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Influencing the disruptive potential of sustainable technologies through value proposition design: The case of vehicle-to-grid technology

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ABSTRACT

Disruptive innovations often struggle to enter the mainstream market, especially those that benefit society. Innovative business models can help to make inferior technologies attractive and disrupt existing market linkages. As value propositions are an integral part of business models, they can play a key role in this process. This study explores the effect of value proposition design (VPD) on the customer value of sustainable technologies in the case of vehicle-to-grid charging. The result suggests that VPD can influence the trajectory and customer value of a technology and pave the way for disruptive innovation. It suggests to focus on utilitarian or hedonic values in VPD to target the low-end or high-end market respectively; a mixed approach reduces customer value. Hence, the study establishes a link between technology, value proposition, and market disruption. The results have important implications for research and practice as they offer an explanatory framework that can help managers in designing value propositions to accelerate the diffusion of sustainable technologies.

1. Introduction

How can novel, sustainable technologies disrupt the market if technological progress is too slow? This problem can be observed with many technologies, particularly those that create societal value, as the comparative slow uptake of solar panels and electric cars illustrate (cf. Bohnsack et al., 2020; Boons et al., 2013; Prado et al., 2016). Studies on disruptive innovation and business model innovation argue that, if a technology is not advancing fast enough, an innovative business model can make an inferior technology attractive, create new markets, and in turn disrupt existing market linkages (Chesbrough, 2003, 2006; Chesbrough and Rosenbloom, 2002; Christensen and Raynor, 2003; Govindarajan and Kopalle, 2006; Teece, 2010; Yu and Hang, 2010). In this vein, business model innovation is an important source of competitiveness specifically for sustainable innovations (Boons and Lüdeke-Freund, 2013; Schaltegger et al., 2012), put differently "firms need different business models to transform the specific characteristics of sustainable technologies into new ways to create economic value" and to "create new sources of value for customers in addition to their positive impact for the environment" (Bohnsack et al., 2014, p. 284).

Particularly the customer perspective is important for such innovations since it is generally assumed that sustainable technologies create value, yet customers fail to appreciate it. Hence, the value proposition, a central component of a business model (Abdelkafi et al., 2013; Chesbrough and Rosenbloom, 2002; Osterwalder and Pigneur, 2010), can play a vital role. A value proposition refers to a firm's promise or statement of benefits offered to customers (Lanning and Michaels, 1988). Studies have shown that firms modify or in other words 'design' value propositions in order to increase the customer value of a technology or service (Anderson et al., 2006; Bohnsack and Pinkse, 2017; Wu et al., 2010; cf. Osterwalder et al., 2014). Recent research on sustainable business models have offered tools and guidelines to increase attractiveness of sustainable business models (see, for instance, Baldassarre et al., 2017; Bocken et al., 2013, 2015;

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Notation list

EV	electric vehicle
I-CVI	item-level content validity index
KMO	Kaiser-Meyer-Olkin
n	sample size
NPD	new product development
PCA	principal component analysis
V2G	vehicle-to-grid
VPD	value proposition design

Geissdoerfer et al., 2016); however, to the best of the authors' knowledge, only few studies have explored how 'designing' value propositions may increase the success of disruptive innovations that offer social and environmental benefits. One such exception is the study by Bohnsack and Pinkse (2017) who show that firms apply different tactics, designing their value propositions to increase the customer value of electric vehicles (EVs). Another exception is Wu et al. (2010), however their study does not focus on a sustainable technology. Notably, Lim and Anderson (2016) state that it is imperative to study the value proposition that represents technology performance measures to understand future disruption. This paper, therefore, aims to fill this void by answering the research question: *how can the design of the value proposition influence the disruptive potential of a sustainable technology?*

