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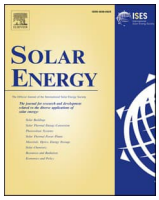

Business models for enhanced solar photovoltaic (PV) adoption: Transforming customer interaction and engagement practices

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ABSTRACT

Solar energy can play an important role in meeting global energy needs in a sustainable and environmentally friendly manner. However, despite solar energy's accelerated growth in recent years, its level of diffusion is highly uneven when looked at on a global scale. The solar photovoltaic (PV) companies involved in the sales of PV systems are central to fostering diffusion. A company's ability to devise and deliver value offerings that match customers' needs is vital in encouraging the adoption of solar PV technology. The extent to which a company can address market needs and deliver value often depends on the business model it has adopted. The extant research has explored business models based on ownership structures, financing options, the effect of regulatory regimes and policies, industry practices, alliances, and business models for distributed generation and large-scale utility companies. However, the research to date, has mostly neglected the business models of solar companies involved in the sales and installation of solar PV. This qualitative study based on twenty semi-structured interviews contributes to the existing knowledge by exploring how sales and installation companies can enhance solar photovoltaic adoption by transforming customer interactions and engagement practices, which is a key element of a company's business model. Companies' ability to communicate value offerings and address consumer concerns is important in enhancing diffusion. The study highlights that transforming customer interaction and engagement practices can help companies broaden customer reach, improve the dissemination of information, reduce transaction costs and efficiently utilise market insights and trends.

1. Introduction

Renewable energy technologies (RETs) can play an important role in meeting global energy needs in a sustainable and environmentally friendly manner. Countries across the globe are looking to adopt measures and ways to support their development and increase their share of the energy mix [3]. Solar energy, in particular, has the potential to be used in large-scale commercial facilities, as well as serving needs at the household level [4]. Its improved efficiency, decreasing price and supportive policy regime have made solar one of the leading forms of renewable energy in the world [5,6]. However, it is widely believed that this growth is far lower than its potential in most regions, and efforts should be made by all stakeholders to foster its development [7,8]. The widespread adoption and use of RETs is a complex and multifarious process influenced by a number of personal, socioeconomic, technical, market-related and regulatory factors [9–12]. The process is particularly challenging as the technology is disruptive in nature, and its successful diffusion requires changes in the existing structure and approaches as well as a change in mindset [13,14].

Solar Photovoltaic (PV) companies, directly involved in interaction with consumers, dissemination and sales, become an important actor in this regard [15–17]. Companies' ability to devise and deliver value offerings that match customer needs can play a vital role in encouraging adoption. Teece [18] suggests that the extent to which a company can address market needs and deliver value depends on the business model it has adopted. Business models direct a company's course of action, help channel resources, address challenges and provide opportunities for growth [19–21]. RET companies often face challenges in developing market-centric business models that can enable them to thrive independently [22,23]. A number of studies have explored business models for companies operating in the solar industry. However, an overwhelming majority of the existing research has focused on business

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models based on ownership structures [24–27], financing options [1,2], the effect of regulatory regimes and policies [28,29], industry practices [30], alliances [31], business models for distributed generation [32–34] and large-scale utility companies [22]. To date, the research has overlooked customer interaction and engagement practices in the business models of conventional solar PV companies involved in the sales and installation of solar systems [35–38].

Customer interaction and engagement is an essential element of a company's business model [20–22,39]. Companies constantly strive to make their offerings attractive to customers to cater to their interests and enhance their willingness to pay for the services offered [15,40,41]. This is particularly important in the case of disruptive technologies as they often bring value offerings that are novel to the market, and consumers may have limited knowledge and awareness about their use and benefits [14,42], making it challenging for companies to commercialise an innovation [10]. Solar PV companies, due to the high cost of the technology, limited awareness, the technicalities associated with its use, and the secondary nature of value addition often find it challenging to compete with the conventional solutions dominating the market [43–45]. Strengthening customer interaction and engagement can play a vital role in enhancing adoption by addressing some of the barriers decelerating its adoption.

To date, the research on customer interaction and engagement practices of conventional solar PV companies, involved in the sales and installation of solar PV systems, to a large extent, remains scarce. While some studies have touched upon and highlighted its role in enhancing adoption, there is a notable gap in the in-depth analysis and intricacies the subject demands. Research has revealed how customer relationship practices can help companies improve existing businesses by increasing customers' trust [36], improve customer retention [34], and serve as a tool to ensure long term growth and competitive advantage [46]. Cai et al. [32] and Hanon et al. [47] have highlighted how customer relationship practices could benefit by minimising operation costs and assisting companies in introducing new services and sources for revenue generation. Zanjirchi et al. [46] examined critical factors that could lead to successful customer relationship management practices. Rigo et al. [36] affirm that comprehensive post-sale services, ease of interaction [31] and quality of services offered could further contribute to strengthening relationships with customers [35]. The extant research highlights the importance of customer interaction and engagement practices. However, very little emphasis has been paid to how conventional solar PV companies can develop their customer interaction and engagement practices. This research aims to fill this knowledge gap by answering the research question: "How can solar PV companies, involved in the sales and installation of solar PV systems, enhance customer interaction and engagement practices?" We contribute to knowledge on solar PV business model by drawing from twenty semi-structured interviews with key actors. On a practical front, the study offers specialised industry specific insights and actionable recommendations for solar PV companies to transform and optimise their customer interaction and engagement practices. The insights gained from the research can help companies broaden customer reach, improve the dissemination of information, reduce transaction costs and efficiently utilise market knowledge and insights.

The rest of the paper is structured as follows: Section 2 introduces important theoretical concepts. Section 3 explains the methods, data and empirical setting. Section 4 presents the main results. The final section offers a conclusion, outlines the limitations of the study and provides suggestions for future research.

2. Literature review

2.1. Understanding value creation logic by using the concept of business models

Firms' success often hinges upon the value they create and the perception of this value by the outside world [48,49]. Organisations strive to optimise their internal processes and interactions with external partners to create and disseminate a value offering – in the form of a product, service or a combination of the two – to consumers in a manner that can generate revenue [50–53]. However, channelling resources, operations and partnerships in an optimal manner and enticing customers to pay for the companies' offering may not be as straightforward as it sounds. The literature is overwhelmed with evidence of inventions that fail to make an impact on the market due to the strategies pursued by companies [54,55]. Business models can serve as a tool to effectively commercialise new ideas and technologies [56]. Chesbrough [56] suggests that taking an invention to market through different business models yield different outcomes. Margretta [57] and Chesbrough [56] affirm that mediocre technology accompanied by a good business model is likely to generate more value than excellent technology with a mediocre business model. It is, therefore, important for firms to study the internal and external environment and frame core activities and tasks in a manner that can achieve success in the market [52,56]. A company's inability to devise a model that creates value for its customers by utilising available in-house and external resources, sharpening business processes, reducing costs and developing efficiencies is bound to struggle. An efficient business model can help companies to focus on the key aspects of the business and structure operations that can improve their chances of success [20,21].

