A Service-driven Energy Transition: Understanding the consumer and business perspective of Solar-as-a-Service

Empirical inductive research on the impact of Solar-as-a-Service on the adoption of Solar systems in German households

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ABSTRACT

The transition toward decentralized energy production has positioned homeowners as key players in the energy market. While various pathways to prosumerism have been explored, emerging business models such as Solar-as-a-Service (SaaS) present new opportunities and challenges. This study investigates how SaaS can increase prosumerism and drive solar adoption in single- and two-family homes in Germany, where 89% of such households remain untapped for solar energy adoption.

The research explores barriers, motivators, business model improvements, and expert insights on SaaS. Using an exploratory approach that includes qualitative interviews with experts and homeowners, as well as quantitative data from the consumer research platform GWI. The study identifies lack of awareness, complexity, financial concerns, reliance on SaaS providers and limited flexibility as key barriers to adoption. However, motivators include cost savings, ease of installation and maintenance, and environmental benefits. The findings suggest that current SaaS models could be improved by offering more flexible contracts, bundling solar with energy management services, and educating consumers on flexsumerism.

The study concludes that Solar-as-a-Service is unlikely to drive solar adoption in German single- and two-family homes. While improvements could boost appeal, profitability remains a challenge. However, SaaS can play an important role in multi-party buildings and rental properties, becoming a catalyst for mass prosumer adoption and contributing to Germany's renewable energy transition.

Keywords: Solar-as-a-Service, Servitization, Business Model Innovation, Prosumerism

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SUMÁRIO

A transição para a produção descentralizada de energia colocou os proprietários de habitações no centro do mercado da energia. Embora tenham sido explorados vários caminhos para o prosumerismo, os modelos de negócio emergentes, como o Solar-as-a-Service (SaaS), apresentam novas oportunidades e desafios. Este estudo investiga a forma como o SaaS pode aumentar o prosumerismo e impulsionar a adoção da energia solar em residências unifamiliares e bifamiliares na Alemanha.

A investigação explora as barreiras, os motivadores, as melhorias no modelo de negócios e as perceções dos especialistas sobre o SaaS. Para o efeito, foi utilizada uma abordagem exploratória que incluiu entrevistas qualitativas com especialistas e proprietários de casas, bem como dados quantitativos da plataforma de estudos de mercado GWI. Os principais obstáculos incluem a falta de sensibilização, a complexidade, as preocupações financeiras, a dependência de fornecedores de serviços e a flexibilidade limitada, enquanto os motivadores são a poupança de custos, a facilidade de instalação e os benefícios ambientais. Melhorias como contratos flexíveis, integração com gestão de energia e educação do consumidor podem aumentar a adoção.

O estudo conclui que é improvável que o SaaS aumente a adoção da energia solar nas habitações unifamiliares e bifamiliares alemãs. Embora as melhorias possam aumentar a atração, a rentabilidade continua a ser um desafio. No entanto, o SaaS pode desempenhar um papel importante em edifícios multifamiliares e propriedades para arrendamento, tornando-se um catalisador para a adoção em massa por parte dos consumidores e contribuindo para a transição da Alemanha para as energias renováveis.

Palavras-chave: Solar-as-a-Service, Servitização, Business Model Innovation, Prosumerismo

Título: Uma transição energética orientada para os serviços: Compreender a perspetiva dos consumidores e das empresas do Solar-as-a-Service,
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SaaS Solar-as-a-Service

BMC Business Model Canvas

Introduction

The global energy system forms the foundation of modern economies and societies and will be even more important in the future since the demand for electricity in Germany will triple by 2050 (Fraunhofer, 2024). On the other hand, the global energy system, meaning energy production and consumption, also accounts for 75% of greenhouse gas emissions, making it the leading cause of climate change (International Energy Agency, 2024).

Climate change, governmental regulations and sustainability goals put enormous pressure on the energy utility sector to shift towards new innovative solutions to reduce the carbon footprint. In figures, the Renewable Energy Sources Act decided by the German government sets the target of achieving an 80% share of renewable energy in Germany by 2030, thus contributing to the implementation of the Paris Climate Agreement (BMWK, 2023). As a result of the shift towards renewable energy, a more fragmented and decentralized energy utility market can be observed, since decentralized energy systems are an accelerator of the energy transition (Xiaohu, 2024). Studies indicate that decentralized energy systems can significantly decrease gas consumption and carbon emissions from power generation. This leads to reduced economic and environmental costs for both providers and consumers. Decentralized energy systems bring energy production closer to the point of consumption. Leveraging modern technologies like artificial intelligence, these systems optimize energy production with greater precision, efficiency, and flexibility compared to centralized models (Xiaohu, 2024).

Decentralized energy systems also allow citizens to become more engaged in the energy transition since they can not only consume energy but also become a producer through renewable energy technologies like for example with solar panels and heat pumps (Xiaohu, 2024; Hoppe and De Vries, 2018; Mihailova, 2023). But the new fragmented energy utility market does not just allow citizens to take part in the energy transition, it is also dependent on the participation, as prosumers are a crucial success factor of the energy transition (Kotilainen, 2019). The topic of prosumerism will be further discussed within the literature review.

The shift from a centralized to a decentralized energy landscape is also shaping new business opportunities and especially new energy startups are emerging and taking on the challenge of the energy transition (Henzelmann et al., 2017). Particularly, the field of Service shows great growth potential for startups, with the main category of new startups being Solar and Microgrid (Singh et al., 2022). Since Solar is one of the most popular servitization models, the thesis will

focus on Solar-as-a-Service to reduce complexity and to be able to deliver more precise research results. Servitization in the energy utility market and Solar-as-a-Service will further be discussed in the literature review of this thesis.

In theory, new service-based business models allow everyone to participate in the energy transition by lowering the initial investment for homeowners to install the new energy technology (BASE & E4S, 2023). But in reality, only 11% of one and two-family homes in Germany are equipped with solar panels, leaving a huge untapped potential of 89% of one and two-family households (EUPD, 2024). This suggests that more incentives are needed for citizens to successfully change their behavior and become active solar participants in the energy transition. Therefore, the question is how Solar-as-a-Service can increase prosumerism and thus drive the adoption of solar systems in one- and two-family homes in Germany? The thesis will first proceed with a literature review, then the methodology is described and after results will be presented and discussed.

Literature review

In order to acquire the needed knowledge, first a literature review from the fields of Social Innovation, Prosumerism, Business model theory, Business model Innovation, Servitization, Solar-as-a-Service and barriers and motivators for solar system adoption was conducted.

Social Innovation in a decentralized energy utility market

As mentioned in the introduction of the thesis, the energy utility market is changing due to external factors like climate change, increasing need of electricity, governmental regulations and new consumer demands. The result is a decentralized energy system. Before explaining business model theories and new Servitization trends in the energy utility market, a theoretical fundament of these shifting needs in the energy sector and society is useful. Thus, the theory of social innovation must be taken into consideration to create a better understanding of these changes in the energy utility market. Mulgan (2006, p.146) defines social innovation as „innovative activities and services that are motivated by the goal of meeting a social need“, Bergmann et al. (2015) emphasize on the word „social“ and its two meanings which are „social“ as an added value for society and second as a new way of behavior of an individual or a citizen-collective, including new social

practices, lifestyles or new relationships between stakeholders (Bergmann et al., 2015, Mihailova, 2023). Wittmayer et al. (2020) see social innovation as a realization of the necessity for change which is created through various sources like civil society, business and the public sector.

Shifting consumer roles

In the decentralized energy utility market social innovation is reflected in several new energy technologies like solar photovoltaic panels and heat pumps. Besides social innovation accompanying technological innovation, it can also be observed as a power shift from big energy companies to individual households. New technological innovations allow consumers to become active members in their energy market and thus prosumers, which represents new relationships between stakeholder as mentioned above (Hoppe and De Vries, 2018, Mihailova, 2023). To cite a more specific definition, which is relevant for this thesis, Brown et al. (2020, p.2) define renewable energy prosumers as „Actors who both produce and consume renewable energy and actively modulate their demand".