In this paper we approach value proposition design (VPD) by looking at how the composition of value proposition bundles for a technology affects the trajectory of a disruptive innovation and the value for customers. This study adds to this debate by studying a novel sustainable technology that could disrupt the utility industry – vehicle-to-grid (V2G) charging. V2G allows plugged-in EVs to feed electricity back into the grid or throttling the charging rate during peak demand. Still, V2G technology faces not only technical but also social barriers which are difficult to overcome (Sovacool and Hirsh, 2009). Based on a focus group and a survey on V2G charging, different value proposition designs were tested for V2G and their effect on attractiveness. The results confirm that VPD can increase the attractiveness of sustainable technologies and hence influence the disruptive potential. Our findings further show that a performance-focused value proposition can help the technology diffuse from the high-end while an affordability-focused value proposition is entering via the low-end of the market. In doing so, this study heeds the call of Spieth et al. (2014) for more "*customer-centric business model* innovation and cocreation of value proposition" (p. 244). In addition, this paper explains a piece of the puzzle that business models are a translation device of technological input to commercial success (Teece, 2010). It studies the link between technology's performance attributes, value proposition, and disruptive innovation (cf. Lim and Anderson, 2016). It shows how VPD can shape the trajectory of disruptive innovation (cf. Govindarajan and Kopalle, 2006) and the importance of integrating the customer perspective in business model innovation specifically for sustainable technologies (Baldassarre et al., 2017; Boons and Lüdeke-Freund, 2013; Spieth et al., 2014). Moreover, only a few tools are available to help practitioners in the design of sustainable value propositions (Bocken et al., 2013; Geissdoerfer et al., 2016). This study uses a customer value perspective and offers managers an explanatory framework to configure different value bundles.

The structure of the paper is as follows: Section 2 reviews the existing literature and contextualizes VPD. Section 3 describes the methodology and the case of V2G as a disruptive innovation. Subsequently, section 4 presents the results, section 5 provides a discussion of results, and section 6 concludes the study and presents implications and limitations.

2. Literature review

Disruptive innovation emphasizes particularly the impact an innovation has on the market and refers to both disruptive technologies and disruptive business models yet does not necessarily require radical technologies (Yu and Hang, 2010). Disruptive innovations can offer less demanding, more demanding, or entirely new customers at the fringes of the market advantages that were previously not fulfilled by the incumbent technology (Danneels, 2004). While Christensen and Raynor (2003) argued that disruptive innovation diffuses from the low-end of the market or creates new markets, subsequent studies have shown that such innovations can also diffuse from high-end markets (Govindarajan and Kopalle, 2006; Schmidt and Druehl, 2008; Utterback and Acee, 2005). Low-end markets focus on lower tiers of main markets (e.g. discount stores), new markets compete with non-consumption (e.g. the PC), and high-end markets focus on the higher end of markets (e.g. mobile phones) (Govindarajan and Kopalle, 2006).

The success of disruptive innovations is determined by the technological progress, the value network, and the business model. If technological progress is not fast enough to cross the trajectory of the incumbent technology, the technology might fail. In this case, business model innovation can help to appeal to a wider market and still disrupt the incumbent technology (Bohnsack et al., 2014; Markides, 2006; Teece, 2010). For instance, when Apple introduced the iPod they were not the first to introduce a digital music player, but in combination with the iTunes store, which offered convenient downloading of digital music, they were able to disrupt the market (Johnson et al., 2008). Hence, business model innovation can redefine a technology and the way it is brought to the customer (Markides, 2006). This implies that there are more or less ideal business models for a technology to be attractive for the market (cf. Osterwalder et al., 2014). Because the value proposition – a firm's promise to deliver a bundle of benefits and values to its customers such as quality, price, performance, and convenience (Lanning and Michaels, 1988; Osterwalder and Pigneur, 2010; Treacy and Wiersema, 1993) – is an integral element of the business model, its modification can help to make the technology more attractive for the market, particularly when a technology is not advanced enough yet. The underlying modification mechanisms – i.e. VPD – have so far been studied in related fields, most notably Marketing, Strategy, Design-driven innovation, and sustainable business model innovation.

