Guidelines for business model innovation on the example of PV self-consumption optimization

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Abstract. The market for energy management systems that optimize the degree of self-consumption of locally produced renewable energy is still immature. This is evidenced by the large variety of existing offerings and the many newcomers entering the market. Hence, business models are still adapting. Based on a broad literature review and extensive market observations, we developed an abductive categorization system for value propositions, revenue models customer groups and invoicing models. This study then analyzed more than 80 offerings focused on the optimization of self-consumption of photovoltaic power. Based on these observations and the market context, this study recommends offerings connected to a recurring payment system to be combined with a licensing and/or renting/leasing revenue model and to highlight a strong social, ethical/normative and emotional value proposition.

1. Introduction

Business model innovation is necessary when new technological innovations can be exploited [1]. In the case of the self-consumption of locally produced photovoltaic power (PV), key technologies achieved significant innovations over the past few years. Firstly, prices for electricity generated by PV declined rapidly and secondly, new developments in algorithms for control systems emerged [2]. This makes it increasingly attractive, both financially and environmentally, to install rooftop PV and self-consume as much of the generated electricity on site as possible [3–5]. As a consequence, various offerings emerged that optimize the self-consumption. With this study, we describe a generic methodology to facilitate the analysis of business models and their innovation, which is applied on the practical example of self-consumption optimization.

A business model (BM) is understood as the way a company generates and delivers value to customers and in return generates revenue [6]. BMs can be analyzed at different levels, from individual offerings to the strategy of a company up to the scale of a business-ecosystem [7]. While there is no universally accepted definition for a BM and neither the elements it would include, literature typically includes the elements "Value Proposition", "Market/Customer Segment", "Revenue Mechanism", "Cost Structure", "Distribution Channels", and "Key Resources" [8]. Information about these elements is in general publicly accessible [6], only the cost structure is confidential and the key resources often can only be inferred. The value proposition is a core element of a business model and describes the value a company proposes to deliver to the customer [9]. Please note that it does not matter whether the customer actually perceives the proposed or a different value [10]. Sheth et al. [11] structured value propositions

in functional, emotional, epistemic, social and conditional values, which was taken up, refined and extended by other scholars, to include normative and economic values too [9,10,12,13].

BMs are frequently used in research to analyse markets and success factors [14], as they serve as a solid construct for empirical analysis [15]. Several studies used BMs as an element for analysis, for example to cluster initiatives contributing to a sustainable development [16], residential retrofit [17], product-service systems for distributed renewable energy [18] or data-driven start-ups [8]. However, to the best of our knowledge no study so far systematically investigated BMs for self-consumption of photovoltaic power with the aim to provide guidelines for the innovation of those BMs.

BM innovation describes the adaption of certain elements of a BM [19]. Systematic analogy seeking has shown to be successful for innovating business models [20], particularly concerning the revenue model [19,21]. As a consequence, this study provides a replicable systematic and quantitative market overview of BMs for the optimization of self-consumption.

2. Methods

In this study, only offerings explicitly addressing the optimization of self-consumption were included. The offerings were collected through literature research, participation at expert symposia, from newsletters, dedicated online forums as well as internet keyword searches. This study analyzes BMs at the offerings-level, as they represent similar elements of analysis across different companies. A focus was put on offerings available in Switzerland.

Figure 1 displays the used taxonomic tree with short definitions for each code. Due to page limitations, the full definitions of the codes are not shown but are delivered by the authors upon request. This study considers only the most common business elements, which are value proposition and customer segments [6], along with revenue model, which is suitable for innovation through analogy seeking [19,21]. Building upon work for value proposition typologies [11,12], customer groups and revenue mechanisms [22], a typology [23] of BMs was developed and tested. The code set represents a subset of a larger taxonomy [13]. However, conditional value was excluded from the value proposition types as it is hard to operationalize in this context [12]. The value proposition was understood as a piece of text or an image from the marketing material from the company, typically found on the company's website. The BM-element revenue mechanism was split into invoicing model and revenue stream, as this approach yielded higher inter-coder reliability. The invoicing model and revenue stream of an offering was coded by attempting to acquire the respective offering. The customer group was inferred from phrases that specifically address a certain customer group, style of the language used, as well as reference cases shown by the marketing material. Please note that any combination of codes is possible, as an example, an offering might address both, B2C as well as B2B customers and involve a one-time payment along with a fee-model.