Business models can be defined as the logic of how an organisation creates and captures value [20]. Business models have been the subject of scholarly discussion since the 1950s when the term started to appear during the internet boom [58]. However, in essence, business models are not essentially new or novel; they have always been an integral part of a company's operations. What may have changed recently is explicitly laying out a structured plan of processes and activities that companies can adopt to deliver value. Scholars have dissected different components of the business model. For instance, Christensen and Johnson [59] suggest that it comprises key resources, key processes, a value proposition and a profit formula. Key resources here refer to the competencies such as people, different tools and technologies, while key processes describe the activities relating to manufacturing, distribution and so on needed to create value for customers while allowing the overall costs and revenue to form a profitable equation for the business. Bocken et al. [19] defined the business model in terms of three principal elements: value proposition, value creation and delivery, and value capture. Richter [60] conceptualised business model components into four elements, referred to as value proposition, customer interface, infrastructure and a revenue model. Osterwalder and Pigneur's [20] business model canvas delineates organisational processes and operations into nine segments, namely: key partners, key activities, key resources, customer relationships, customer segments, channels, cost structure, revenue streams and value propositions, as the centre and core of all activity. Despite these varied conceptualisations and applications of business models, there seems to be a consensus that, at its core, a business model serves as a blueprint or operational manual for companies [18]. In the present paper, we have defined business models according to four main components (Fig. 1): value proposition, customer interaction and engagement, core activities and processes and revenue generation (Table 1) (adapted from [20–22]).

2.2. Emerging business models of solar PV companies

Business models are becoming an increasingly important topic in the context of renewable energy technologies. An increased emphasis on expanding the share of cleaner sources in the energy mix has stimulated the development of novel renewable energy technologies. However, their successful commercialisation hinges on their ability to compete with existing solutions. A decrease in PV prices over the past decade has led to a rise in the overall uptake of this energy solution. However, its diffusion has remained uneven globally [61]. A stringent monetary

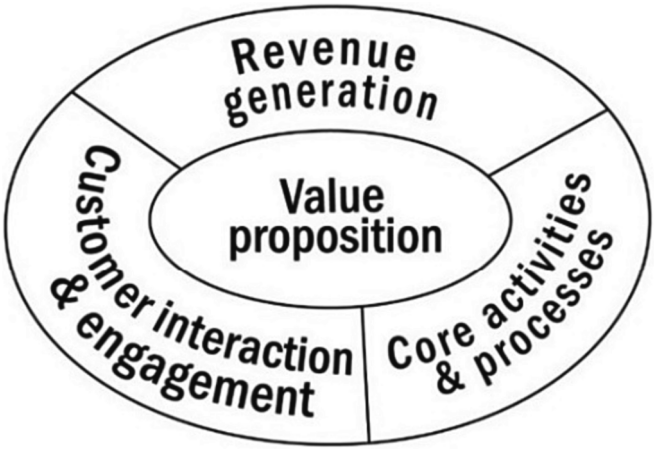

Fig. 1. Conceptual business model framework adopted from [20–22].

Table 1
Business model conceptualisation.

Business model component	Description
Value proposition	The value that a company offers to its customers in the form of products, services or a combination of the two
Customer interaction and engagement	The use of communication channels and set of activities a company need to carry out to market their product, interact and engage with customers
Core activities and processes	Set of activities and processes a company adopts in order to create value for the customers
Revenue generation	An equation of revenue generation and expenses incurred in order to create value

requirement and the prevailing socio-technical landscape highlight the need to adopt new financial instruments and solutions that make solar PV a competitive alternative affordable for people, enabling them to become part of this transition. This requires that companies look beyond the conventional model of sales–purchases and instead adopt innovative business models to create and capture the value to make solar PV attractive to consumers [62]. The business model perspective can serve as a catalyst for the diffusion of novel technologies by overcoming internal and external barriers [63] and offering insights into how solar PV companies can focus their value proposition on addressing consumers' concerns [62].

The literature has examined how different business models have facilitated the adoption of solar PV. Karakaya et al. [35] explored how solar PV companies operating in the local environment can transform their business model to thrive in new market conditions. Strupeit and Palm [62] suggested that the complementarity of additional services offered in product service systems models, such as maintenance, financing, extended warranties, consultancy and related services, can play an important role in enhancing value and enhancing diffusion. Huijben and Verbong [28] identified that business models providing different ownership structures facilitated the development and growth of distributed solar PV. Amus [64] suggested that adopting a community business model addressed infrastructural hindrances, making it cost-efficient for consumers to utilise solar PV. Schoettl and Lehman-Ortega [65] discussed the increasing role of utilities in building, owning and running PV sites when using a business model where consumers are connected to virtual power plants and can share revenues with producers and utilities. Zhang [2] suggested that those business models offering financing instruments are important for increasing the share of solar PV installation.

It is important to highlight that in each business model type, the financial consideration and extent of consumer involvement can vary, affecting the relationship between consumers and technology providers [66]. Consumers are an active part of the mix when they own or pool resources to build PV systems, whereas their role becomes somewhat passive in third party–owned business modes [28]. Moreover, many of these models are limited in their approach or scope. For instance, different ownership models offering financing solutions alone are primarily what Sauter and Watson [67] referred to as deployment models; these have very narrow orientations and have little to do with how a firm creates and captures value [68]. In general, there is an overall lack of understanding regarding how PV companies can transform their operations to create value. These value creation and capturing aspects are particularly inevitable because PV companies' business models are heavily influenced by the unexpected risks and opportunities created by policy measures [69]. Therefore, it is pivotal for companies to remain agile and strengthen their business model innovation capabilities to transform in response to external market changes [34].

2.3. Customer interaction and engagement in the context of solar PV

Customer interaction and engagement is an important aspect of a company's business model [20–22]. It refers to how companies interact and maintain relationships with their customers; it involves the means through which companies disseminate a message to their target market and the strategies and processes they employ to build, maintain, improve and capitalise on these relations. Customers are the key resource to a firm's profit growth. Understanding customers' needs and offering value-added services are often recognised as the factors determining companies' success or failure [70]. In a competitive business environment, companies constantly strive to adopt ways to keep their customers engaged [71]. A strong customer relationship can help companies excel on various fronts [71–73]. It can serve as a tool for companies to gain a competitive advantage by differentiating it in the marketplace and making it attractive to customers [71]. Customer engagement can add value by creating a feedback loop that can help ascertain a deeper understanding of customer preferences and behaviours, insights on improving existing products or services and devising new offerings to serve customers' needs [71]. Furthermore, it can lead to customer loyalty, retention and profitability [72]. A customer's overall positive experience manifests in future purchases, feedback and references while strengthening the company's brand name through positive word of mouth [71,74]. This has become particularly important in the digital and social media age, where positive word of mouth could lead to positive customer influence [75]. Customers are increasingly using different online and social media channels to share their experiences [74]. A positive experience can create a ripple effect that extends beyond their conventional network and marketing channels, increasing companies' reach, minimising marketing costs, building trust, strengthening companies' images and solidifying sales.

