichter, A Fuad-Luke, O Hjelm, M Klofsten, M Backman, L Bergset, D Bienkowska, J Clausen, J Geier, AL Hirscher, et al. Shifting the support of entrepreneurship in eco-innovation. *Summary of results and recommendations from the Eco-Innovera project SHIFT. Berlin, Helsinki, Linköping University: SHIFT*, 2016.

Nicolai J Foss and Tina Saebi. Business models and business model innovation: Between wicked and paradigmatic problems. *Long range planning*, 51(1):9–21, 2018.

George M Giaglis, Stefan Klein, and Robert M O'Keefe. The role of intermediaries in electronic marketplaces: developing a contingency model. *Information systems journal*, 12(3):231–246, 2002.

Hannah Girardeau, Alicia Oberholzer, and Subhrendu K Pattanayak. The enabling environment for household solar adoption: A systematic review. *World Development Perspectives*, 21:100290, 2021.

Besma Glaa and Ingrid Mignon. Identifying gaps and overlaps of intermediary support during the adoption of renewable energy technology in sweden–a conceptual framework. *Journal of Cleaner Production*, 261:121178, 2020.

Erik G Hansen and Johanna Klewitz. Publicly mediated inter-organisational networks: A solution for sustainability-oriented innovation in smes? In *Entrepreneurship, innovation and sustainability*, pages 254–278. Routledge, 2017.

Michael Hodson, Simon Marvin, and Harriet Bulkeley. The intermediary organisation of low carbon cities: a comparative analysis of transitions in greater london and greater manchester. *Urban Studies*, 50(7):1403–1422, 2013.

Mike Hodson and Simon Marvin. Can cities shape socio-technical transitions and how would we know if they were? *Research policy*, 39(4):477–485, 2010.

Dóra Horváth and Roland Zs Szabó. Evolution of photovoltaic business models: Overcoming the main barriers of distributed energy deployment. *Renewable and Sustainable Energy Reviews*, 90:623–635, 2018.

Jeremy Howells. Intermediation and the role of intermediaries in innovation. *Research policy*, 35(5): 715–728, 2006.

Sampsa Hyysalo, Jouni K Juntunen, and Mari Martiskainen. Energy internet forums as acceleration phase transition intermediaries. *Research Policy*, 47(5):872–885, 2018.

Flavius Iacobescu and Viorel Badescu. The potential of the local administration as driving force for the implementation of the national pv systems strategy in romania. *Renewable energy*, 38(1): 117–125, 2012.

W IMD. Imd world digital competitiveness ranking 2021. 2021.

Wander Jager. Stimulating the diffusion of photovoltaic systems: A behavioural perspective. *Energy Policy*, 34(14):1935–1943, 2006.

Kathryn B Janda and Yael Parag. A middle-out approach for improving energy performance in buildings. *Building Research & Information*, 41(1):39–50, 2013.

Marijn Janssen, George Kuk, and René W Wagenaar. A survey of web-based business models for e-government in the netherlands. *Government information quarterly*, 25(2):202–220, 2008.

Wil Janssen, Harry Bouwman, René van Buuren, and Timber Haaker. An organizational competence model for innovation intermediaries. *European Journal of Innovation Management*, 2014.

Kinshuk Jerath, Liye Ma, and Young-Hoon Park. Consumer click behavior at a search engine: The role of keyword popularity. *Journal of Marketing Research*, 51(4):480–486, 2014.

Suyash Jolly, Rob Raven, and Henny Romijn. Upscaling of business model experiments in off-grid pv solar energy in india. *Sustainability Science*, 7(2):199–212, 2012.

Wisdom Kanda, Pablo del Rio Gonzaléz, Olof Hjelm, and Dzamila Bienkowska. A function of innovation systems approach for analysing the roles of intermediaries in eco-innovation. In *Global Cleaner Production and Sustainable Consumption Conference, 1-4 November, Sitges-Barcelona, Spain*, 2015.

Emrah Karakaya, Cali Nuur, and Antonio Hidalgo. Business model challenge: Lessons from a local solar company. *Renewable energy*, 85:1026–1035, 2016.

Bernhard Katzy, Ebru Turgut, Thomas Holzmann, and Klaus Sailer. Innovation intermediaries: a process view on open innovation coordination. *Technology Analysis & Strategic Management*, 25(3): 295–309, 2013.

Laurens Klerkx and Cees Leeuwis. Balancing multiple interests: Embedding innovation intermediation in the agricultural knowledge infrastructure. *Technovation*, 28(6):364–378, 2008.

Laurens Klerkx and Cees Leeuwis. Establishment and embedding of innovation brokers at different innovation system levels: Insights from the dutch agricultural sector. *Technological forecasting and social change*, 76(6):849–860, 2009.