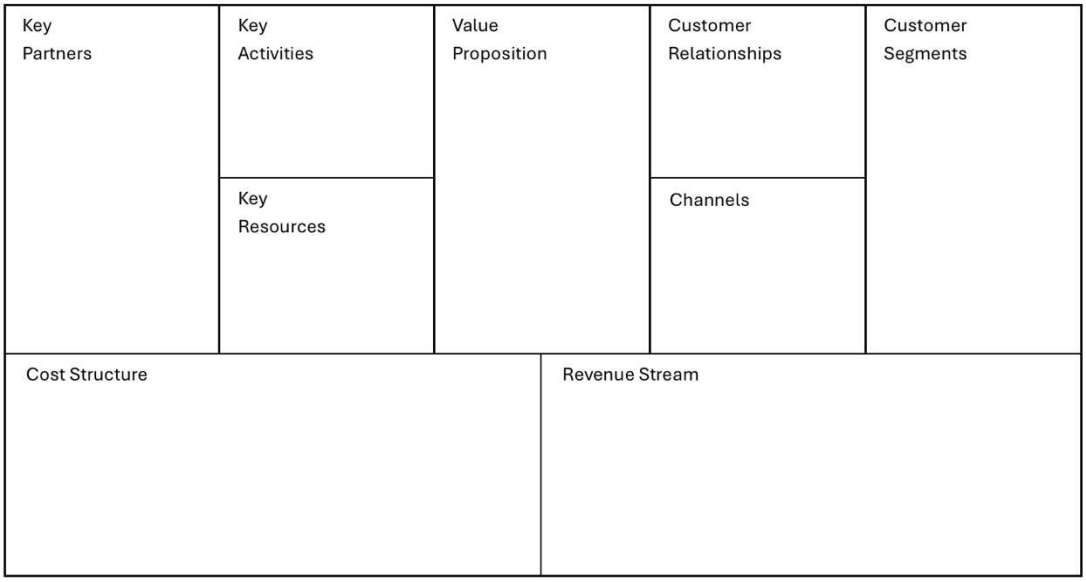
In general, prosumers are mostly connected with producing and consuming energy through renewable energy technologies like solar panels, heat pumps and wind turbines. They reduce reliance on centralized power systems by generating energy locally. Prosumers are critical for the decentralized energy system, feeding excess energy back to the grid and contributing to grid stability with their storage capacities and smart technologies (Kotilainen, 2019). Therefore, prosumerism gains relevance since it is seen as a solution to challenges within the energy transition. Prosumers are contributing to environmental goals by reducing greenhouse gas emissions, fostering the adoption of clean energy technologies and driving local value creation (Brown et al., 2020, Kotilainen, 2019).

Despite their benefits, prosumers pose challenges to traditional energy systems, such as grid management issues and economic impacts on incumbent utilities. Clear policies, incentives, and regulatory frameworks are needed to support prosumer activities and address these challenges effectively (Kotilainen, 2019). These challenges are mentioned here for completeness but will not be in focus within the thesis.

Business model theory for sustainable energy

For a successful transition towards decentralized and prosumer led energy utility market, it is necessary to understand the importance of business model innovation, as this scenario requires a change in supplier offerings (Brown et al. 2020). To gain a coherent understanding of business model concepts, first a basic comprehension of the elements of a business model is helpful. Osterwalder and Pigneur (2011, p.14) say „a business model describes the rationale of how an organization creates, delivers, and captures value". Further their business model concept can be divided into nine segments which are following: Customer Segments - For whom is the value created? Value Propositions - Which customer needs are being fulfilled? Channels - Where can customers being reached best? Customer Relationships - How can connections with customers be established and sustained? Revenue Streams – For what value are customers willing to pay? Key Resources – What resources do the Value Propositions need? Key Activities – Which activities do the value propositions require? Key Partnerships – Who are the most important partners? And lastly Cost Structure – What are the main costs factors in the business model? These nine segments build a handy tool, which is called the Business Model Canvas. When filled out appropriately, the Business Model Canvas shows detailed, how the organization actually creates, delivers and captures value (Osterwalder and Pigneur, 2011).

Figure 1: Business Model Canvas based on Osterwalder and Pigneur (2011)



After explaining the basic components of a business model, it becomes clear that a working model is also important for sustainable energy technology providers to ensure long-term success, as it is important for any business. Wüstenhagen and Boehnke (2017) explore business models for sustainable energy and describe that when relevantly designing business models in the sustainable energy sector barriers in commercializing sustainable energy technologies can be overcome. Their main identified challenges are environmental externalities, capital intensity & long lead times and the power of incumbents. First, environmental externalities can be addressed with the value proposition, especially when focusing on the individual customer value. The second and third challenges can both be turned into an opportunity by the configuration of value creation and the revenue model, especially by introducing innovative revenue models from energy ventures like leasing or contracting (Wüstenhagen and Boehnke, 2017).

Business model innovation in the energy utility sector

When speaking about adapting business models to new market and customer needs to seize new opportunities, the concept of business model innovation must be taken into consideration (Palafox-Alcantar et al., 2024). Business model innovation can be described by helping firms to commercialize new ideas and advances, therefore the „business model turns into a vehicle for innovation“ (Karami and Madlener, 2021, p.4). However, another description of business model innovation is that organizations may likewise consider the business model both as a catalyst for growth in itself and as a source of competitive advantage (Zott and Amit, 2007). Connecting the term innovation and business model even more, business model innovation can also be related to an idea for a new business model or even to a recently founded venture (Kerami and Madlener, 2021).

Furthermore, business model innovation gained more relevance for companies affected by the energy transition in order to keep creating value while handling the rise of new technologies and sustainability goals. The global shift towards sustainable energy has driven a variety of business model innovations, focusing on advancements in energy generation, distribution, storage, access, and trade. Next to product and process innovations, a popular direction is also the engagement of a broader range of stakeholder (Palafox-Alcantar et al., 2024). Here the connection to the before mentioned shift of consumer roles from passive customers to active prosumers can be drawn (Brown et al., 2020, Palafox-Alcantar et al., 2024).

Servitization based business models in the energy transition and Definition of Solar-as-a-Service

With prosumerism reshaping the energy sector, many new business opportunities are rising. One major innovation opportunity is servitization based business models, created through the energy transition (Palafox-Alcantar et al. 2024). This chapter dives deeper into the topic of servitization and then focuses on Solar-as-a-Service, one of the most prominent servitization based business models (Singh et al., 2022).

First to mention is the definition of servitization. Kowalkowski et al. (2017) regard „servitization as the transformational process of shifting from a product-centric business model and logic to a service-centric approach. […] A service business model means that the supplier commits to improving customers‘ value in use, so assuming greater responsibility for the overall value-creating process as compared to product-centric, transaction-based business models.“ (Kowalkowski et al., 2017, p.7). In general, servitization business models can be divided into three types. The first type is product-oriented, meaning that a product value is increased through a complementary service. The second one is use-oriented, which describes the model of selling services instead of assets and the third type is result-oriented, meaning to sell a specific outcome (Palafox-Alcantar et al., 2024).

In regard of the energy transition, use- and result-oriented servitization models are most relevant because they are integrating environmental and economic goals by encouraging energy-efficient practices. Additionally, servitization-based business models make it easier for users to adopt sustainable technologies, like heat pumps or solar panels, by minimizing upfront expenses (Palafox-Alcantar et al., 2024).

In the energy sector, service-driven business model innovations are mainly realized by startups to be able to create value next to traditional energy companies. The motivators and enablers for service business models are, that there is a demand for new services from customers and also a changing mindset of ownership. Resulting in customers valuing the energy-related services more than owning the technology. On the other side, economic motivations for startups are for example a competitive advantage, new revenue streams and a changing business ecosystem. Also, environmental goals are a great motivator for service-based business models (Singh et al., 2022).
Singh et al. (2022) classified the most popular service business models in the energy sector of startups in six categories, which are solar and micro-grid, energy efficiency and management,

energy software solutions, flexibility and trading, charging and battery and lastly indoor comfort and heating, with solar and micro-grid representing 38,2% of the startup distribution. To deliver more precise research results, this thesis is focusing on solar as already mentioned in the introduction. Therefore only the use-oriented service concept of Solar-as-a-Service (SaaS) will be explained further.

SaaS is a subscription-based business model „that provides the use of solar electricity to its end-consumers instead of selling solar/ PV systems as a product“ (Singh et al., 2022, p.8), thus the ownership of the solar system remains with the service provider. The subscription typically includes installation, monitoring, maintenance, and flexible financing options, easing the financial burden on customers. SaaS operates primarily through long-term rental agreements between households and companies in the private sector. This model is commonly adopted by startups (Singh et al., 2022; Galan, 2024).

Overview of current enablers and barriers of traditional photovoltaic systems

This overview focuses on sociotechnical and economic barriers since these are the most addressable by service-based business models, whereas governmental regulations are harder to influence. The main barriers of photovoltaic adoption from a sociotechnical point of view are firstly lack of knowledge, meaning that potential customers and professional architects and planners often have insufficient information about photovoltaic systems and their advantages. Furthermore, the adoption process is perceived as highly complex and potential customers have concerns about maintenance (Karakaya and Sriwannawit, 2015). Main barriers from an economic point of view are high upfront costs which traditional photovoltaic systems often require (Kraschewski, 2025) and uncertainty about financial returns (Karakaya et al., 2015).

A significant driver for photovoltaic adoption is environmental concerns. Various research highlights that potential customers have higher environmental problem awareness and are motivated by the desire to protect the environment (Schulte et al., 2022). Other enabler are economic benefits like the protection against rising electricity prices and the desire for energy independence (Karakaya et al., 2015). Also, technological interest is a motivator since early adopters often have a higher propensity for adopting innovative products. Additionally, peer effects and social norms play a role in photovoltaic adoption because they influence the perception of benefits and adoption intention (Schulte et al., 2022).

Research Question

Various pathways leading to prosuming in the energy utility sector have already been researched and discussed in existing studies (Karakaya et l., 2015, Inderberg et al., 2018, Schulte et al., 2022), still many factors remain that may result in different outcomes especially with new electricity market trends and services (Inderberg et al., 2018), like for example Solar-as-Service emerging. The unique characteristics of the drivers and barriers for the adaption of Solar-as-a-Service are still not completely understood and more researched is needed to be able to increase widespread participation of solar within homeowners in Germany.