Customer interaction and engagement become significant in the case of disruptive technologies because they bring value offerings that are novel to the market, and consumers may have limited knowledge and awareness about its use and benefits. Solar PV due to its high cost, technical nature, being at earlier phases of adoption and the secondary nature of the value addition, often faces challenges regarding its widespread adoption and use [43,45]. This warrants additional efforts on the company's behalf to raise awareness, address consumer inertia and strengthen trust in the technology and the company's offerings.

3. Methods and data

This research has employed an exploratory qualitative research design. The methodology is a particularly interesting and suitable mode of enquiry as it provides an inquisitive lens to explore the subject while studying the phenomenon in a natural setting [76]. Business models for solar PV companies are a rapidly evolving phenomenon. The chosen method offers an opportunity to examine subject matter without pre-

conceptualised hypotheses or assumptions and to follow an appropriate path to reach justified outcomes [77]. The study has used a purposeful sampling approach to select informants [78]. The rationale behind this approach is based on the assertion that transforming a business model is a complex and multifaceted process, involving a range of actors and stakeholders, both within and outside the organisation. Although from a strategic perspective, devising a business model is an internal action, however, the factors shaping the process could be influenced by companies' internal operations and practices, collaboration and interaction with external parties, the market in which the company operates, the outside environment or regulatory regimes that directly or indirectly influence the company's operations and the industry as a whole. Therefore, rather than limiting our scope to a company as the sole unit of analysis, the study has incorporated other actors and stakeholders to gain input and practical insights into factors that have the potential to influence the process [10,79]. The list of interviewees includes solar PV companies involved in installations and selling equipment, distributors, experts from utility companies, consultancies, industry and academia; and customers (See Table 2 for the list of interviewees). To identify respondents, we explored the list of companies and relevant actors involved in solar PV in Finland and invited them to participate in the study. In addition, we employed a snowball technique, seeking suggestions from the informants on who they thought might be suitable participants to further explicate the subject [80]. The incorporation of a range of informants helped us gain an in-depth understanding and develop a comprehensive picture through listening to diverse voices and analysing the phenomenon through a range of lenses.

Table 2
Overview of respondents, affiliation, duration and mode.

Interviews	Designation/ Role	Affiliation	Combined industry experience	Duration (Approx. in hours)/ Mode
Interview 1	President & CEO	Company	+15 years	1 h/ Telephonic
Interview 2	Sales manager	Company	+15 years	1 h/Online
Interview 3	Manager, Business affairs	Company	+20 years	1 h/Online
Interview 4	CEO	Company	+20 years	0.5 h/Online
Interview 5	Manager marketing	Company	+15 years	1 h/Online
Interview 6	Group manager, B2C Sales	Company	+25 years	1 h/Online
Interview 7	CEO	Company	+20 years	1 h/Online
Interview 8	Partner & Director	Company	+15 years	0.75 h/ Online
Interview 9	Director, Energy unit	Distribution company	+20 years	1 h/Online
Interview 10	Development manager	Utility company	+15 years	1 h/Online
Interview 11	Development director, Energy and Infrastructure	Consulting	+20 years	0.5 h/Online
Interview 12	Director energy	Consulting	+20 years	1.25 h/ Online
Interview 13	Director, Head of energy unit	Consulting	+15 years	1 h/Online
Interview 14	Executive director	Advisory services	+25 years	1.5 h/Online
Interview 15	Specialist, Energy affairs	Advisory services	+10 years	1 h/Online
Interview 16	Managing director	Advisory service	+15 years	0.75 h/ Online
Interview 17	Industry expert	Consulting	+10 years	0.75 h/ Online
Interview 18	Industry specialist	Academia	+30 years	1.25 h/ Online
Interview 19	Customer	households	–	0.5 h/ Telephonic
Interview 20	Customer	households	–	0.75 h/F2F

Primary data were collected in the form of 20 semi-structured interviews conducted online using Zoom or Microsoft Teams, except for two conducted by telephone and one face-to-face interview. On average, interviews lasted approximately one hour, and were recorded for the purpose of transcription. Respondents were informed in advance of the subject of the discussion and given a list of key topics and questions on which the interview would be based. Likewise, they were briefed about the use of information, anonymity issues and the storage of personal data before the formal start of the interview. Primary data were substantiated with secondary sources, including companies' websites, industry resources and reports, previously published literature, local magazines and newspapers, and other grey literature. A data triangulation approach was employed to ensure accuracy and to obtain a detailed and balanced picture of the situation [81].

Data analysis was carried out in multiple steps following the approach detailed by Gioia et al. [82]. The process initiated with an open-coding approach to construct generic categories emerging from the data [82,83]. Inductive coding helped identify relationships between the data, emerging themes and the existing literature. The coding process was repeated until new connections emerged, codes were refined and the data saturation point was reached [84,85]. The analysis then moved to the next phase where second-cycle axial coding was conducted to generate second-order themes [82,86]. This helped reduce the number of code units and enabled us to identify general categories relevant to the analysis. The last step consolidated the second-order themes into logical groupings to form aggregate dimensions and a more formalised view of relationships between dimensions [82,87]. Appendix 1 and Fig. 3 depict the iterative process and data structure to illustrate the process of analysis from raw data to concepts and themes [82].

3.1. Empirical setting

Finland is chosen as the context of the study as it offers an interesting and rich empirical setting to explore the phenomenon. Finland's solar PV market is in an early phase of development. Conventionally, since it is located in northern Europe and experiences long, cold and dark winters, Finland has been considered a less suitable place for solar energy utilisation. However, assessments suggesting that radiation levels and generation potential match some of its European counterparts, together with successful generation from local installations, have reinforced the potential role of solar energy in increasing the share of renewable energy generation [88]. Estimates suggest that solar energy consumption has grown more than twentyfold for the period 2015–2019, and this trend is likely to continue in the foreseeable future [89]. The Finnish Energy Authority's (Energiavirasto) figures suggest that Finland had reached 635 MW of installed capacity connected to the distribution network by the end of 2022 (Fig. 2) [90]. In practice, the grid connected market opened in 2016, and the growth has been most significant during the last four years. To this end, a substantial proportion of existing growth has come from detached houses and large-scale industrial installations; however, the consumer market has started to grow in recent years, and their share is likely to expand because of recent changes in the regulatory regime allowing for the formation of local energy networks or energy communities [91]. A number of factors have contributed to this recent accelerated uptake of solar PV. For instance, the recent increase in electricity prices is one of the driving factors. The electricity price in Finland has remained relatively low in recent years in comparison to other European countries. Between 2016 and 2023, the average price has increased from €0.16 to €0.23 per kWh, which is below the EU area average (€0.29 per kWh in 2023) [92,93]. Likewise, the overall reduction in solar PV system prices has also played an important role in this regard. During the period of 2016 to 2021, the price of a typical detached home installation (with a size of 5–6 kWh) has decreased from €1.6 per kWh to a range of 0.8–1.13 kWh (VAT 0 %) [94].