In Marketing for instance, innovation refers to changes in any of the 4 P's of marketing that is product, price, promotion, and place (OECD, 2005; Shergill and Nargundkar, 2005). Through marketing innovation, firms can increase the sales performance of a technology. For example, by breaking traditional value/cost trade-offs in a market, firms can find new value for customers and create so-called 'blue oceans' (Kim and Mauborgne, 2005). Elements of VPD have also been studied in strategy where it is related to the notion of positioning, i.e. "the creation of a unique and valuable position" (Porter, 1996, p. 68). In relation to technology, firms such as Dell or Apple can either adopt a differentiated position for which customers are willing to pay a premium price or a cost leader position. This can be achieved by designing an efficiency-centered business model, which reduces transaction costs or a novelty-centered business model, which finds novel ways of transactions (Brettel et al., 2012; Zott and Amit, 2007). The business model can help create this unique position (Baden-Fuller and Haefliger, 2013; Casadesus-Masanell and Ricart, 2010; Chesbrough and

Rosenbloom, 2002; Wirtz et al., 2010). Casadesus-Masanell and Ricart (2010) show that Ryanair's distinct choices in its business model, such as using secondary airports or offering no meals, created a unique low-cost leader position in the industry. Last, the underlying logic of VPD for technologies has also been studied in design-driven innovation, where it "aims [to] radically change the emotional and symbolic content of products (i.e., their meanings and languages)" (Verganti, 2008, p. 436), which suggests that changing value propositions can lead to a new meaning of a product or service (Battistella et al., 2012).

Changing meaning is particularly relevant for sustainable technologies which suffer often from slower market diffusion. This is because such technologies are often perceived as inferior by customers compared to incumbent technologies as externality costs are not reflected. Thus, recent studies have emphasized the importance of user-driven innovation (Baldassarre et al., 2017; Bocken et al., 2013, 2015; Geissdoerfer et al., 2016). Involving different customers or potential users in the design process (Baldwin and Von Hippel, 2011) can result in better value propositions (Baldassarre et al., 2017). As such, customer-centric design is relevant to induce behaviour change and to accelerate the adoption of sustainable innovations (Daae and Boks, 2015). Moreover, sustainable value propositions go beyond creating economic value by including other forms of values (Boons and Lüdeke-Freund, 2013) for a wide range of stakeholders including the environment and society (Bocken et al., 2014; Tyl et al., 2015). Therefore, conceptualizing value proposition for sustainable technologies is relevant but also complex (Kristensen and Remmen, 2019, p. 29). New tools and novel perspectives are required but still rare. A notable exception is the value mapping tool (Bocken et al., 2013), a network-centric tool that helps start-ups or incumbent firms in designing or changing their value propositions. It allows to identify stakeholders' needs and maps the value captured, value missed, value destroyed, and value opportunities-the four aspects of a value proposition (Geissdoerfer et al., 2016). Similarly, Yang, Evans, Vladimirov, and Rana (2017) propose a perspective on uncaptured value and develop four archetypes, namely value surplus, value absence, value missed, and value destroyed for sustainable business model innovation.

However, in relation to disruptive (sustainable) technologies, VPD has only gained limited attention. Hwang and Christensen (2008) argue that organizations that engage in disruptive innovation need to determine the configuration of a value proposition that fits their resources, processes and profit formula. Also, Wu et al. (2010) show that latecomer firms in the Chinese mobile handset industry and in the online peer to peer trading industry were able to capture market share with disruptive technologies by actively redesigning their value proposition. Recently, Bohnsack and Pinkse (2017) showed that firms reconfigure attributes of value propositions of disruptive technologies in order to increase their customer value. At the example of the car industry, they show that firms use tactics to increase the overall value of EVs compared to conventional vehicles.

While these studies have illustrated that firms configure value propositions, the relationship between the technology, the value proposition, and the customer is so far elusive. Yet, establishing the link between technological innovations and customers is important in order to generate value for customers, environment and society (Baldassarre et al., 2017; Keskin et al., 2013). Thus, there is a need to understand, how the technical inputs of a technology should be combined with a value proposition as a bundle of attributes to be attractive to a customer, either low-end, high-end or new market. This study fills this gap by proposing and exploring a framework of the VPD process for technologies that struggle to enter the mainstream market. Fig. 1 illustrates this process of VPD.