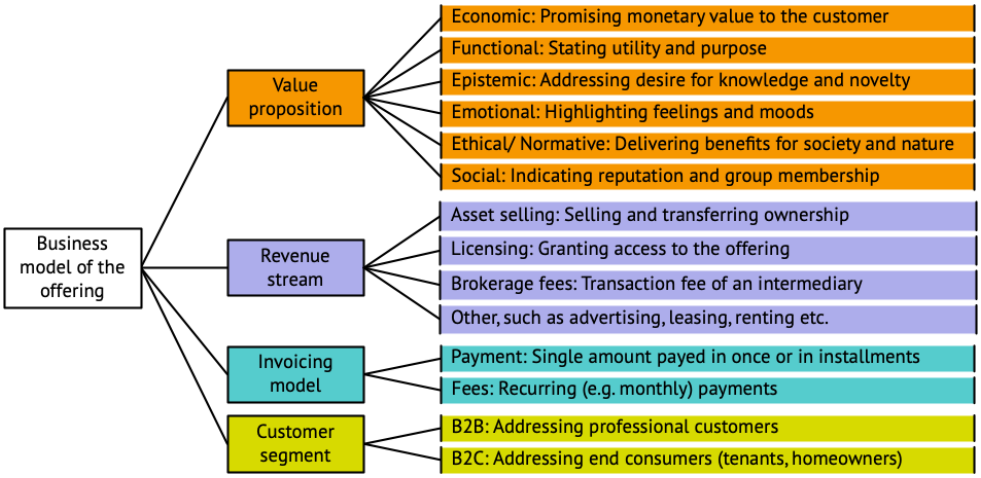

Figure 1. Taxonomic tree of the applied business model codes and their short definitions

A total of 81 offerings were analyzed during the second half of 2018. Two researchers coded the business model of the offerings. The intercoder reliability of the codes was assessed through a cross-coding workshop with 5 coders and calculation of Gwet's AC1-scores [24]. Gwet's AC1 ranges from -1 (perfect disagreement) to 1 (perfect agreement) and in our case yielded values of 0.43–0.77 (ø 0.59) for value proposition, 0.4–0.7 (ø 0.69) for revenue streams, 0.64 (payments) and 0.66 (fees) for invoicing model, and 0.44 (B2C) and 0.52 (B2B) for customer group, indicating moderate to substantial levels of agreement [25].

3. Results

Figure 2 displays the frequency of occurrence for each value proposition type. More than 60 % of the analysed offerings feature an economic and more than 50 % a functional value. Table 1 displays the frequency of co-occurrence between two different value proposition types. Please note that the matrix is not symmetrical, the percentages refer to the column header, i.e. only 31 % of the offerings with economic value proposition pair with emotional ones, while 63 % of the offerings with emotional value proposition pair with economic ones. No single case combining of social and functional value were found. So a value proposition like "with this product you belong to the group of people that can adjust the charging behaviour of their electric vehicle to optimize the self-consumption of their local PV-production" was not observed. Furthermore, all social value propositions were combined with ethical/normative ones.

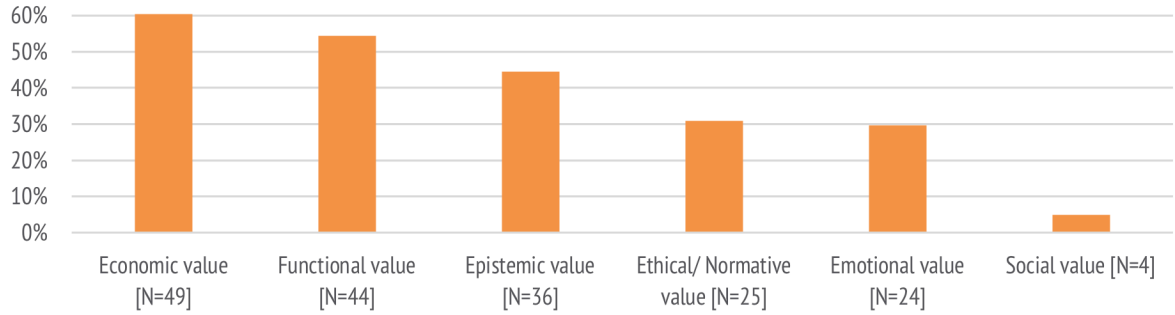

Figure 2. Distribution of value proposition codes across the analysed 81 offerings. Each offering could contain multiple value propositions