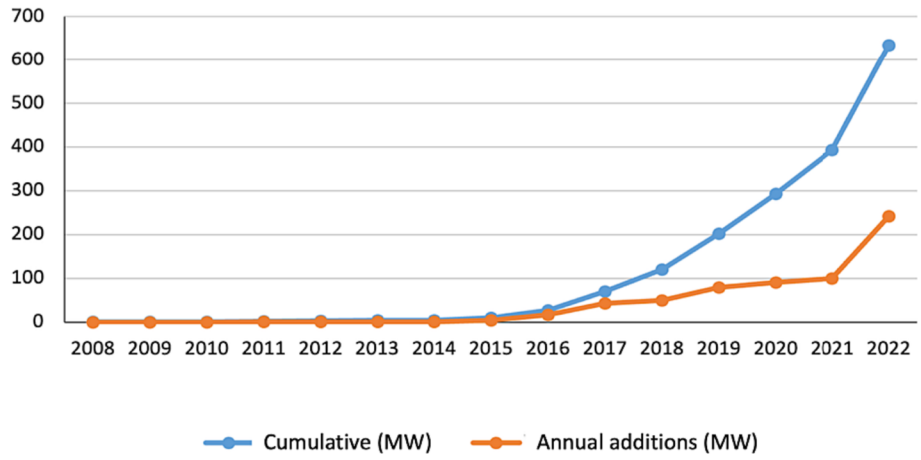

Fig. 2. Development of installed PV capacity in Finland. Source: Energy Authority of Finland.

The concept of an energy community involves a property, a number of houses or apartment buildings forming one unit to set up their own energy production and distribute electricity to their members [95]. Currently, more than two million Finnish residents live in apartment buildings [96]. Their inclusion in the nexus potentially means that companies have a larger segment of the market to serve, with different needs and requirements.

This potential growth of the domestic market has led to an increase in the number of companies operating in the market. Motiva's figure suggests that the number of companies has increased from 144 to 206 between 2019 and 2022 [97]. This growth is also driven by the fact that the PV market is highly lucrative and relatively straightforward to enter. For vendor companies involved in solar PV sales and installation, entry to the market is generally not restricted by requirements of substantial initial capital, research and development capabilities, huge infrastructural needs or a sizeable workforce. Most of the equipment, including panels, batteries, meters and inverters, can be purchased or imported from other local or international companies. All a new solar PV company needs is to find the right partners to provide the equipment, identify customers and start selling. This increase in the number of solar PV companies also means that the market is becoming increasingly competitive, as small players often compete on price, consequently reducing margins and profits. Therefore, to succeed, companies need to expand their customer base at the lowest possible costs.

4. Results

The result highlights that transforming customer interaction and engagement practices can help companies broaden customer reach, improve the dissemination of information, reduce transaction costs and efficiently utilise market knowledge and insights (Fig. 3).

4.1. Broadening customer reach

4.1.1. Effective means to reach customer

Companies need to adopt effective means to reach customers. Conventionally, in the early phase of market development, many companies have relied on direct approaches to reach customers through door-to-door sales, telephone marketing or similar measures. The approach worked for some but has largely been a difficult endeavour for companies seeking growth and high sales volumes due to the effort and cost involved in materialising a single sale. As one group sales manager suggested: *"It was quite common for companies to directly reach out to customers. This seemed to have worked as companies were able to generate sales. … However, companies soon realised that the process is too labour-intensive and is costing too much, mainly in terms of labour hours."* On the other hand, the expense of conventional mass media marketing makes it unaffordable for companies operating in the PV sector. The manager further suggested, *"…. for the vast majority of companies, the use of media such as electronic and print media has been out of reach. Companies selling solar systems are hardly of a size to afford such a thing [medium]."*

The financial limitations and the need to disseminate the message to wider society warrant companies to devise alternative approaches and measures to address this issue. The use of digital media and social media offers an excellent opportunity for companies to address the problem efficiently. The low cost, high reach and interactive nature of social media make these channels desirable for reaching customers [98]. However, as of now, a large majority of companies still use conventional means to reach customers. As suggested by a consultant, *"I am surprised how little companies have used social media to target customers. There is huge scope."* This was further affirmed by a CEO who has utilised social media to market solar systems, *"We were among the very few who have run campaigns on social media, and we were surprised by the positive response we got."*

In addition, companies can use social media as a means to interact with consumers [99,100]. Participating in online discussions, being part of the wider online community and sharing expert advice and opinions are not only effective ways to increase visibility but can also provide companies with invaluable insights that are vital for devising market-centric offerings [98,101].

4.1.2. Interactions with and through intermediaries

Companies should seek to engage with intermediary actors who can help foster the diffusion process by acting as a bridge between technology providers and adopters [102]. The widespread diffusion of solar PV in apartment buildings and connected homes necessitates companies to transform their approaches to effectively reach out to this segment of the market. As suggested by one consultant, *"The decision-making here [at apartment buildings or network households] is going to be so cumbersome, bureaucratic and time-consuming that it might frustrate companies who are generally eager to close the deal at the earliest possible."*

As opposed to individual customers, the decision-making authority in apartment buildings or connected homes often lies in the hands of the housing manager and its board members. As suggested by a household, "… *As a resident in a connected housing unit, the decision to opt for a solar system at the [housing] unit is not of mine or anyone else [another resident] alone, but of the housing board who overseas issues at the housing.*" Companies face challenges in developing more personalised approaches, requiring engagement activities extending beyond individual consumers that consider the use of local housing associations and decision-making groups acting as intermediaries on their behalf [103]. A marketing manager echoes these concerns, "*Getting to know who is the person in*