Fig. 1 shows that to design a value proposition, the attributes of a technology – which are mostly referred to as performance attributes – need to be translated by the value proposition to the customer to create customer value (Christensen and Raynor, 2003; Lim and Anderson, 2016). Performance attributes are the features or specifications of a technology, for instance, vehicle speed, colour, fuel consumption, etc. Customer value is derived from the benefits from these attributes, for instance, comfort, feel, safety, etc. As such, customer value is multi-faceted and understanding what a customer really values, is a precondition to design a differentiated value proposition (Rintamäki and Kirves, 2017). Customer value constitutes four dimensions: functional, economic, social, and emotional value (Rintamäki et al., 2007; Sweeney and Soutar, 2001). Functional value is defined as the utility derived from the offering due to its quality, convenience, and performance. Economic value is defined as the utility derived from the offering due to its lower price, higher value-in-exchange, or a better trade-off between price and quality. Some studies refer to functional and economic values, the two primary drivers of consumer choice, jointly as functional values (cf. Sheth, Newman and Gross, 1991a, b); others emphasize the importance of studying performance and price separately as two functional sub-factors (cf. Sweeney and Soutar, 2001). Social value is defined as the utility derived from the offering's ability to enhance self-concept and self-expression in a social circle. Finally, emotional value is defined as the utility derived from the offering due to the feelings or affective states attached to the offering. These value dimensions form a continuum, namely from utilitarian to hedonic dimensions (Rintamäki et al., 2007). Functional and economic are more utilitarian while social and emotional values are more hedonistic.

In the context of disruptive innovation, the design of a value proposition for a sustainable technology can emphasize one, two or all of these values. What is more, considering the nature of features, a value proposition for a technology can be configured in ways that pave the trajectory for the low-end, high-end or new market (see Fig. 1). The following empirical part of this study explores these respective effects of VPD.

3. Method

3.1. Research setting: vehicle-to-grid technology

This study explores VPD at the example of a new EV charging technology, called vehicle-to-grid technology. V2G technology is a novel technology in the utility industry based on EV charging. Today, with increasing adoption of EVs in some lead markets (e.g. California, the Netherlands, and Norway) (Olson, 2018), charging batteries of increasing numbers of EVs has increased peak demand in the electric grid which can lead to power outages and can damage the grid (Jahangir et al., 2019). This is primarily due to the increasing number of EVs but also because EVs are often charged at the same time (e.g. at 6 p.m. when drivers return home from work). With V2G technology EVs can be charged in a smarter way, namely the timing of charging can automatically be allocated to different times and the battery of an EV can also be discharged, i.e. feed back (excess) energy to the grid when there is peak demand for electricity. Hence, the unique idea behind V2G is to use EVs as a source of energy generation and power reservoir in the grid. While the V2G technology itself may not be able to disrupt the market, combined with an innovative business model it has the potential to disrupt the electricity industry (Guille and George, 2009; Parsons et al., 2014). V2G technology enables efficient use of electricity resources, balances energy fluctuations, provides control and flexibility to the EV owner, and enables them to trade electricity during peak hours. It can also reduce the lifetime cost of EVs, indirectly

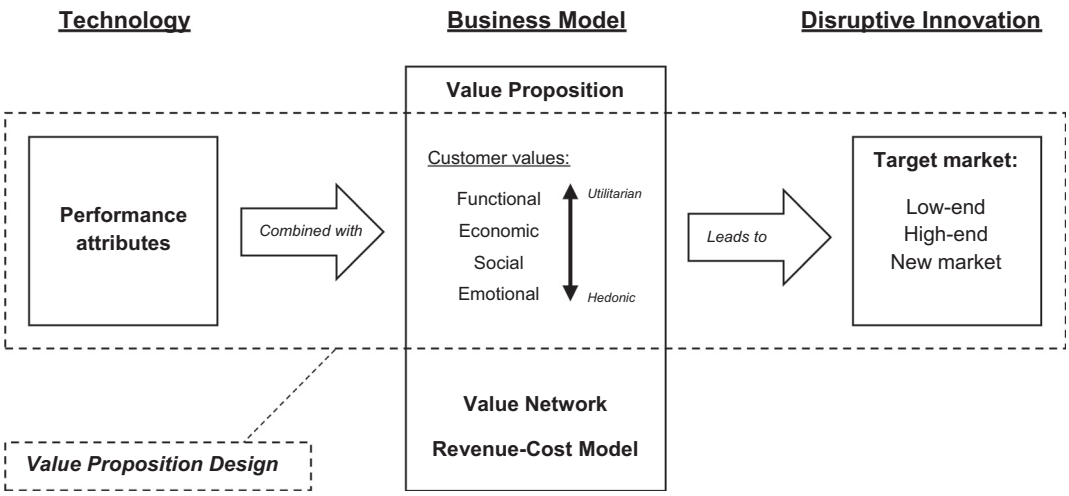

Fig. 1. The process of value proposition design for disruptive innovations.