Therefore, this thesis discusses the following question: How can Solar-as-a-Service increase prosumerism and thus, drive the adoption of solar systems within single- and two-family homes in Germany to unlock the potential of the unexploited 89% of single- and two-family homes (EUPD, 2024)?

The question can be split into four different pillars, which the thesis is trying to answer. First, which barriers are there from a homeowner perspective to integrate rented solar panels into their homes? Second, what motivates homeowner to integrate rented solar panels into their homes? Third, how can current Solar-as-a-service business models for single- and two-family homes be improved to fulfill customer needs? This can include the integration of new Technology, further services or even new integrated product offers. This aspect is also relevant for solar adoption since it is possible that potential customers find current offers not appealing enough and an adaption of the SaaS business model is needed to convince a larger audience. And fourth, which future perspective do experts see for Solar-as-a-Service. These questions should help to understand how SaaS can be the right business model to drive mass adoption of solar.

Methodology

For the thesis, a suitable scientific framework needs to be identified, which will give the research process an appropriate structure. In research, there are three distinct approaches: quantitative, qualitative and mixed methods (Bryman, 2006).

In this case, the research focuses on exploring potential answers rather than validating assumptions. Therefore, a more exploratory approach is used with qualitative interviews as the main research method (Stebbins, 2001). Additionally, the quantitative third-party consumer

research platform from GWI will be taken into account to answer parts of the research questions. According to Stebbins (2001), both qualitative and quantitative research can be collected in an exploratory approach, although qualitative data tend to predominate. As qualitative research is the main method used, the thesis is located in the continuum between interpretivism and pragmatism towards interpretivism (Bryman and Bell, 2015; Saunders et al., 2016). The qualitative interviews are „an interpretative approach, which attempts to gain insight into the specific meanings and behaviors experienced in a certain“ situation through the subjective point of view of the interviewee (Palmer and Bolderston, 2006, p.16). The method of conducting qualitative in-depth interviews is especially useful for the thesis since its goal is to identify barriers and opportunities for Solar-as-a-Service where the interviewee ‘s attitude and behavior towards the service is most relevant in order to develop future service innovations (Hammarberg et al. 2015). Whereas the quantitative reports used in the thesis are a „highly objective, systematic approach and work with numerical data“ (Palmer and Bolderston, 2006, p.16). The additional quantitative part of the thesis supports the qualitative approach with more general information about attitudes and expectations of brands from consumer who have an interest in clean energy solutions to gain a broader understanding of what is important for growth opportunities (Hammarberg et al. 2015).

Although exploratory approaches, where qualitative research is predominant, are common in research, some researchers still have reservations about the approach. One disadvantage of exploratory research is that, although it may point in the right direction, the answer it provides is usually inconclusive (Swaraj, 2019). In addition, exploratory research often lacks a big sample size and consequently „the results cannot be accurately interpreted for a generalised population“ (Swaraj, 2019, p.669). At this point it is also vital to address the fact that some difficulties may arise when using qualitative methods and semi-structured interviews. As mentioned above, the goal of the qualitative interviews is to generate qualitative in-depth findings (Hammarberg et al. 2015). Therefore the interviews will be conducted with a semi-structured questionnaire, which offers more flexibility and enables the researcher to have in-depth conversations with the interviewees (Pamer and Bolderston, 2006). Concerning research results, there may be shortcomings in reliability, validity and generalizability, as bias may occur in interviews. Due to the possibility that participants influence their response behavior, it can endanger the results' reliability. This problem can be solved by carrying out appropriate pre-tests in advance of the interview to check the interview questions. The interview partners are informed about the topic in advance of the interview to

minimize any possible bias (Saunders et al., 2016). In addition, the quantitative data helps to generate more generalised findings, overcoming the disadvantage of the smaller qualitative sample size partly, because the quantitative data is not sufficient to cover all topics of the qualitative interviews.

On the other side, there are also advantages to exploratory research. Exploratory research has great potential to provide more insightful research results than confirmatory research. This is particularly true for emerging topics, where it is important to explore existing problems and gain initial insights into a topic. Exploratory research also helps researchers to become more familiar with a research problem and to formulate more precise or future research questions, leading to better problem identification (Swaraj, 2019). Therefore, the inconclusiveness that can result from exploratory research, can be highlighted in the discussion and help to build a foundation for future research. In addition, exploratory research shows great flexibility and adaptability, allowing researchers to adjust their methods and explore unexpected areas of interest (Stebbins, 2001).

Sample strategy for qualitative interviews

Considering the goal of the thesis, the sample of the qualitative interviews was based on the Stakeholder theory which says that businesses operate most efficient and contribute to a greater good when their actions align with the interests of all stakeholders, including employees, suppliers, the community, partners and shareholders (Parmar et al., 2010). Therefore, the business and customer perspective were taken into account. The sample consisted of six industry experts of the energy utility sector and five potential Solar-as-a-service customers. The industry experts span from experts in business development in the energy utility sector, planners for photovoltaic systems, energy efficiency experts to consultants and business & venture strategist with significant experience in the energy utility market. The chosen expert sample creates an overview from various perspectives on the topic of SaaS. The criteria for the industry experts were a significant knowledge about the energy utility market with focus on Solar-as-a-Service and knowledge about customer demands. The criteria for the potential customers were that they live in a single- or two-family home and would have the possibility to install a photovoltaic system. To assemble a fitting sample group the author‘s personal network and LinkedIn, as a tool to acquire more industry experts, was used.

Since time was limited to acquire interview partner a self-selection sampling method was used where the author selected the inclusion and exclusion criteria by herself. Furthermore, snowball sampling was applied where interviews industry experts and potential customers recruited future participants for the thesis (Berndt, 2020). Snowball sampling was the case for expert SS, which was pointed out by interview participant AP and expert TM established the contact with expert JZ.

Data collection and analysis of qualitative interviews

The qualitative research is based on semi-structured interviews which have the advantage of being adaptable during the interview process and „provide a more in-depth appreciation of a subject matter than a questionnaire“ (Pamer and Bolderston, 2006, p.17). The interviews were conducted online via Microsoft Team video call and had a duration of 30 minutes per interview. All interviews were transcribed using Microsoft Teams In-App Transcript tool. Furthermore, the interview protocol was structured as follows in table 1.

Table 1: Interview Guideline (Author)

Topic	Semi-structured Questions	Sources
Introduction	First the interviewer and the interviewee introduced themselves to each other and general demographic information about age, location and profession were asked.	Hughe et al., 2022
Awareness of Solar-as-a-Service	In the customer interviews the interviewer checked again if the person asked, was living in a house which was a criterion for the sample selection. After, questions about the awareness and interest towards solar systems and especially Solar-as-a-Service were asked. In the expert interviews, the interviewees were asked to describe their profession in more detail to proof their expertise in renewable energy technologies.	Hughe et al., 2022; Karakaya and Sriwannawit, 2015

Barriers for adoption of Solar-as-a-Service	Next, the experts and customers were asked what kind of concerns they have, or challenges they see towards Solar-as-a-Service. Experts were asked to think from a customer ‘s point of view.	Karakaya and Sriwannawit, 2015; Kraschewski, 2025; Karakaya et al., 2015
Motivators for adoption of Solar-as-a-Service	After that, the interviewees were asked what would encourage them to use Solar-as-a-Service. Again, experts were asked to think from a customer ‘s perspective.	Schulte er al., 2022; Karakaya et al., 2015
Possible Improvements	Then questions about how Solar-as-a-Service should improve, in terms of product variety, services or technology in order to make potential customers feel more confident about committing to a Solar-as-a-Service agreement, were asked. Experts were additionally asked about emerging trends, that could impact the adoption of SaaS.	Palafox-Alcantar et al., 2024; Karami and Madlener, 2021
Future Perspective	Finally, the experts were asked about their prediction for future SaaS business models and how they would estimate the potential for single- and two-family homes in Germany.	Zott and Amit, 2007; Karami and Madlener, 2021; Palafox-Alcantar et al., 2024

Based on the collected data, results and recommendations for action are derived and bundled into generalizable findings. As a result, the research approach is more characterized by inductive than deductive features (Bryman and Bell, 2015; Saunders et al., 2016). The collected qualitative data is analyzed by interpreting individual statements against the background of the research subject. Based on the resulting findings, results are derived in an inductive conclusion.