Table 1. Co-occurrence of different value proposition types. Percentages refer to the number of cases per column

Value type	Economic	Functional	Epistemic	Ethical/ Normative	Emotional	Social
Economic	100%	57%	50%	72%	63%	25%
Functional	51%	100%	67%	32%	38%	0%
Epistemic	37%	55%	100%	32%	21%	25%
Ethical/ Normative	37%	18%	22%	100%	33%	100%
Emotional	31%	20%	14%	32%	100%	25%
Social	2%	0%	3%	16%	4%	100%
# of cases out of 81	**49**	**44**	**36**	**25**	**24**	**4**

Figure 3 shows that the majority of offerings (about 75 %) makes use of payments (mostly a one-time one), while only a fraction (about 20 %) involves recurring fees. The figure further shows that value propositions making use of social and ethical arguments correspond well to recurring payment schemes,

such as fees, while value propositions highlighting functionality and knowledge gains are more prone to be combined with payment invoicing models.

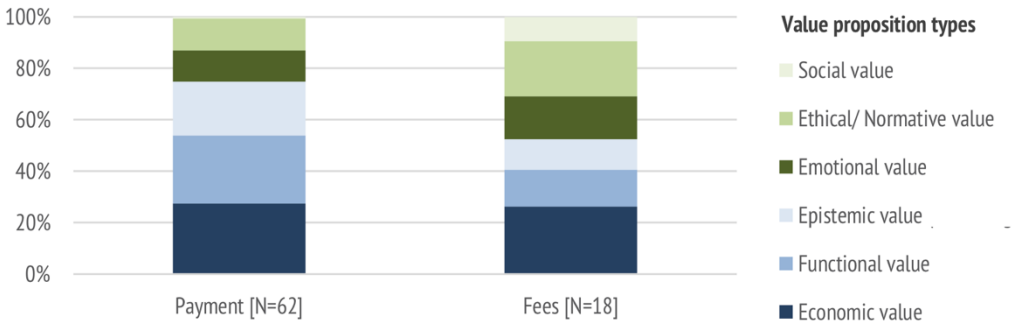

Figure 3. Correspondence between value propositions and invoicing models

Figure 4 shows that most offerings (> 80 %) address consumers – mostly owners of a self-occupied house. Fewer offerings (about 45 %) address other businesses, such as developers of real estate, governments, or owners of non-residential buildings. Both customer types are being addressed with the comparable types of value proposition.

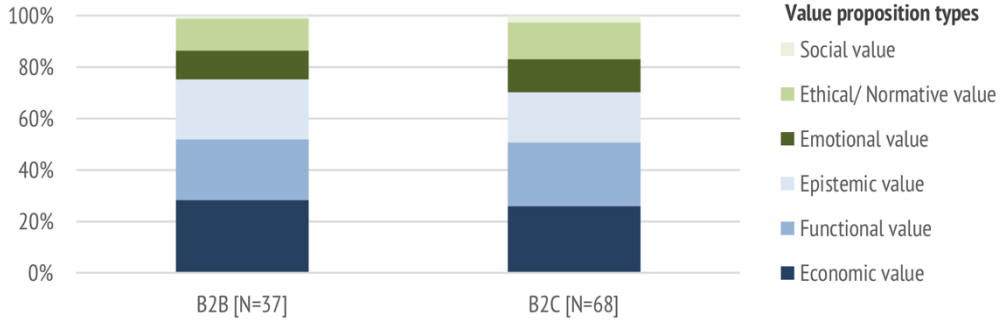

Figure 4. Correspondence between value propositions and customer groups

Figure 5 illustrates the correspondence between revenue stream types and different invoicing models as well as customer groups. The majority of offerings sell assets (about 80 %). Most of the time, generating revenue from selling assets is combined with a payment invoicing model. On the other hand, offerings which apply a licensing or brokerage revenue model, are more common to occur with a recurring, fee based invoicing model. The revenue models based on asset selling are somewhat less common in the B2B than in the B2C market.