increasing the benefits of driving EVs (Sovacool and Hirsh, 2009). This creates value for suppliers of energy but also for consumers. It also benefits the environment by reducing greenhouse gas emissions, utilizing renewable energy sources, and improving the uptake of sustainable vehicles (Lund and Kempton, 2008). Yet, only few EV drivers opt for the adoption of V2G technology as it entails costs and complexities (Sovacool and Hirsh, 2009), namely a suitable infrastructure for V2G is missing, the technology can have a deteriorating effect on the battery of EVs, and it requires behavioral changes from the user. Thus, the value of V2G is controversial. It has positive effects for utilities, but for (potential) consumers the benefits come at a cost. Clearly, this context makes V2G an interesting case for VPD.

3.2. Data collection process

Following a mixed-method approach, data was collected in two steps: via a focus group and an online survey. First, a focus group meeting was conducted in the Netherlands with lead users (Von Hippel, 1986) in June 2015. Twenty-four EV enthusiasts who either owned an EV or had already tried and decided to adopt an EV were purposively selected from a list of a randomly drawn Dutch sample. Lead users were selected as they expect high benefits from a new technology and are ahead on important trends in the marketplace (Von Hippel, 1986). However, the purposive sampling technique in which "particular settings, persons, or events are deliberately selected for the important information they can provide that cannot be gotten as well from other choices" (Maxwell, 1997, p. 87) suffers from bias as the selection of the sample is based on the researcher's subjective criteria. The purpose of the focus group meeting was to identify and explore the value and nature of attributes for three value propositions which were previously designed and confirmed with industry experts. Before consulting industry experts, the authors first designed a list of utilitarian and hedonic V2G attributes. In line with Treacy and Wiersema (1993), two value bundles were configured according to a particular value discipline – the first included a fixed monetary reward but relatively low flexibility with an emergency button option and the other emphasized performance with high flexibility and included a membership function. The last one was the *all benefits* value proposition (Anderson et al., 2006) that combined functionality (flexibility and relocation option) and affordability with an additional benefit of being part of a social club. The participants of the focus group were shown each value proposition and asked what they value in terms of economic, functional, hedonic and social performance attributes. Their feedback confirmed the clarity and consistency of each configuration.

Second, an online survey was conducted amongst Dutch EV and non-EV drivers from November to December 2015. Prior to the survey, a pre-test assured the clarity and validity of the instrument. For the survey, a snowball non-probability sampling technique was used. For that, industry associations, EV interest groups, and colleagues working in the field were contacted with a request to fill in the online survey and to send the survey link to their acquaintances. Follow up strategies were adopted to get timely and maximum responses. For that, gentle reminders were sent via email and telephonic calls were made to request associations and colleagues to fill in the survey. This process resulted in 102 responses. However, after deleting responses with missing data, 54 responses were left as a useable set of data. The descriptive statistics of the final sample are shown in Table 1. The majority of respondents were above 45 years (56%), were highly educated (89%), earned more than € 4.001 (57%), and owned EVs (61%).

In the survey, first the V2G technology was explained. Subsequently three different value propositions for the V2G technology were presented: one addressing the low-end market, focusing on affordability called the Electricity Bank (see a screenshot in Fig. 2), one addressing the high-end market focusing on performance called the Electricity Club, and one combining both elements, affordability and performance, called the Green Electricity Club (see Table 2 for the characteristics of all value propositions). The respondents were shown the configurations one by one and asked to rate the attractiveness of each on a 5-point scale where 1 = "very unattractive" and 5 = "very attractive". The configuration section collected not only the attractiveness scores but also respondents' comments for the three configurations of the V2G value proposition. The different propositions were not randomized as a sequence of configurations was assumed.