Data collection and analysis of quantitative research

Additionally, to the qualitative interviews, a data analysis through the consumer research platform GWI was conducted to gain further insights on brand expectations from potential customers. The data can help to adapt the Solar-as-a-Service Value Propositions according to actual consumer expectations (Osterwalder and Pigneur, 2011). The base audience from GWI is represented by all internet users, aged 16-64 across all markets. To gain insights which are relevant

for the thesis, the base audience was narrowed down to the German market, waves of Q3 2024, Q2 2024, Q1 2024, Q4 2023, representing the latest data. Additionally, a chosen audience was created which consists of people who are interested in clean energy solutions, since there is no more specific item about interest in solar systems within GWI. Then a custom chart was created with the relevant audience „Clean energy interested people in Germany“ and the two items „Brand Role in Consumer‘s Life: Brand Qualities“ and „Brand Role in Consumer‘s Life: Brand Actions“. The item „Brand Role in Consumer‘s Life: Brand Qualities“ includes following attributes: authentic, bold, exclusive, funny, innovative, reliable, smart, traditional, trendy/ cool, young. The item „Brand Role in Consumer‘s Life: Brand Actions“ includes following attributes: be eco-friendly, be socially responsible, be transparent about how they collect and use your data, help you improve your knowledge/ skills, help you organize/ simplify your life, listen to customer feedback, make you feel valued, offer customized/ personalized products, run customer communities/ forums, support charities, support local supplies. The data output is given in form of an excel sheet provided by GWI.

To analyze the data from the consumer research platform GWI the index is used as a decisive value. The index gives information about how much more or less likely the chosen audience is to match with a given data point compared to the base audience. The numerical difference from 100 represents the percentage difference relative to the base. For instance, an index of 120 indicates that the chosen audience is 20% more likely than the base audience to align with a specific data point (GWI, 2024). To identify the most important Brand Qualities and Actions only attributes with an index of 120 or higher were considered.

Results

The findings section first lists the key consumer concerns and motivators that emerged from the qualitative interviews to provide an understanding of what inhibits or drives people to adopt Solar-as-a-Service. Next comes an overview of the expected brand qualities and actions from the quantitative analysis to better understand customer needs in terms of brand behavior. This is followed by three identified improvements for SaaS based on the qualitative interviews. Finally, a future outlook for SaaS as a business model is given from the perspective of the utility experts who were queried during the qualitative interviews. The evaluation of the qualitative interviews can be found below in table 2, the description of the customers and experts are within the appendix.

Table 2: Interview analysis based on Gioia et al., 2013

First-Order Concepts – Direct Quotations	Second-Order Themes	Aggregated Dimensions
„People don‘t know much about Solar-as-a-Service“ (PL)	Lack of customer awareness	Customer Concerns
„I‘ve never heard about Solar-as-a-Servics.“ (GB)		
„I don know anything about solar service providers.“ (SP)		
„Yes, things like that always bother me anyway, when I have the feeling that I don't know everything.“ (AP)	High complexity	
„In general, that they inform more transparently.“ (AP)		
„How does the insurance look like if the system doesn't actually belong to me, but it is my building and what about damage and so on, so the provider should actually cover everything. Also, what if I want to add new solar modules after a few years?“ (SO)		
„There ‘s also this perception of complexity, not just to install, but even just to figure out how much could I save and how do I get those grants. (JZ)		
„The main problem is that the whole topic is very intransparent and has many dependencies (storage, wallbox, heat pump) which no one manages for you.“ (LV)		
„And the alternative is do nothing and pay what you currently pay. So, there's very little effort in that. You're trying to motivate people to go and do something that's really quite effortful and viewed as costly for a payoff later down the line.“ (TM)		
„It ‘s a question of do I need those services or are they just trying to get more money out of me? And that ‘s with anything subscription these days.“ (JZ)		
„The cost structures for renting a PV system are sometimes complicated. The rental model is likely to be somewhat expensive compared to a 20-year purchase. Because of the risk factors that the provider has to bear.“ (LK)		
„In most cases, you pay significantly more with such providers than if you were to purchase a PV system yourself.“ (MB)	Knowledge about profitability	
„In general, you pay more when leasing a system longterm compared to buying the solar system yourself.“ (GB)		
„Profitability is the key barrier.“ (TM)		
„The pricing models seem to appear unclear for customers“ (PL)		
Many customers assume that ownership is the only financially viable option.“ (PL)		
„You need to make your own calculations, otherwise you won‘t realize that you are losing a lot of money with SaaS. For the money your saving when buying your own system, it‘s worth investing some time in the topic.“ (SS)		
„It needs to be clear how you can earn money with the solar system.“ (LV)		
„In the end, most of it is about the costs and I would like the offer to be structured in such a way that you can understand it very quickly, i.e. what costs you will incur and what you can actually save.“ (GB)		
„the financial payoff comes later on, which I think is what stops it from, from mass adoption“ (TM)		
„The only real concern is that you buy a good quality system and that it will somehow pay off over time, i.e. through the feed-in tariff, that the investment will be repaid at some point.“ (AP)		

„So I was afraid that I would be tied to a supplier for a very long time. And I actually prefer to be independent.“ (AP)	Uncertainty about provider reliability	
„Of course, there is also the risk that the provider may go bankrupt at some point.“ (MB)		
„I don‘t want to be dependent on one provider.“ (SP)		
„I don‘t really trust these service provider since I am not sure if they would be really there if I need assistance, I prefer to know the people I am working with.“ (SP)		
„On Social media you can also read lots os comments from people that provider will go bankrupt anyways, so I am not sure if that‘s trustworthy for me.“ (SP)		
„If I say I want these modules, I want this inverter, I want this battery storage system, how flexible is the whole thing? Because we also want a wallbox that can be connected directly to the inverter, so how much can you choose yourself?“ (SO)	Missing contract flexibility	
„Right, so from the tenant's point of view, maybe even if the landlord says you can do it, but it has to come down again if you move out, is actually quite interesting if that is a possibility.“ (SO)		
„Also, there is this misconception about long-term adhesion contracts. Many providers offer flexible terms and buyout options nowadays.“ (PL)		
„I would find it interesting if you could take over the photovoltaic system at some point.“ (MB)		
„Of course, there are some fire protection risks that every technical system entails.“ (MB)	Property risks	
„Customer have concerns about possible installation damages to the roof.“ (LK)		
There's a stigma around how effective they actually are, because the technology has been perceived… like all the people owning homes have seen solar arrive, they still think that it's really nascent and it's not that developed and it's continuing to improve. So the big question remains, when shall I make the switch?“ (JZ)	Uncertainty about Technology	
„There have been a lot of government grants that enable you to get discounts on the changes that you make to get a more sustainable home, however. Now with the new government and the growing far right, you don't actually know if those grants are here to stay. So over the last couple of years, you could actually say adoption's been quite strong because of the grants that are in place.“ (JZ)	Change in Politics	
„Also, policy changes and incentives will play a huge role. Heat pump subsidization in Germany over the past year is the perfect example of how governmental support can drive the adoption of renewable technologies. Same goes for Solar-as-a-Service. If barriers of entry are being lowered and costs for consumers go down, these models will get more attractive. However, can go both ways with the current political shifts.“ (PL)		
„A benefit is, that it is cheaper.“ (AP)	Cost savings	Customer motivators
„You save the initial investment by paying it off monthly.“ (MB)		
„The main advantage is simply that there is no initial investment. If you don't have the money on the side, you have to go to the bank, then you have interest and everything on top.“ (SO).		
„The profitability is my main decision criteria.“ (SP)		
„Of course it feels good to use sustained energy but the it feels even better when you know that you don‘t pay anything for it.“ (LV)		

„A benefit of Solar-as-a-Service is for me that you don‘t have to spend all the money at once.“ (SP)		
„The main thing people want is reliable and affordable energy.“ (TM)		
„People don't get solar because they want solar, the masses don't. They would get it because they want cheaper energy.“ (TM)		
„the main reason people want to adopt, is to save money on the energy bills“ (JZ)		
„Cost savings on their energy bills is definitely something that motivates customers to consider SaaS.“ (PL)		
„However, it gives consumers the opportunity to break into being solar powered without the high upfront costs.“ (PL)		
„That would be a big plus point, that you don't have to worry about the repairs yourself.“ (AP)	Extensive service & reduced risk	
„The provider also has tradesmen on hand, everything moves quickly, so there are also advantages.“ (MB)		
„I see the longterm service partner who takes care of the solar system as a benefit.“ (MB)		
„Of course, you also have no trouble if something breaks, that will be repaired for you. It‘s an all-round carefree package“ (GB)		
„A Partner who takes care of everything. You have a guaranty if something breaks that it will be replaced by the provider“ (SO)		
„The customers have less risk factors like defect parts of the system and also all bureaucratic issues are responsibilities of the provider.“ (LK)		
„they're not bearing the full financial risk, the company are“ (TM)		
„In order to really cut through to customers, you need to have a painfully simple offering, and that's where solar as a service is really interesting because we'll take care of everything. Don't worry. We need to provide like a very premium service.“ (JZ)		
„Solar-as-a-Service most of the time offers benefits like maintenance, monitoring, and performance guarantees.“ (PL)		
„In Solar-as-a-Service models it is in the interest of the provider to ensure that the system operates efficiently to prevent payment errors. Most of the Solar-as-a-Service will notify the customer if the something is wrong and making support and maintenance a key advantage over traditional ownership.“ (PL)		
„But we wouldn’t ‘t do it to make money, we did it for the sake of sustainability.“ (AP)	Sustainability	
„I like that it is sustainable to generate clean green electricity that does not pollute the environment“ (MB)		
„Sustainability is an important reason why to invest in a solar system.“ (GB)		
„I think the people that will adopt to it are people who are excited about making steps towards a greener future, taking responsibility for that.“ (TM)		
„Increased reliability and energy independence are drivers for SaaS adoption.“ (PL)	Independence	
„Energy Independence is also a motivator for adoption, even though that reason was stronger when the Russia-Ukraine war started than it is now.“ (LK)		
„So that customers can actually control some of their power. As the world becomes more destabilized, it feels absolutely critical.“ (JZ)		
„Possibility of contract buyouts – A lot of customers do not have the required capital upfront to buy directly. If you follow the market a lot of customers in Solar-as-a-Service models, that offer pricing models with the	Contract buyout options	SaaS Improvements to drive