Fabian Kley, Christian Lerch, and David Dallinger. New business models for electric cars—a holistic approach. *Energy policy*, 39(6):3392–3403, 2011.

Johan Lindahl et al. National survey report of pv power applications in sweden 2020. *The International Energy Agency*, page 18, 2020.

Moritz Loock. Unlocking the value of digitalization for the european energy transition: A typology of innovative business models. *Energy research & social science*, 69:101740, 2020.

Peter D Lund. How fast can businesses in the new energy sector grow? an analysis of critical factors. *Renewable Energy*, 66:33–40, 2014.

I Mignon and W Kanda. A typology of intermediary organizations and their impact on sustainability transition policies. environ. innov. soc. transitions 29, 100–113, 2018.

Ingrid Mignon. Intermediary–user collaboration during the innovation implementation process. *Technology Analysis & Strategic Management*, 29(7):735–749, 2017.

Ingrid Mignon and Anna Bergek. System-and actor-level challenges for diffusion of renewable electricity technologies: an international comparison. *Journal of Cleaner Production*, 128:105–115, 2016.

Sujith Nair and Hanna Paulose. Emergence of green business models: The case of algae biofuel for aviation. *Energy Policy*, 65:175–184, 2014.

Colin Nolden, Jacob Barnes, and J Nicholls. Community energy business model evolution: A review of solar photovoltaic developments in england. *Renewable and Sustainable Energy Reviews*, 122: 109722, 2020.

OED Online. intermediary, adj. and n., 2022. URL www.oed.com/view/Entry/97979.

Lasse Okkonen and Niko Suhonen. Business models of heat entrepreneurship in finland. *Energy Policy*, 38(7):3443–3452, 2010.

Alexander Osterwalder. *The business model ontology a proposition in a design science approach*. PhD thesis, Université de Lausanne, Faculté des hautes études commerciales, 2004.

Alice Owen, Gordon Mitchell, and Andrew Gouldson. Unseen influence—the role of low carbon retrofit advisers and installers in the adoption and use of domestic energy technology. *Energy policy*, 73:169–179, 2014.

Stephen Pacala and Robert Socolow. Stabilization wedges: solving the climate problem for the next 50 years with current technologies. *science*, 305(5686):968–972, 2004.

Alvar Palm and Björn Lantz. Information dissemination and residential solar pv adoption rates: The effect of an information campaign in sweden. *Energy Policy*, 142:111540, 2020.

Yael Parag and Kathryn B Janda. More than filler: Middle actors and socio-technical change in the energy system from the "middle-out". *Energy Research & Social Science*, 3:102–112, 2014.

Karine Perset. The economic and social role of internet intermediaries. 2010.

Marina PP Pieroni, Tim C McAloone, and Daniela CA Pigosso. Business model innovation for circular economy and sustainability: A review of approaches. *Journal of cleaner production*, 215:198–216, 2019.

Friedemann Polzin, Paschen von Flotow, and Laurens Klerkx. Addressing barriers to eco-innovation: Exploring the finance mobilisation functions of institutional innovation intermediaries. *Technological Forecasting and Social Change*, 103:34–46, 2016.

Robinson Rai. Effective information channels for reducing costs of environmentally- friendly technologies: evidence from residential pv markets. *Environmental Research Letters*, 8(1), 2013.

Varun Rai and Scott A Robinson. Effective information channels for reducing costs of environmentally-friendly technologies: evidence from residential pv markets. *Environmental Research Letters*, 8(1):014044, 2013.

Varun Rai, D Cale Reeves, and Robert Margolis. Overcoming barriers and uncertainties in the adoption of residential solar pv. *Renewable Energy*, 89:498–505, 2016.

Agneta Ranerup, Helle Zinner Henriksen, and Jonas Hedman. An analysis of business models in public service platforms. *Government Information Quarterly*, 33(1):6–14, 2016.

Brian T Ratchford, Debabrata Talukdar, and Myung-Soo Lee. A model of consumer choice of the internet as an information source. *International Journal of Electronic Commerce*, 5(3):7–21, 2001.

Lee Ratchford, Talukdar. A model of consumer choice of the internet as an information source. *International Journal of Electronic Commerce*, 5(3), 2001.

James E Richardson. The business model: an integrative framework for strategy execution. *Available at SSRN 932998*, 2005.

Mario Richter. German utilities and distributed pv: How to overcome barriers to business model innovation. *Renewable Energy*, 55:456–466, 2013.

Harald Rohracher. Intermediaries and the governance of choice: the case of green electricity labelling. *Environment and Planning A*, 41(8):2014–2028, 2009.