Marketing and technology adoption literature advocates that individuals' characteristics like socio-demographics and psychographics affect the decision choice (Arts et al., 2011). Therefore, the respondents were also asked to provide the socio-demographic and psychographic data. For psychographics, questions were asked to measure the individual's environmental beliefs, innovativeness, and sharing and social media use on a 5-point Likert scale ranging from 1 = "strongly disagree" to 5 = "strongly agree". Consumer

Table 1
Descriptive statistics of the explorative online survey (n = 54).

Socio-demographics		Frequency *(%)*
Gender	Male	48 *(88.9)*
	Female	6 *(11.1)*
EV experience	1 year & less	33 *(61.1)*
	More than 1–2 years	13 *(24.1)*
	More than 2 years	8 *(14.8)*
Monthly Income	€ 3000 and less	8 *(14.8)*
	€ 3001-4000	15 *(27.8)*
	€ 4001-5000	14 *(25.9)*
	€ 5001 and above	17 *(31.5)*
Age	18–34	11 *(20.4)*
	35–44	13 *(24.1)*
	45–54	19 *(35.2)*
	55 and above	11 *(20.4)*
Education Groups	Lower vocation education	1 *(1.9)*
	Secondary vocational education	5 *(9.3)*
	Higher professional education	21 *(38.9)*
	University Education	27 *(50.0)*
EV usage	EV driver	33 *(61.1)*
	Non-EV driver	21 *(38.9)*

innovativeness, involvement, beliefs, media proneness, etc. most frequently appear in the literature (cf. Arts et al., 2011; Bartels and Reinders, 2011; Goldsmith and Hofacker, 1991; Hirschman, 1980; Roehrich, 2004). The scale items of consumer innovativeness were adopted from Goldsmith and Hofacker (1991) while the scale items for the other two constructs were developed based on a literature survey and experts' suggestions. The measures available in the literature were adapted and few new items were added based on experts' opinions to fit the empirical setting. The descriptions of these variables are given in Table 3. The new scale items were content validated. Items were refined or deleted based on experts' suggestion when item-level content validity index (I-CVI) was lower than 0.78 (Lynn, 1986). Nine items were retained for inclusion in the survey and factor analysis.

4. Results

In the following the findings of this study are presented. First, an exploratory cluster analysis was carried out based on factorized consumer psychographics and socio-demographics (McLeay, Yoganathan, Osburg, & Pandit, 2018; Osburg et al., 2016). For this, a principal component analysis (PCA) was conducted and then a hierarchical cluster analysis based on the socio-demographic variables and extracted factors from PCA was conducted using SPSS (cf. Hinkeldein et al., 2015). There is no strict rule regarding subject to item ratio to run the factor analysis, a rule of thumb, however, suggests a ratio of 10:1 or less (Osborne and Costello, 2009). Like the majority of other studies, this paper reports PCA based on the ratio of 2:1 (Osborne and Costello, 2009). However, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy value was greater than the threshold value 0.60 which confirms that the sample was adequate to run the factor analysis. Similarly, the significant p-value of Bartlett's test of sphericity confirms that the factor extraction was useful. A PCA was run for all the psychographic measures recorded on a 5-point Likert scale using direct oblimin rotation method. Results are shown in Table 4. Four factors were extracted from the component analysis referred as innovativeness, sharing propensity, environmental friendliness, and social media use. Sharing propensity and social media use were split into