opportunity the buy out the system whenever they want, realize that option. I strongly believe that customers want the flexibility of being able to opt out of contracts and own the asset themselves at some point.“ (PL)		customer adoption
„I would find it interesting if you could take over the photovoltaic system at some point.“ (MB)		
„Also, it would be interesting if I could buy the photovoltaic system after a certain time period from the provider.“ (GB)		
„that you can charge the electric car when the sun is shining and that this stops automatically when the sun stops shining, that this speaks to the battery, it only make sense when all systems function together.“ (AP)	Smart energy management	
„A dynamic electricity tariff is now also at the top of my list.“ (AP)		
„In fact, I have to say that you really have to look at the whole picture now.“ (SO)		
„It‘s not just about one product. The more distributed energy resources that you have, the more value you will get from having that system. So if you have a solar panel, that's great, but it's more valuable if you have a battery and it's even more valuable if you use that storage for your Electric vehicle, then you can gain financially more by taking yourself off the grid when it's really expensive.“ (TM)		
„Solar as service providers, the ones that are going to win, are the ones that can combine an offering that's end to end.“ (JZ)		
„Innovations will be around balancing the grid and technology that enables flexibility. So, batteries are a part of that system for sure.“ (TM)		
„Most valuable benefit in the future will be access to VPP (Virtual Power Plant) combined with smart energy management tools. Sell energy to the grid when energy prices are up and buy when prices are down. Big players are all working on their own solutions to not only connect customers to the grid but to each other. (PL)		
„In the modern electricity system, consumers have increasingly become producers. This is currently leading to complications in the system (grid operators' obligation to purchase EEG electricity) In future, prosumers will have to be re-educated as flexsumers. It must increasingly be possible to control consumption and generation in a grid-friendly manner in order to maintain system security. As the EEG surplus feed-in will become increasingly unattractive in the future, the service model could give customers the opportunity to market the surplus electricity via the contractual partner outside the EEG (Renewable Energies Act).“ (LK)	Education towards Flexsumerism & Gamification	
„We need to educate customers more.“ (LV)		
„Either visualizing the financial benefit and then letting customers manage it themselves in like a gamified way which I like or taking that stress away. And almost just turning them into a passive producer/ consumer of energy. But they can still see that they're getting the best out of it. It's almost like do people want to trade themselves on energy markets, or do they want someone else to be to play trader and broker for them?“ (JZ)		
„It also needs a simple interface where you can see, how much energy do I consumer? And where you also have Tips on how to manage your energy consumption better in order to get more out of it financially.“ (LV)		
Providers are already advertising and promising that systems will pay of themselves and if optimized will generate profit for end users.“ (PL)		
„SaaS is inefficient for homeowner, the provider on the other side makes a lot of money with it.“ (SS)	SaaS will lose attractiveness for homeowners	Future perspective for SaaS
„The benefit for the company are that after the 10 years or however long it would take to pay off the cost of the solar and the systems, then it's pure profit for them.“ (TM)		

„If you look at the general public, then I have different criteria, then I tend to see what is generally necessary now to drive forward the energy transition and it is necessary that I equip the houses with PV systems now, regardless of who invests these PV systems and where the money really comes from and who really benefits from it, because it benefits the general public and so on and then I would say OK, then perhaps it is good that you have such models.“ (SS)	SaaS as a Driver of the energy transition	
„To reach the goal of 80% renewable energy solutions in Germany, we need to expand photovoltaic system enormously and there SaaS businesses can play an important role since they invest a lot because they also profit from it.“ (SS)		
„If there's a simple solution when several parties are involved, that would be great, because it's often very difficult to find a good solution for homeowners' associations because everyone has to get their investment back. And I could well imagine a service partner taking over and also providing cheaper electricity for the rent.“ (MB)	SaaS for tenants	
„Or where you need to get permission from multiple people within the house. So for example where I live, we have 5 floors but two floors owned by one person, one floor owned by us, two floors owned by another and yeah, you have to make the call as a full group whether or not you're going to make that investment or not. (JZ)		
„And then, of course, I have the whole area of tenant electricity, if I now say I'm installing this in apartment blocks with 10, 15, 20 or 100 parties, I can really set up a tenant electricity model.“ (SS)		
„I would also think that all the big incumbents like E.ON are entering the SaaS market and then I don‘t think that Startups have a big chance anymore to coexists next to the incumbents. (LV)	Traditional energy player entering the field of SaaS	

Consumer concerns for SaaS adoption

Potential customers appear to have various concerns about Solar-as-a-Service offerings. One reason which is keeping potential customer from adopting to SaaS is that they are just not aware of the offering or have only **very limited knowledge about it**. The limited awareness influences the second identified barrier highly which is the **perceived high complexity of SaaS**. The topic of Solar systems in general is seen as a complex decision because of the large variety of options from different providers available. Also, it seems effortful for people to educate themselves more about the topic of solar, especially compared to the alternative of not changing anything. Furthermore, **SaaS is perceived as intransparent in the way the business model works and how providers inform customers about it**, details about the contract are hard to find publicly and the question about ownership details of the solar system are confusing for potential customers. Additionally, the intransparency leads also to the fear of paying significantly more compared to buying their own photovoltaic system in the longterm.

This leads to the third customer concern which is a **lack of knowledge about profitability for customers** since „ many customers assume that ownership is the only financially viable option“ (PL). Customers want reassurance that in the longterm they are making more money with the photovoltaic system then they are losing with the monthly payments. Or to say it in other words, „Profitability is the key barrier.“ (TM).

Next potential customers are uncertain about the provider ‘s reliability. Dependency on one provider over a longer period of time seems to be causing skepticism within potential customers. Also, potential bankruptcy of providers is a valid customer argument against SaaS particularly since many providers are still startups which have no longstanding reputation of good reliability yet.

Another concern from potential customers is a **perceived missing contract flexibility**. This shows in different ways. First potential customers are concerned about having only limited choices in regard of the solar system which can get problematic when customers want compatibility with other renewable energy solutions like wallboxes or heat pumps. The second concern about flexibility regards the contract itself. Potential customers worry about missing buyout options and contract cancellation options.

Furthermore, concerns about **damages of or risks for the customers property** were mentioned but within the minority of the interviews. Additionally, an uncertainty about the progress of technology was discussed in one expert interview. According to JZ the solar technology is still perceived as „nascent“ and potential customer are unsure about when they should switch to a photovoltaic system. Lastly, the change in politics has been discussed during interviews as a potential barrier for customers to adapt to solar systems. With new right-winged governments all over Europe and also a strong tendency to it in Germany, governmental support and incentives for renewable energy systems may not be there for long anymore.

Consumer motivators for SaaS adoption

Potential customers do not only have concerns but also reasons for an adoption of Solar-as-a-Service. The first motivating factor, which also appears to be the most important one for potential customers, is to **save costs on energy bills and also on the initial investment**. In particular, people who do not have the money to invest in a photovoltaic system see SaaS as an advantage over buying the system, as they do not have to take out a loan. Or to put it in the words of the expert TM:

„People don't get solar because they want solar, the masses don't. They would get it because they want cheaper energy.“.

The second motivator for SaaS adoption is **extensive service and reduced risk**. Potential customers value that they do not have to worry about maintenance, monitoring and performance and that they do not bear the full financial risk. SaaS is seen as „a partner who takes care of everything.“ (SO), where the guarantee that the supplier will provide a replacement in the event of damage is highly valued. The extensive service is not only a benefit for the customers but also for providers since it is in their interest to have an efficiently operating systems to avoid payment defaults.

Third, even if it is not the main reason, **customers still value the positive impact that SaaS has on the environment**. Almost all customer interviewees mentioned the sustainability aspect as a benefit but would put cost saving as a first priority. Just one potential customer said that sustainability is the main reason to adopt to SaaS.

Another reason which was mentioned by experts is **energy independence**. Especially political events like Russia’s war against Ukraine which caused rising energy prices in Germany increase the interest in an independent energy production and therefore made solar systems more attractive to customers.

Brand expectations from clean energy interested customer

The following are the results of the quantitative analysis of the data carried out by GWI. The only Brand Quality reaching an index over 120 was „smart“. **Therefore people who are interested in clean energy solutions in Germany are 23,7% more likely to expect a brand to have the quality of being smart compared to the base audience**.