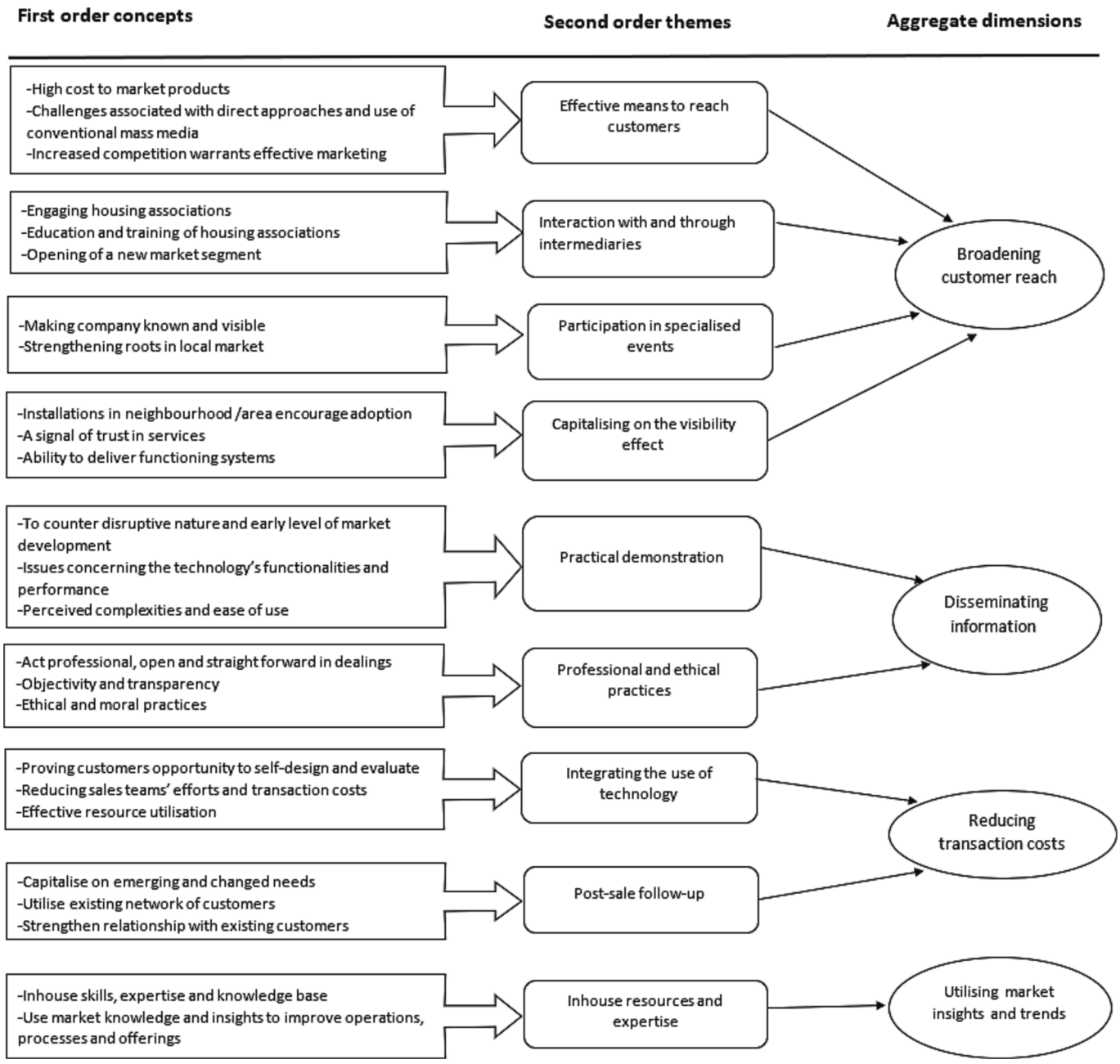

Fig. 3. Data structure.

charge of the decision-making in a housing cooperation, finding their details, reaching out to them, so on and so forth seems a bit difficult. With these GDPR rules, less and less information is available or can be utilised. So, it is a challenge."

The challenge is particularly daunting in the early years, as only a limited number of housing associations are familiar with the possibilities and benefits of such networks. It may require significant effort and awareness on the part of companies to interact with intermediaries to close a deal. As suggested by an advisor, "*There are many reasons why the development of energy communities is not accelerating at the pace it was initially expected […] and one of the leading factors is limited awareness and understanding about these among the housing associations and boards.* Once these communities or networks of households are established and gain visibility, they are likely to break down barriers, making it easier for others to follow.

4.1.3. Participation in specialised events

A presence at specialised trade exhibitions, industry events and sessions focusing on environmental and sustainability issues can make a company known in the local market. As suggested by one company director, *"Being a small company with a limited budget, we had this challenge of making ourselves known. Being there [trade events and exhibitions] offers an opportunity to interact with hundreds of new people and local ecosystem actors during the course of a two-three days event and have a lot of interesting and valuable exchanges."* These events and sessions generally attract interested individuals, and a company's representation can serve as a valuable point of interaction with prospective customers. The technical and costly nature of PV systems often encourages consumers to do business with companies that can be trusted and are easily accessible [35]. Participation in such events can also help companies to become known in a local area. As affirmed by the consultant, *"People are generally very cautious about whom to buy from, particularly if the company*

is small or relatively unknown. Being visible at the event certainly makes companies familiar in the local market." A household also echoed, "*For me, it has always been easier to deal with someone who I know or have interacted with in one way or another. Trust and confidence are certainly higher if you are familiar with a company compared to one who has only tele-marketed you their product.*"

4.1.4. Capitalising on the visibility effect

The visibility effect plays a vital role in fostering the adoption of solar PV energy [104]. Companies can benefit from following interactive approaches to benefit from existing or planned installations. A major part of the solar PV installation is carried out outside of homes, and the installations are often visible to the residents of neighbouring houses and the wider community. A company can benefit from this visibility effect and use it to its advantage to increase sales within the area [104,105]. As suggested by one company CEO, *"An interesting thing attributed to the PV market is how quickly its sales can grow in one area. Lets' say, if we are making installations in a particular neighbourhood, we do not see this as a single isolated act, rather as an opportunity to cash in more sales and potential installations in adjacent homes and streets."* This view is echoed by another sales manager, *"… In addition, what we frequently do is visit the site few days after the installation to interact with neighbouring homes, explaining that we have made installations in their area and, if they are willing, we can make them the same offer."* A household also asserted, "*… I had heard a lot about solar systems previously as well. However, I personally had never given it [using solar PV at home] a serious thought, unless I saw a PV system being installed in our neighbourhood. It gave me confidence, and I said to myself, that since it [the solar PV system] has worked next door, this might work for me as well.*" The sale at one premise creating new leads and potential sales could be due to a number of factors, including the visibility effect, peer effect or social influence [43,106,107].

4.2. Disseminating information

4.2.1. Practical demonstration

The complexity associated with PV systems and the concerns around technological functionality, ease of use and the potential of generating electricity can be effectively addressed by providing prospective customers with an opportunity to experience the technology first-hand [108]. For instance, a possibility of visiting a site to experience how the technology functions is likely to increase consumers' familiarity with the technology and raise their level of trust in it, thus making it easier for them to make a purchase decision. As shared by the household, *"It was not until I had a chance to visit a place that had a solar system installed [at the premises]. I went there, saw it [the system] functioning with my own eyes, [and] figured out how easy it was to use. The visit just paved the way for me."* A consultant also affirmed, *"If you see from a consumer perspective, the stakes are really high for a common household. The high price and the financial commitment are often a barrier, especially, if they do not know what the outcome will be (if it will fully serve their needs or not). Having experienced this first hand certainly helps in understanding and raising confidence."* Companies can organise visits where prospective customers are offered an opportunity to experience the technology in the real world. This can practically be done by developing a model site for customers to experience the technology themselves [35]. This measure, in addition to offering a practical demonstration of the panels, is likely to raise interest and curiosity among the general public by encouraging them to visit the site and see how it might feel to have this technology at their premises. A high number of visits also means a higher visibility for the company and an opportunity to interact with potential customers.