Mitra Barun Sarkar, Brian Butler, and Charles Steinfield. Intermediaries and cybermediaries: a continuing role for mediating players in the electronic marketplace. *Journal of computer-mediated communication*, 1(3):1–14, 1995.

Stefan Schaltegger, Florian Lüdeke-Freund, and Erik G Hansen. Business cases for sustainability: the role of business model innovation for corporate sustainability. *International journal of innovation and sustainable development*, 6(2):95–119, 2012.

Chelsea Schelly. Residential solar electricity adoption: What motivates, and what matters? a case study of early adopters. *Energy Research & Social Science*, 2:183–191, 2014.

Akbari Shahsavari. Potential of solar energy in developing countries for reducing energy-related emissions. *Renewable and Sustainable Energy Reviews*, 90:275–291, 2018.

SolarReviews. Utility-scale solar: what is it, how does it work?, February 2022. URL https://www.solarreviews.com/blog/how-does-utility-scale-solar-work.

Benjamin K Sovacool, Bruno Turnheim, Mari Martiskainen, Donal Brown, and Paula Kivimaa. Guides or gatekeepers? incumbent-oriented transition intermediaries in a low-carbon era. *Energy research & social science*, 66:101490, 2020.

James Stewart and Sampsa Hyysalo. Intermediaries, users and social learning in technological innovation. *International Journal of Innovation Management*, 12(03):295–325, 2008.

Svensk Solenergi. Nu har 3 procent av svenskarna en solenergianläggning, August 2020. URL https://svensksolenergi.se/nu-har-3-procent-av-svenskarna-en-solenergianlaggning/.

David J Teece. Business models, business strategy and innovation. *Long range planning*, 43(2-3): 172–194, 2010.

David J Teece and Greg Linden. Business models, value capture, and the digital enterprise. *Journal of organization design*, 6(1):1–14, 2017.

Paul Timmers. Business models for electronic markets. *Electronic markets*, 8(2):3–8, 1998.

Peter C Verhoef, Thijs Broekhuizen, Yakov Bart, Abhi Bhattacharya, John Qi Dong, Nicolai Fabian, and Michael Haenlein. Digital transformation: A multidisciplinary reflection and research agenda. *Journal of Business Research*, 122:889–901, 2021.

Karl SR Warner and Maximilian Wäger. Building dynamic capabilities for digital transformation: An ongoing process of strategic renewal. *Long range planning*, 52(3):326–349, 2019.

N Winkel. Gemeenten op het internet, problemen en mogelijkheden, 2005.

Bernd W Wirtz et al. *Digital business models*. Springer, 2019.

Nira Yacouel and Aliza Fleischer. The role of cybermediaries in reputation building and price premiums in the online hotel market. *Journal of Travel Research*, 51(2):219–226, 2012.

Christoph Zott, Raphael Amit, and Lorenzo Massa. The business model: recent developments and future research. *Journal of management*, 37(4):1019–1042, 2011.

Appendices

A Interview questions

Following questions were given to the interview subjects. The interview was held in Swedish and the questions in the appendix has been translated to English. Questions were generally asked in the structured order. However, variations in regards to order and which questions were asked depending on the interview answer the interview subject gave on a previous answer.

Introduction

- Who are you and what do you do at the company?
- How would you describe what the company / organization does and what its purpose is?

Value proposition

- What does the company do within the framework of solar power?
- Which customers are you targeting?
  - How would you describe your customer segments?
  - Questions about customers:
  - What do your customers usually ask you?
  - What information is the most common that you give to your customers?
  - What do they usually need more advice on?
  - How long in the process of investing in solar cells do customers usually be when they come in contact with you?
- What (digital) services does the company offer?
- Why do customers use their services instead of:
  - To do it yourself and / or go directly to a supplier?
  - A competitor (if they exist)
    - Do you know who your biggest competitors are? Would you be willing to tell us what these are?
- Is there anything you do not offer but:
  - Want to offer?
  - Offer partners through collaboration?

Value creation and delivery

- Do you have any collaborations with other organizations or companies?
  - Who are they?
  - If not: is there any reason why you do not cooperate with others?
- What activities do you transfer / outsource to your partners?
- How do your partners most easily reach their / your customers?
- What channels do you use to interact and deliver value to your customers?
- How much of the business is in the digital sphere?
- What are the overall cost bearers that prevail for the business?

Value capture and discussion surrounding strengths and weaknesses

- How do you finance your business / how do you generate income for your business?
- What do you consider to be your business's greatest strengths?
  - How do you nurture these?
  - Are there additional opportunities that you see in your business?
- What are the biggest challenges in running the business?
  - How do you handle these challenges?
  - Is there anything that prevents you from reaching your goals / growing?

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

CHALMERS
UNIVERSITY OF TECHNOLOGY