On the other side, the chosen audience expects various actions from brands. **People who are interested in clean energy solutions are 36,9% more likely to expect a brand to be eco-friendly**, compared to the base audience. Furthermore, the **chosen audience is 32% more likely to insist on a brand to be socially responsible, 39,8% more likely to call for being more transparent about how a brand collects and uses their data and 28,9% are more likely to expect a brand to help them improve knowledge and/ or skills compared to the base audience**. Additionally **25,3% are more likely to want brands help them organize and/ or simplify their life, 24,5% are more likely to ask for listening to customer feedback, 20,2% are more likely**

to expect brands to make them feel valued, 26,1% are more likely to insist on customized and/ or personalized products compared to the base audience. Last but not least, people who **are interested in clean energy solutions are 27% more likely to expect brands to run customer communities and/ or forums, 40,4% more likely to want brands to support charities and 36% more likely to insist on support of local suppliers, compared to the base audience**.

Solar-as-a-Service Improvements to drive customer adoption

Contract buyout options for trust generation: Consumers appreciate the fact that they have no initial upfront investment with SaaS, however they are sceptic about longterm contracts with providers. Therefore, an improvement in terms of contract flexibility and buyouts is necessary in order to gain trust towards Solar-as-a-Service providers and retain a feeling of independence. To cite the SaaS expert PL: „I strongly believe that customers want the flexibility of being able to opt out of contracts and own the asset themselves at some point.“. The change in contract conditions can make SaaS more attractive to potential consumers as it aligns with consumer needs. Furthermore, transfer options in case of a house sale would drive consideration of Solar-as-a-Service.

Smart energy management as a differentiator: Customer needs for product innovation were particularly strong in regard of smart electricity management. Smart electricity management offers are already emerging but are not widespread within solar users yet and it is effortful to find seamlessly working solutions. Also, experts have expressed the opinion that „the ones that are going to win are the ones that can combine an offering that ‘s end to end“ (JZ). Therefore, further product development of Solar-as-a-Service should include a smart electricity management as a standard feature. According to the customer interviews, these smart systems should include a dynamic electricity tariff, meaning that customers get cheaper electricity when electricity prices are falling due to a surplus of electricity due to higher production from sun and wind energy. Additionally, it should also include better integration and optimization of products, meaning the management of for example wallboxes, heat pumps and batteries which then automatically use electricity surplus to recharge electric vehicles and electricity storage like batteries, resulting in cheaper energy prices for customers. SaaS expert PL also says: „Providers are already advertising and promising that systems will pay of themselves and if optimised will generate profit for end

users.“. In conclusion smart energy management system will provide more ease for customers and increase profit for customers due to dynamic electricity tariffs.

Education towards flexsumerism: „We need to educate customers more“, said the Interviewed expert LV and that is very true. The increasing participation of consumers in the electricity system, also called prosumerism, is leading to complications in the grid operation. Therefore, it needs to „be possible to control consumption and generation in a grid-friendly manner in order to maintain system security.“ (LK). By re-educating prosumers to adapt their electricity usage to the grid ‘s needs, prosumers become flexsumer. Smart energy management is closely linked to education and is crucial to achieving grid stability. Through an artificial intelligence management system, customers can become flexsumers without any education because their electricity consumption is automated, and no active customer role is required. Additionally, a simple interface with an overview of energy usage, savings and environmental impact can spark motivation for grid-friendly behavior and gives the customers positive feedback about their automated energy management and cost savings. However, not all customers want to be passive participants in the energy system. Consequently, education on grid-friendly behavior is needed. An option to achieve flexsumerism can be a gamified management tool, where homeowners become active traders in the energy market. There, consumers can be educated through financial incentives for grid-friendly behavior and receive electricity consumption and generation tips which is resulting in more profit for customers and grid stability. Even though re-education of consumers appears to be more relevant for providers than for customers to achieve grid stability, customers will still profit from it through financial incentives and a more transparent overview of their energy consumption, which can be a motivator for SaaS adoption.

Future perspective for Solar-as-a-Service

According to experts SaaS seems to be a promising and lucrative business model for one and two-family homes in Germany, however it will probably not be the deciding factor that generates mass adoption of solar systems within that segment. **That is due to the fact that photovoltaic systems are getting cheaper and therefore the subscription model becomes significantly more expensive compared to buying the solar system in the longterm.** The argument is strengthened by the fact that SaaS providers tend to have long-term contracts that are almost pure profit after the first few years, when the solar technology is paid for. Nevertheless,

SaaS can play a pivotal role in the energy transition in Germany. Here energy efficiency expert SS says: „To reach the goal of 80% renewable energy solutions in Germany, we need to expand photovoltaic system enormously and there SaaS businesses can play an important role since they invest a lot because they also profit from it.“. When staying within the business to consumer segment, experts see the biggest potential for SaaS in multi-party buildings where the provider functions as an investor for solar systems and coordinates the participation of the various tenants.

In addition, the SaaS business model will be increasingly adopted by large incumbents in the energy market, so the existing and emerging startups that are now the main players in the SaaS space will face fierce competition. As a result, experts say that SaaS could move from being a business model dominated by start-ups to one dominated by large energy companies.

Discussion

This section discusses the findings obtained from the qualitative interviews and the quantitative data provided by GWI and relates these to the literature reviewed. Finally, limitations and further research implications will be identified.

SaaS barriers and motivators in comparison to traditional solar systems

Looking at the barriers to SaaS, the first thing to note is that even though customers do not need to have extensive knowledge of solar systems as the provider takes care of everything, lack of knowledge is still a perceived barrier. The difference compared to traditional photovoltaic adoption is, that it is not limited knowledge about the system itself but also a lack of awareness of SaaS existence (Karakaya and Sriwannawit, 2015). Also the barrier of perceived high complexity remains within the SaaS offer since contracts and the business model itself seem complex and intransparent to consumers (Karakaya and Sriwannawit, 2015). Another customer concern which remains unsolved within SaaS is the uncertainty about financial returns (Karakaya et al., 2015). **The subscription model even adds more skepticism since consumers need to agree to the providers contract conditions and trust its reliability.** Additional barriers which were identified are the uncertainty about the progress of the solar technology in general and the effects of a change in politics in Germany.

Even though SaaS can answer the customer concerns about maintenance with its extensive service and reduced risks, some concerns about property damages endure within a minority of the interviewees (Karakaya and Sriwannawit, 2015). But still, the service of maintaining, monitoring and performance checking are highly valued within the SaaS offer and are perceived as the biggest advantage of Solar-as-a-Service compared to buying the solar system yourself. Another barrier which can be removed with SaaS is the high upfront costs of photovoltaic systems because of the subscription model (Kraschewski, 2025).

Motivators for SaaS adoption, which remain the same as for traditional solar adoption, are the economic return on investment in solar systems, a positive impact on the environment and energy independence (Karakaya et al., 2015; Schulte et al., 2022). On the other side, technological interest and peer effects can not be confirmed as drivers for SaaS adoption (Schulte et al., 2022).

To sum up, Solar-as-a-Service offers are particularly attractive to customers who do not want to bear the full risk of the investment or who value extensive service. Otherwise, there are no perceived benefits that differentiate the SaaS offer from buying the solar system, especially since buying the solar system is currently still cheaper than renting it in the long term. Hence the interview results are contrary to the literature review, where it was identified that customers value energy-related services more than owning the technology (Singh et al., 2022). **Thus it is questionable if SaaS can be a driver for solar adoption.**

Brand qualities and actions for Value Propositions

When looking at the BMC by Osterwalder and Pigneur (2011), the Value Proposition segment asks the question of what customer needs are being fulfilled. As the value Proposition is a promise to customers, it is useful to look at customer expectations of the brand, because the brand communicates the values and benefits of the SaaS provider to its customers.

The results of the quantitative research shows three important aspects for creating a Value Proposition that fulfills customer needs. **Firstly, people who are interested in clean energy solutions want a brand to be smart, help them improve knowledge and skills and help them organize and simply their life.** This result fits also to the perceived high complexity of solar systems, therefore a perceived smartness and simplification of processes can be a great benefit for SaaS customers and can convince them to adopt to a solar system.

Second, customers expect to be valued by a solar provider. In particular, they want personalized products and customer communities, but they also want brands to use personal data transparently and to listen to their feedback. Feeling valued by a SaaS provider matches also the wish for a reliable longterm partner who is trustful and takes care of everything.

Thirdly, customers interested in clean energy solutions not only want to act responsible themselves, they also expect brands to be good. So customers expect brands to be eco-friendly, socially responsible, support charities and insist on supporting local suppliers. This means that SaaS providers cannot rest on the fact that they offer an environmentally friendly product. They need to go further and demonstrate a real commitment to the environment and society to fully convince customers.

These aspects of brand expectations are important to take into consideration when creating a meaningful Value Proposition for SaaS businesses, but they can also be considered when creating new products or company guidelines which are for example more focused on personalization or society and environment. Giving thought to these results when developing a Value Proposition can make a SaaS offer more appealing to customers and thus drive solar adoption. This suggestion resonates with the literature review where Wüstenhagen and Boehnke (2017) propose that environmental externalities can be addressed with the Value Proposition and therefore barriers in commercializing sustainable energy technologies can be overcome.