4.2.2. Professional and ethical practices

The technical features of solar PV systems are often too complex for ordinary householders to understand on their own. Therefore, they often rely on experts when seeking relevant information to help them make a decision, for instance, the number of panels needed to ensure optimal generation at a site, the savings the use of the system can yield or other related considerations. Therefore, companies must offer thorough advice and remain realistic in their claims about the technology's functionality. It has been observed that, at times, systems have been sold to residents by making promises about their use and generation potential, which have later proved to be factually incorrect. As suggested by one marketing manager, *"We came across individuals who got quotations from other companies or actually got [purchased] a system, and they were told that the system would generate certain kilowatts, but the actual performance was much lower than what was promised. Looking deeply, we can very easily see that these [customers] have been given incorrect information… apparently, only to make sales."* A sales director echoed this experience, "*… and some customers are tired because of the situation [inaccurate/false claims] and are not willing to buy at all because they don't know what to believe. And then all of us in the business suffer from this situation."* The advisor also echoed these concerns, *"The general perception in the market is that you [consumers] should do your [their] own research rather than just relying on everything that is fed by the sales personal."* The household explained, *"You do not know who to trust. Often, these companies will not tell you what the truth is but what would actually make you buy the system. We [consumers] are often bombarded with information about something we know very little about. And if it turns out to be far from reality, it impacts confidence and trust in the seller"*. Such experiences tend to make people reluctant and hamper their trust in the company, the technology and the industry as a whole. It is, therefore, important that companies adopt cautious approaches and promote practices that are based on professional, ethical and moral principles.

4.3. Reducing transaction costs

4.3.1. Integrating the use of technology

The technical nature and huge financial commitment attached to the purchase often make the sale of solar PV a labour-intensive process. The total time spent discussing technical and economic aspects with potential customers compared to the actual sales often creates a less profitable equation for companies.

The sale of solar PV is highly dependent on a number of factors, including the generation potential at the customer's premises, the cost of system installation, the value to the consumer (economic, emission reduction, energy-saving etc.), perceived complexity and trust in the technology [43]. Consumers often want to understand these issues more deeply before making a purchase decision [43,45]. Effective use of digital tools can help companies to address this problem. The use of location data to estimate the generation potential of the site and potential savings could serve as a good starting point. Such assessments can also help companies to develop a basic understanding of a customer's needs and devise a value offering that better matches these needs, consequently reducing the time and effort needed to finalise a sale. As one CEO suggested, "*I think there are very few companies out there that can install a small PV system at less costs than it takes them to sell the system. Companies need to cut these costs. One way is to minimise the role of humans and make systems efficient, open and transparent by utilising new technologies. Sales personnel should only chip in at the final stage and not the other way around."* A director of a solar PV company made a similar suggestion, *"something that we are considering doing is to develop an interface for customers where they can kind of design the system themselves. More specifically, they should be able to assess system price and size according to their needs."* The household shared his opinion on the possibility, *"The idea that we can do it ourselves, and can make necessary calculations on our own sounds great"*. Companies' websites can serve as a valuable tool in this regard. Providing prospective customers the opportunity to feed in basic information to gain a preliminary assessment could be an excellent way to reduce transaction costs.

4.3.2. Postsale follow-ups

Solar panels are often sold as a turnkey solution that can operate without excessive repair and maintenance needs. However, setting periodic post-sale follow-up visits can be a good way to maintain a bond with the customers and pave the way to discuss potential needs and offer complementary solutions [109]. As expressed by the group sales manager, *"Typically, after a year or year and a half, we approach customers to ask about how the system is functioning and whether their needs have changed, if they need more panels or any complementary solutions."* Consumers often start with the basic installation and once additional needs emerge, such as energy storage, the installation of electric-charging units for electric vehicles, or other upgrades, the company naturally becomes the preferred choice due to its established relationship with the customer. As stated by the household, *"If I am happy with the technology, price and services offered, why would I want to try someone else."*

4.4. Utilising market insights and trends

4.4.1. In-house resources and expertise

Companies can benefit from adopting an agile approach. The early phase of market development and changing market dynamics require companies to remain proactive and use market knowledge (knowledge of tech trends, competitors, regulation etc.) and insights to transform their operations and value offerings. The ability of a company to act optimally is often influenced by in-house resources, skills and knowledge base [110]. Currently, a large majority of companies seem to lack the required resources and expertise. As suggested by an industry consultant, *"Many of the companies are doing things in a conventional manner mainly because they do not have the resources to do it in any other way. Companies need to pay close attention to developing in-house expertise that can make them work in an agile manner and remain ahead of the competition."*

This problem may be due to the fact that a substantial majority of the companies operating in the industry are of relatively small size, with limited resources. Many do not even have a dedicated team for marketing, distinct from those responsible for carrying out sales activities and basic installation work. This, at times, can leave little scope to implement new initiatives and things that are somewhat novel and require effort in learning and execution.

4.5. Customer interaction and engagement practices: perspectives across different respondent groups

The results highlight a number of factors that companies need to transform in order to effectively transmute their customer interaction and engagement practices. These factors range from broadening customer reach, improving the dissemination of information, reducing transaction costs, and utilising market insights and trends. The qualitative analysis, based on interviews with a diverse group of informants, has helped us gain an in-depth understanding of how companies can transform their customer interaction and engagement practices by listening to different voices and analysing the phenomenon through a range of lenses. However, the diversity within the respondents also necessitates deeper analysis to understand varying preferences on how actors highlight importance of different customer interactions and engagement practices, as well as the similarities and differences across the respondent groups. Table 3 presents a quantitative analysis of responses provided by different groups of actors and stakeholders. The rationale behind dissecting the responses and presenting a detailed account of the answers lies in the recognition that each group brings different expertise, experiences, preferences, and expectations to the discourse of customer interaction and engagement. For instance, in the case of companies, informants consistently ranked broadening customer reach as an important factor. However, the consultants have also emphasised aspects such as interaction with and through intermediaries, professional and ethical practices, developing inhouse resources and expertise, and integrating the use of technology as equally important. Likewise, households have recorded high importance for professional and ethical practices, post-sale follow up, and integrating the use of technology. However, they have not accorded the importance to improving market reach or developing inhouse resources and expertise. The distinct factors highlight the multifaceted nature of customer interaction and engagement and emphasize the importance of integrating diverse voices to the analysis to fully understand the complexities and nuances of the subject.

The colours employed within the table signifies the collective importance accorded by respondent groups to various factors. In an instance when a respondent considered a factor of high importance, it was scored as 'three', while the factor that has little importance was scored as 'one'. Factor regarded as moderate important were scored as 'two' while 'zero' was assigned to a factor that was stated as not important. Each interviewee's responses were recorded in the table based on the answers provided. For instance, in the case of 'company one', effective means to reach customers was considered of high importance, so it was accorded 'three' while integrating the use of technology was assigned 'one', since it was regarded as little important. Likewise, in the case of 'household one', professional and ethical practices were stated as of high importance, so it was accorded the score of 'three', while inhouse resources and expertise was not considered important, receiving the score of 'zero'. Once all scores were assigned, respondents were grouped together, and their scores were averaged. The average score of all companies was then amalgamated into the final table to streamline and simplify the presentation of results. This process was replicated for each group of respondents. Once each factor has

Table 3
Significance of customer interactions and engagement practices across respondents.