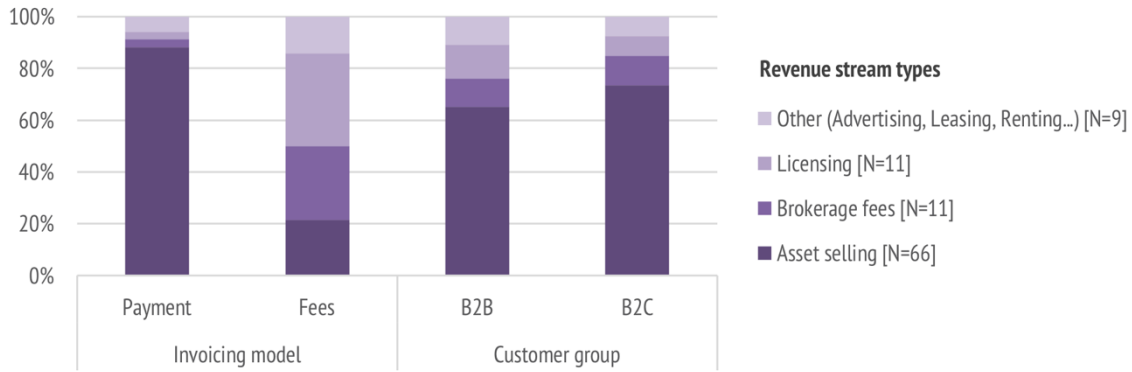

Figure 5. Revenue streams across the different invoicing models and customer segments

4. Discussion

For self-consumption offerings, similar value proposition types were observed for B2C and B2B customers. Other, more mature markets analyzed in different studies [26], such as the mobile phone market or markets for renovation of housing feature more specified value propositions for different customer groups. Given the rapid evolution and the fragmented nature of the market for self-consumption optimization, we expect various changes in the composition of the BMs as the market matures. As a consequence, the results of this study are subject to change. However, the used data was mainly collected in the second half of 2018 and the drawn conclusions deemed to be valid as of today (May 2019). However, frequent re-examination of the market is necessary.

A possible reason why emotional and ethical values are connected to fee-based business models, is that those values go hand in hand with people's personalities, which are self-reinforcing too. On the other hand, one-time payments match the reasoning of an investment decision, which is linked to economic and functional values. This observation is particularly interesting in the light of the ongoing debate and uncertainty concerning the economic value of battery storage and other means for increasing the self-consumption [3,4]. In contrast, the debate concerning ethical benefits of self-consumption is much less of a concern to individual households; but a political discussion due to the distribution of grid costs [27]. Additionally, the benefits from lower greenhouse gas emissions due to consuming locally produced renewable energy (an ethical value) [5] and the gain in comfort from smarter homes (an emotional value) are largely undisputed. Hence, fee-based BMs tend to feature less controversial value propositions.

As a limitation, this survey only investigates carefully selected elements of the business model. Further studies should survey additionally elements such as channels and/or more detailed customer groups. Additionally, the presented correspondences of business model elements are only a selection. Other correspondences could be analyzed and shown, too. Further, despite the acceptable cross-coding measures and the continuous refinement of the codes, the inter-coder reliability could still be improved. However, as the study does not only yield unexpected outcomes but as well corroborates expected correlations, such as the correspondence of asset selling (as revenue stream) and payments (as invoicing model). Nevertheless, for applications the conclusions need to be adapted to the individual case.

5. Conclusion

The study shows that the current offerings focus mostly on individual homeowners, provide economic and functional value propositions (VPs), apply a payment system as invoicing model and make use of asset selling as revenue model. However, there is a group of offerings that provide non-economic VPs, such as the contribution to the energy transition (ethical/normative VP), security and peace of mind (emotional VP) and/or membership to a group (social VP). These offerings tend to be more often associated with a recurring payment model, such as fees. Fees are also more common to feature advertising, licensing, brokerage-fees and/or renting as revenue mechanism. As a consequence, we recommend actors that wish to establish a recurring payment system to present a strong social, ethical and emotional VP, combined with a licensing and / or renting revenue model. The survey revealed similar patterns for the B2C and the B2B market and, compared to other markets, the VP seem to be too little adapted to the B2C market. Hence, we further recommend to a) better distinguish the VP between B2C and B2B markets and b) craft the VPs consumer centric, including more emotional values.

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