Connection of the identified SaaS improvements to Business Model Innovation

Considering the literature review, the thesis identified the importance of business model innovation to maintain value creation in the energy transition while addressing emerging technologies and sustainability goals through product and process innovation (Palafox-Alcantar et al., 2024). Consequently, this section is discussing how the possible SaaS improvements, identified in the interview analysis, can be used to innovate the BMC for a possible SaaS business (Osterwalder and Pigneur, 2011).

Firstly, the contract buyout option would affect the Customer Segments and Value Proposition as the more flexible tariff and contract options add a new customer promise and would additionally address the customer concern of being dependent on one SaaS provider longterm. Thus it would make SaaS attractive for a larger audience. Furthermore contract buyout options can also influence Revenue Streams, since customers might pay the subscription fee for a

shorter period of time compared to before. Still, the buyout can be a replacement for the missing subscription fee for SaaS businesses (Osterwalder and Pigneur, 2011).

Second, smart energy management would affect many segments of the BMC for a SaaS business. New customer segments could be addressed with the new integrated product within the SaaS offer as the smart energy management was seen as a great benefit in the conducted interviews. Consequently this can be a convincing factor for SaaS adoption. Also the Value Proposition would change as the new offer fulfills more customer needs. Furthermore, the smart energy management would add more value which customers would be willing to pay for, thus Revenue Streams for SaaS businesses can increase. On the other side the new offer would need more Key Resources for the development and maintenance of the management tool which would also add new cost factors. Key Partnerships could also be affected if the SaaS business chooses to buy the management tool from a different provider (Osterwalder and Pigneur, 2011).

Third, education towards flexsumerism in general and through an artificial intelligence management system or a gamified management tool would also affect many aspects of the BMC for a SaaS business. Possible financial benefits through flexsumerism would influence the Value Proposition as it fulfills the need of financial returns. Next, Customer Relationships would also change since especially the gamified tool could be a potential communication tool between customer and provider. Furthermore, Revenue Streams could increase through the added value of education and a resulting financial benefit. On the other side, either Key Resources need to be adapted to be able to provide the educational component or new Key Partners need to be acquired to provide the additional services. This would also increase the Cost Structure (Osterwalder and Pigneur, 2011). Moreover, education towards flexsumerism aligns with the literature review where it was mentioned that prosumers pose a challenge to grid management and clear regulators are needed to address this challenge effectively (Kotilainen, 2019).

In conclusion, the potential enhancements identified in the interviews can either be a success factor for the SaaS business, making the offerings more attractive to customers and drive solar adoption, or they can add significant costs and reduce the profitability of the SaaS business. Further research into these enhancements is therefore needed to gain a full understanding of the real benefits to customers and the SaaS business, and to accurately estimate the revenues and costs involved.

Future perspective for SaaS in regard of the literature review

As mentioned above in the discussion of barriers and motivators, the future perspective gained through the expert interviews tends to lean towards the facet that buying is still more attractive than renting a solar system, which is in contrast to Singh et al. (2022). The positive impact of servitization on the energy transition, which was identified in the expert interviews, aligns with the literature review. There it was identified that on the one hand, more renewable energy sources are needed to fulfill sustainability targets (BMWK, 2023) and on the other hand, that servitization based business models are evolving through the energy transition (Singh et al., 2022). This strengthens the case for the synergy of energy transition and Solar-as-a-Service. With regard to one- and two-family homes and multi-party buildings, the existing literature is vague and tends to describe SaaS provider more in general terms, without a specific differentiation of the housing types (Singh et al., 2022; Galan, 2024). Therefore, no concrete comparison to the literature review can be drawn in this aspect.

Lastly, the future scenario that traditional energy incumbents will enter the market and create fierce competition for the existing startups does align partly with the literature review which says that service-driven business model innovations are mainly realised by startups to be able to create value next to traditional energy companies (Singh et al., 2022, Galan, 2024). Thus, the results align about the fact that startups are dominating the SaaS market so far but existing research does not emphasize the fact that incumbents can become the main players in the future.

Limitations and future research

Finally, this section will first look at limitations of the thesis and then on future research implications. A limitation of this thesis is its reliance on qualitative research for most parts, which, while providing in-depth insights, may not offer the generalizability of quantitative approaches. The findings are based on a specific set of participants and contexts, making it difficult to draw broad conclusions or apply them universally.

The quantitative analysis also has limitations, as the target group is very broad and not specifically tailored to the needs of the thesis due to the limited items on the GWI consumer research platform. Therefore, more quantitative research on Solar-as-a-Service is needed to be able to draw more precise conclusions.

In addition, the study focuses on an emerging technology that is evolving rapidly, meaning that new developments could quickly reshape the Solar-as-a-Service landscape. As a result, some findings may become outdated and will need to be continually reassessed to remain relevant.

Moreover, the results of the potential SaaS improvements and Value Propositions should be compared with extensive research on the existing SaaS Business Model Canvas to create a better understanding of the status quo of actual SaaS businesses on an empirical basis. This will help to identify untapped market opportunities within the sector and create differentiation and advantages over other competitors.

Next, the proposed improvements and value proposition aspects of SaaS businesses should be quantitatively tested. This can lead to a more accurate assessment of actual perceived customer value across a wider audience. Therefore, the most relevant business opportunities for SaaS businesses can be identified precisely.

Future research could explore the potential of gamified energy management tools to encourage sustainable energy behavior. Investigating how game mechanics, such as rewards, competition and real-time feedback, can improve user engagement and energy efficiency could provide valuable insights for both policy makers and technology developers.

Lastly, further studies could explore new business models, regulatory frameworks and technological innovations that enable Solar-as-a-Service in multi-party buildings and rental properties in general. Understanding tenant participation, incentives and barriers in shared energy systems could contribute to more inclusive and efficient energy transition strategies and foster the energy transition.

Conclusion

The conclusion of the thesis is disillusioning yet hopeful. Even though Solar-as-a-Service will probably not be the driver for solar adoption within one- and two-family homes in Germany, it can still be a driver for the energy transition.

Even though the current SaaS model is lucrative for service providers the conducted research suggests that for consumers SaaS is not very beneficial. The current SaaS business model still face key challenges like perceived complexity, lack of awareness, and concerns about financial returns. While SaaS eliminates high upfront costs and provides extensive service benefits, the

findings suggest that customers still perceive ownership as the more attractive option in the long run, raising questions about SaaS's role in driving solar adoption. A solution to gain attractiveness for consumers and improve adoption rates can be enhancing SaaS offerings through flexible contracts, smart energy management, and customer education. However, these improvements also introduce new cost factors that could impact the profitability of SaaS providers.

Furthermore, the thesis suggests that the SaaS market matures and traditional energy incumbents will enter the space. This fierce competition will make it even harder for the now dominating startups to exists in the sector of one- and two-family homes. An identified solution for startups can be to refine their Value Propositions to maintain a competitive edge. By aligning business model innovation with customer expectations, SaaS startups can effectively address the barriers identified in this study. But again, the impact on the profitability for SaaS providers needs further research.

In summary, the question, wether Solar-as-a-Service can increase prosumerism and thus drive the adoption of solar systems in one- and two-family homes in Germany, must be answered with a no for now. But still, this can change with new technologies emerging. Moreover, from a business perspective SaaS can retain relevance when focusing on multi-party buildings and rental properties and function more as an investor and coordinator for larger projects rather than providing its services for one- and two-family homes in Germany. Consequently, SaaS can be driving the expansion of solar systems and thus prosumerism and function as an important accelerator for the energy transition.

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APPENDIX

Appendix 1: Interview participants – Experts

Name	Professional Experience	Location	Profession	Specialization
Expert 1 (LK)	2 years	Germany	Photovoltaic Planer, Stadtwerke München	Project management for the Photovoltaic Private customer segment
Expert 2 (TM)	4 years	Germany	Venture Lead, Accenture Song Venture Studio	Energy transition, decarbonizing products, services and ventures
Expert 3 (PL)	2 years	Germany	Associate, Enpal	Strategic project development for Solar-as-a-Service
Expert 4 (JZ)	7 years	UK	Strategy and Growth Director, Accenture Song Venture Studio	Building clean energy products, services and ventures
Expert 5 (SS)	4 years	Germany	Electric Engineer & Energy efficiency Expert, Ingenieurbüro Schlegl	Energy efficiency, Energy advisory for buildings
Expert 6 (LV)	5 years	Germany	Executive Director Product Design, Accenture	Product Design, Utility sector

Appendix 2: Interview participants – Customers

Name	Age	Location	Profession
Customer 1 (AP)	58	Germany	Housewife
Customer 2 (MB)	30	Germany	Software-Engineer
Customer 3 (GB)	65	Germany	Pensioner, Physicist
Customer 4 (SO)	33	Germany	Electric Engineer
Customer 5 (SP)	30	Germany	Managing Director

Appendix 3: Quantitative Analysis - GWI Output

GWI.