	Broadening customer reach				Disseminating information		Reducing transaction costs		Utilising market insights and trends
Respondents Category	Effective means to reach customer	Interaction with and through intermediaries	Participation in specialised events	Capitalising on the visibility effect	Practical demonstration	Professional and ethical practices	Integrating the use of technology	Post-sale follow-up	In-house resources and expertise
Companies	3	2	2	2	2	2	1	2	1
Distribution and utility companies	2	1	1	2	1	2	2	2	1
Consulting	3	3	2	2	2	3	3	2	3
Advisory services	3	2	1	3	1	3	3	2	3
Academia	3	3	1	2	1	3	3	2	3
Households	0	2	2	2	2	3	3	3	0

3-Highly important 2-Moderate important 1-Little important 0-Not important

received a score from zero to three, the numbers were then replaced with the colours to enhance visual comprehension and facilitate better readability. The specific colours corresponding to their respective scores are outlined in the index for ease of reference and interpretation.

5. Discussion and conclusion

Business models are becoming an increasingly important topic of discussion in today's competitive and rapidly changing business environment [18]. The literature has shown how effective business models have enabled companies to increase market share and gain a competitive advantage. The disruptive nature of solar PV technology, limited awareness and high financial requirements often make solar PV disadvantaged compared with its competition [43,45]. A market-centric business model can help solar PV companies address consumers' concerns while offering solutions to enhance its adoption. Studies have examined different business model types and the diffusion of solar PV [2,23–25,111]. However, to this end, very little attention has been paid to how a specific firm can create and capture value by transforming its business models. This study contributes to the solar business model literature by providing new insights into customer interaction and engagement aspects, which is a central part of the solar PV companies' business model. Our analysis reveals that effective customer interaction and engagement can help companies broaden customer reach, disseminate information, reduce transaction costs and effectively utilise market insights and trends (Fig. 4).

Solar PV companies can transform their customer interactions and engagement practices on multiple fronts. The first suggestion concerns the diversification of channels to market the technology. The high cost of conventional mass media and challenges in directly reaching customers highlight the need to transition to a medium that offers a wider reach at an affordable cost. Digital and social media platforms offer an excellent opportunity for solar PV companies to increase their market reach without excessive financial burden [98]. Social media is increasingly used to market products [101] and could serve as an ideal medium for solar PV companies. Likewise, establishing interactions with and through intermediaries [102] and participation in specialised events such as industry or trade exhibitions can also offer a useful platform to reach prospective customers in the local market, develop trust and gain visibility.

Second, the disruptive nature of solar PV—which has perceived complexities and issues associated with its use—often leads to consumer inertia and decisional procrastination [45]. Companies' customer interaction and engagement practices can address issues inducing consumers' reluctance and decelerating its adoption. Companies can set up model sites for prospective customers to experience the technology [35]. Similarly, the use of social media and online portals to share statistics from existing installations can highlight the practical demonstrability of the solutions, increase the level of awareness and mitigate concerns surrounding the practical utility of the technology. Furthermore, there is the potential for companies to develop an in-house culture and values grounded on strong professional, ethical and moral principles. Solar PV's novel features and technical aspects often mean that prospective consumers may not be fully aware of system specifications [10]. Therefore, it is important that companies adopt clear and open communication with customers about what the technology can and cannot deliver, ensuring that systems are not sold on promises the company cannot fulfil. Promoting good practices will not only play a role in strengthening the company's brand name and encouraging word-of-mouth publicity [74], but it is also likely to improve trust and confidence in the technology in general and the industry as a whole.

Third, companies can adopt various ways to reduce transaction costs incurred during customer relationship practices. This could be done by incorporating digital technologies and tools during sales process [112,113]. Consumers are often concerned about energy generation potential, optimal system size, costs and amount of savings and the monetary benefits the installation can yield [43,45,114]. Information on the potential energy generation at a site using location data, the optimal system size and the estimated cost of the system assessed through the use of automated tools can serve as a useful starting point for consumers to obtain the required information, thus reducing the transaction costs. In addition, companies should seek to capitalise on the existing customer base. The use of solar PV tends to spread rapidly in the area to which it has been introduced [107]. Utilising existing installations to identify new potential customers, maintaining relationships with existing ones and following up on changing needs or requirements for complementary solutions can all strengthen interaction and engagement [109].

Fourth, in addition to strengthening external customer relationship practices, companies can benefit from paying closer attention to developing in-house skills, knowledge and expertise. Most companies in the

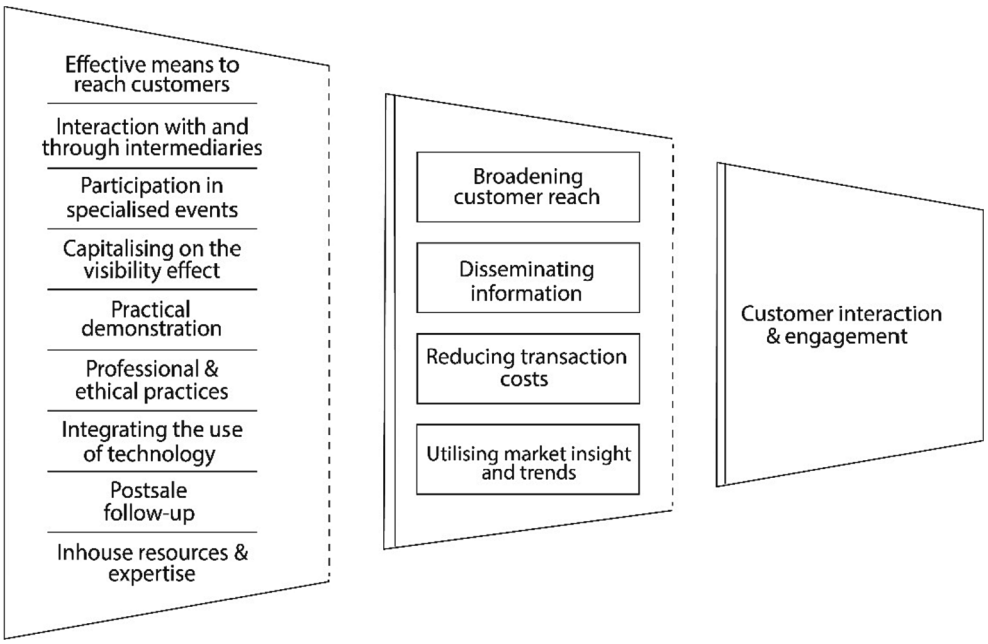

Fig. 4. Transforming customer interactions and engagement practices.

industry lack expertise in marketing; their operations rely primarily on individuals carrying out sales activities alone. This lack of expertise often influences the whole value chain and impacts the company's ability to benefit from market insights and information that could otherwise be of value [115]. Developing in-house capabilities can help companies create and capture customer value.