Source: GWI
Question Name: Brand Role in Consumer's Life: Brand Qualities, Brand Role in Consumer's Life: Brand Actions, Gender, Age (Groups), Education, Life events in the next 6 months, Income (by segment), Household Living
Message: Which of these do you want brands to be?, Which of these things do you want brands to do?, Which of the following best describes your gender?, How old are you?, What best describes the highest level of
Base: All internet users
Countries: Germany
Waves: Q3 2024, Q2 2024, Q1 2024, Q4 2023
Rebase on selected segments: False
Export Date: 20 January 2025

Short Label Question	Attributes	Clean_Ene Audience	Clean_Ene Data point	Clean_Ene Universe	Clean_Ene Index	Clean_Energy Responses
Brand Role in Consumer's Life: Brand Qualitie	Authentic	57	39,1	5,19E+08	124	100792
Brand Role in Consumer's Life: Brand Qualitie	Bold	25,5	37,6	2,32E+08	119,4	37564
Brand Role in Consumer's Life: Brand Qualitie	Exclusive	29,2	37,6	2,66E+08	119,5	40994
Brand Role in Consumer's Life: Brand Qualitie	Funny	25,2	34,8	2,3E+08	110,4	41059
Brand Role in Consumer's Life: Brand Qualitie	Innovative	57,4	40	5,23E+08	127	94865
Brand Role in Consumer's Life: Brand Qualitie	Reliable	68,3	37,4	6,21E+08	118,7	127269
Brand Role in Consumer's Life: Brand Qualitie	Smart	54,3	39	4,94E+08	123,7	86171
Brand Role in Consumer's Life: Brand Qualitie	Traditional	22	34,2	2E+08	108,5	34443
Brand Role in Consumer's Life: Brand Qualitie	Trendy / cool	34,2	37,8	3,11E+08	119,9	49830
Brand Role in Consumer's Life: Brand Qualitie	Young	24,5	34,7	2,23E+08	110,2	32131
Brand Role in Consumer's Life: Brand Actions	Be eco-friendly	58,1	43,1	5,29E+08	136,9	102998
Brand Role in Consumer's Life: Brand Actions	Be socially responsible	55,5	41,6	5,06E+08	132	96475
Brand Role in Consumer's Life: Brand Actions	Be transparent about how they collect and use	43,9	44	3,99E+08	139,8	82010
Brand Role in Consumer's Life: Brand Actions	Help you improve your image / reputation	24,1	37,2	2,19E+08	118,2	33065
Brand Role in Consumer's Life: Brand Actions	Help you improve your knowledge / skills	40,4	40,6	3,67E+08	128,9	63634
Brand Role in Consumer's Life: Brand Actions	Help you organize / simplify your life	40,1	39,5	3,65E+08	125,3	67230
Brand Role in Consumer's Life: Brand Actions	Listen to customer feedback	52,9	39,2	4,82E+08	124,5	93162
Brand Role in Consumer's Life: Brand Actions	Make you feel valued	41,7	37,9	3,8E+08	120,2	66811
Brand Role in Consumer's Life: Brand Actions	Offer customized / personalized products	32,9	39,7	3E+08	126,1	51150
Brand Role in Consumer's Life: Brand Actions	Run customer communities / forums	18,6	40	1,69E+08	127	25245
Brand Role in Consumer's Life: Brand Actions	Support charities	33,6	44,2	3,06E+08	140,4	56876
Brand Role in Consumer's Life: Brand Actions	Support local suppliers	38,4	42,8	3,49E+08	136	71593
Gender	Male	52,6	32,4	5,1E+08	101,1	126937
Gender	Female	47,1	31,5	4,57E+08	98,5	121205
Gender	Other Gender (Select Markets Only)	0,3	58,5	3053512	182,9	1063
Age (Groups)	16 to 24	20,3	29,2	1,97E+08	91,4	40836
Age (Groups)	25 to 34	23,4	30,4	2,27E+08	95,1	52628
Age (Groups)	35 to 44	22,9	32,7	2,22E+08	102,3	54489
Age (Groups)	45 to 54	17	34,3	1,65E+08	107,1	48047
Age (Groups)	55 to 64	12,8	35,3	1,24E+08	110,2	40794
Age (Groups)	65+	3,4	34,7	33065314	108,3	12411
Education	Lower secondary education	5,2	25	50323192	78,2	15595
Education	Upper secondary education	37,4	28,5	3,63E+08	89	83270
Education	Post-secondary vocational education	24,1	33	2,34E+08	103,2	53874
Education	Undergraduate degree (ie. Bachelor)	25,2	37	2,45E+08	115,6	70940
Education	Postgraduate degree (ie. Master's/PhD)	8,1	42	78343410	131,3	25526
Life events in the next 6 months	Buy property (e.g. a home/apartment)	19,2	42,5	1,89E+08	132	14187
Life events in the next 6 months	Get a new pet	19,3	39,6	1,87E+08	123,7	41942
Life events in the next 6 months	Get engaged	4,5	36,9	43372121	115,3	10953
Life events in the next 6 months	Get married	3,9	35,9	38107256	112,3	8755
Life events in the next 6 months	Have a child	4,5	34,7	43868577	108,4	10640
Life events in the next 6 months	Have a grandchild	1,3	39,2	12823029	122,5	3567
Life events in the next 6 months	Have a major medical procedure / treatment	8,7	42,3	84758971	132,3	23541
Life events in the next 6 months	Move out from my hometown	8,2	39,8	80502139	123,7	5942
Life events in the next 6 months	None of these	45,6	27,7	4,42E+08	86,7	117597
Life events in the next 6 months	Quit my current job	7,3	37,1	70866222	115,9	21560
Life events in the next 6 months	Retire from my job	1,9	39,2	18862648	122,4	4603
Life events in the next 6 months	Start dating	13	36,9	1,26E+08	115,3	32553
Life events in the next 6 months	Start my own business	22,9	40,8	2,26E+08	126,7	14872
Life events in the next 6 months	Have a child move away from home (To Q2 202	2,4	42,2	23063675	132,4	4665
Life events in the next 6 months	Have a child graduate from college (To Q2 2024	3	42,6	28906504	133,5	4845
Life events in the next 6 months	Have a child get married (To Q2 2024)	2	41,4	19220768	129,6	2886
Income (by segment)	Low	27,6	28,3	2,68E+08	88,6	65048
Income (by segment)	Medium	31,9	32,2	3,09E+08	100,7	76064
Income (by segment)	High	35,1	37,2	3,4E+08	116,3	90506
Income (by segment)	Highest (Subset of High)	13,4	38,9	1,3E+08	121,6	33942
Income (by segment)	Don't Know / Prefer Not To Say	5,4	24,8	52777354	77,5	17559
Household Living Arrangements	My partner	56,3	33,2	5,46E+08	103,8	139779
Household Living Arrangements	My child(ren)	46,4	34,2	4,5E+08	106,9	106350
Household Living Arrangements	My parent(s)	32,2	30,4	3,13E+08	95,1	59915
Household Living Arrangements	Other family member(s)	17,1	34,4	1,66E+08	107,6	35236
Household Living Arrangements	Roommate(s) / friend(s)	2,8	34,6	27091396	108,1	8477
Household Living Arrangements	Others	1,2	31,7	12012160	99,2	3552
Household Living Arrangements	I live alone	7,8	28,9	75206777	90,3	28997
Urban Context	Urban	61,9	32,4	6E+08	101,1	139498
Urban Context	Suburban	24,1	33,3	2,33E+08	104	68199
Urban Context	Rural	14	28,7	1,36E+08	89,7	41508
Attitudes: Brand Relationships	I am loyal to the brands I like	53,1	37,4	5,15E+08	116,8	130431
Attitudes: Brand Relationships	I buy products / services to access the commun	15,7	37,4	1,52E+08	117	28305
Attitudes: Brand Relationships	I feel represented in the advertising I see	17,5	37	1,69E+08	115,8	30604
Attitudes: Brand Relationships	I look for expert opinions before buying expens	38	42,3	3,68E+08	132,2	96969
Attitudes: Brand Relationships	I research a product online before buying it	64,8	40,1	6,29E+08	125,5	164656
Attitudes: Brand Relationships	I spend time looking for the best deals	53	38,9	5,14E+08	121,6	142071
Attitudes: Brand Relationships	I tell my friends and family about new products	43,5	39,6	4,22E+08	123,8	96692
Attitudes: Brand Relationships	I tend to buy brands I have seen advertised	30	38,5	2,91E+08	120,5	57832
Attitudes: Brand Relationships	I tend to buy the premium version of products	22,9	38,4	2,22E+08	120	45031
Attitudes: Brand Relationships	I trust what online reviews say about products ,	42,3	40	4,11E+08	125	91767
Attitudes: Brand Relationships	I try to avoid all types of advertising	18,6	33,9	1,8E+08	105,8	49957
Attitudes: Brand Relationships	I use discount codes or coupons	52,2	37,8	5,07E+08	118,2	137254
Attitudes: Brand Relationships	I use loyalty / reward programs	39,6	39,5	3,84E+08	123,4	112730
Attitudes: Brand Relationships	None of these	2,1	12,2	20656018	38,1	5235
Personal Interests	Economy / finance	36,1	50,9	6807763	135,3	4140
Personal Interests	Environmental issues	51,5	65,4	9706639	173,8	5939
Personal Interests	Investments	24,3	49,1	4571856	130,5	2821
Personal Interests	News / current affairs	59	48,4	11110436	128,7	6768