The present study has a number of limitations that should be taken into consideration. First, the research was carried out in Finland. Although the context offers empirically rich and unique case material to study business models for PV companies, socioeconomic considerations, demographic factors, market dynamics and regulatory regimes may differ significantly from within other countries. Therefore, these findings should be generalised with caution in different contexts. Second, the study focuses on how companies can transform their customer engagement and interaction strategies, representing only one business model element. Future research should consider other components to offer in-depth insights and a holistic understanding of transforming business models. Moreover, a successful business model transformation depends on company resources and relevant capabilities to plan and execute alterations. Future studies should probe companies' existing capabilities and their impact on business model transformation. Third, the present research has limited its scope to household customers only; future studies should examine large-scale commercial actors and business-to-business customers.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix 1. Illustrative quotes

Themes	Illustrative quotes
Effective means to reach customers	(-) There are companies still doing this [direct selling], but these are mainly small companies and many of the big players who initially followed this track gradually opt out of it (int_1) (-) The very little advertisement we have seen, let's say on tv, has been by big companies for whom solar PV is one part of the product mix. This just cannot work (int_13) (-) We did some calculations, and this [direct selling] did not sound like a wise thing for us to continue doing. So, we quickly changed the system. We no longer call or knock people's door. We want people to reach out to us, explore our website, discuss with our sales team. We certainly need different approach for that (int_1) (-) Though sales are increasing as more people are buying solar but at the same time margins are shrinking, because of tough competition in the market. We need to find a good way to reach customers (int_4) (-) You [as a company] need to reach more people and somehow reduce the time spent in selling a system. You have to have a way to do mass marketing…using digital and social media is the future (int_11)
Practical demonstration	(-) The average system for a household costs tens of thousands. It makes the purchase decision a big thing for a normal family. If they are familiar with the system, have used it at their summer home or have been to a place [where solar system was installed], it kind of removes very many basic level barriers that are related to the technology itself (int_12) (-) Letting them see for themselves is one way to minimise people fears (int_17) (-) There is no better thing than experiencing it by oneself. It looks technical but it is fairly easy to use once its installed and functions in routine (int_20)
Integrating the use of technology	(-) …Most of the time our sale team spend with the potential customers is mainly on discussing issues related to 'how much the system would cost?', 'the change in price if we add or reduce number of panels?', 'how much electricity can be generated at my home?', 'how much money it can save me?'. These are important considerations for the customers… I can say from the experience that it really helps if consumers are aware of these issues, or at least have some basic understanding of these. It makes discussion meaningful, saves a lot of time and enable us to make offers that suits their need. I see the potential use of new technologies as a facilitator in the process by making it efficient (int_8) (-) …Though customers are unlikely to buy without talking to real persons [sales people], but it would be easier if they have done this kind of background work by themselves, they know the pricing and other details [through an online platform] (int_1) (-) So many people are not aware of the potential of the PV system in their own house and how they can efficiently use the system…. Everybody uses internet these days, if companies can provide right mechanisms and tools, and encourage people somehow to use that (at their convenient time), it may increase the interest in future buying (int_3)
Interaction with and through intermediaries	(-) We see the new possibility [to form energy community] as a great leap in the market and would definitely boost the use of solar. However, this also pose a number of challenges. Mainly in terms of making the noise around this and engaging [housing] cooperation. (int_4) It's quite difficult because how to bring the information to the housing companies and the decision makers there. We need to have another layer of actors in between (who are closer to the consumers) to facilitate the process (int_15) (-) … So, I believe, the best would be to educate the boards and design services package that put less burden on the housing association (int_15) (-) …and once with all your efforts you managed to get to the right person [in housing association], have had a successful discussion and they are interested, in most of the cases, they are not going to order straight away, but might rather ask [for quotations] form maybe three four companies and will go with the one that probably is cheapest, or suits them best. Your company might have done all the efforts, paved the way, but it is actually someone else who have benefited. We are currently trying to figure out what kind of routines or practices should be adopted, especially in the early phases (int_2)
Capitalising on the visibility effect	(-) …If we have done installations somewhere. Of course, it's encourages people to buy from us because somebody else has done it. That's how people's minds work. They see others have gone through the process, it is working well, so they want the same thing (int_1) (-) …What could be a better way to show your performance than the system that functions flawlessly, which people can see themselves in their area (int_5)

(*continued on next page*)

(*continued*)

Themes	Illustrative quotes
	(-) …We do frequently hear that we have seen solar panels at our area or a nearby home that encouraged us to buy… These installations are becoming more common now compared to the past, it makes them [people] believe in technology. Seeing it functioning at neighbours' place kind of ensures that it is definitely going to work at their place as well (int_8) (-) …Often during the time of installations or afterwards we do get inquiries from the residents of the area about the perspective installations at their sites (int_5)
Postsale follow-ups	(-) Once they have trusted us and bought something from us, so if they want anything else like a battery system, a terminal to charge cars or something like that we should be the number one choice (int_6) (-) It [solar systems] is an expensive product and if people had good experience with you, why would they try someone else. If they do, it is our failure (int_1) (-) With more people working from home and the speed at which EVs [electric vehicles]) are becoming common, people would want to get bigger systems. Having a good post purchase customer service and maintaining a relationship is invaluable (int_2)
Participation in specialised events	(-) These events give you an easy access to the people who are interested and knowledgeable about these issues (int_2) (-) This can make your brand strong in the local market. Which is important especially, in a market where people are even willing to pay even extra to the companies who can be trusted (Int_9) (-) …We have observed that soon after [participating in the event], we do receive messages asking for details. We have actually turned many these talks into the sales (int_5)
Professional and ethical practices	(-) …Since they knew very little, they were deceived by sales personal with wrong promises. Of course, not all companies are doing this, but even if a few do this, it gets highlighted quickly in a small industry like this (int_7). (-) I have seen one sales material from a company that does this, and it was written very delicately. The message or information was so mix that if you don't know things very well, you will get wrong ideas. For example, what system is good for you (based on your previous energy consumption), how much energy will be produced or savings. That was just not true (int_5). (-) I think it is important to remain fair and hold high professional and moral standards. If someone is sold something with wrong information, its natural [that] they would talk about it in their area, work place, market and where not. Who would than trust on that company. Sometimes people even start to doubt technology (int_6)
Inhouse resources and expertise	(-) But surely, as of now, a wide majority of the companies are missing this opportunity. I think mainly because what they have is sales teams and not marketing (int_14) (-) Not having necessary human resources limits company's ability to practice new things. Its understandable in some way that small company only keep staff for necessary things like selling, installation, etc. This in turn hurts their ability to grow (int_18)

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