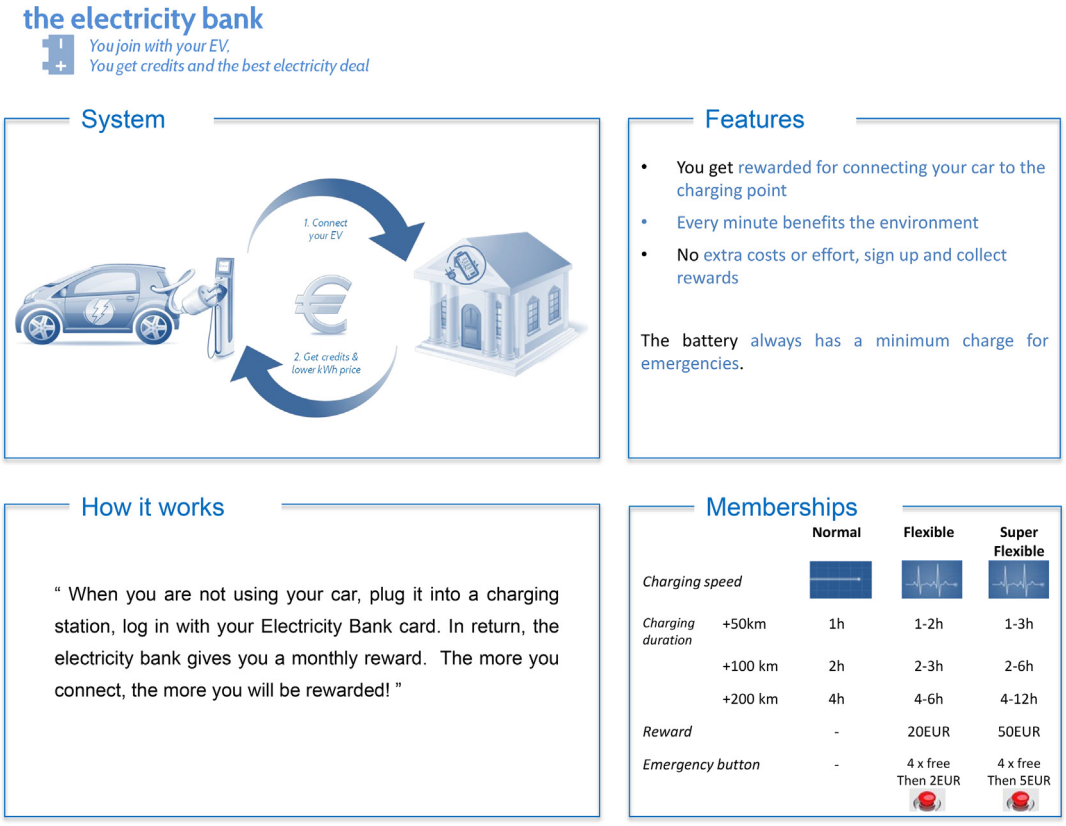

Fig. 2. Example of a value proposition visual which was shown to the surveyees, in this case the Electricity Bank value proposition with a focus on affordability. Each of the four boxes represents elements that the viewer should take into account. Box 1 (top left) provides a visual of the business model, box 2 (bottom left) explains the visual in one or two simple sentences, box 3 (top right) explains the features, and box 4 (bottom right) details the respective monetization mode in detail.

Table 2
V2G value proposition configurations.

	Low-end market value proposition: Electricity Bank	High-end market value proposition: Electricity Club	High-end & low-end market combined value proposition: Green Electricity Club
Value proposition explanation	The customer signs up for a monthly plan in which s/he agrees on a level of flexibility (medium or high) to which the utility company can use the battery of the EV as storage. This could result in prolonged charging time. In return, the customer gets a fixed monetary reward (e.g. 20 Euro or 50 Euros).	The customer signs up for membership. Every time a customer charges s/he is asked for the flexibility (e.g. when is how much battery charge required) to which the utility company can use the battery of the EV as storage. Customers collect credits when they are flexible. These credits can be used for free charging or turned into air miles. Members can gain silver and platinum status depending on their activity.	Customers are part of a community and get green points for each time they are flexible to which the utility company can use the battery of the EV as storage. Customers get free charging for points, can charge for free at participating restaurants and can compare their green points to their peers. In addition, customers can contact other community members to ask them to relocate their fully charged cars from charging locations.
Functional attributes	Low flexibility	High flexibility	Flexibility plus relocation functionality
Economic attributes	Fixed monthly monetary reward	Free charging against credits and collection of air miles	Free charging at participating restaurants with charging points and free charging against green points
Emotional attributes	n/a	n/a	Social comparison in community
Social attributes	n/a	Membership and status	Part of the community
Needs fulfilled	Utilitarian	Hedonic	Utilitarian + Hedonic
Focus	Low-end: Affordability	High-end: Performance	Mixed low and high end: Affordability and performance
Results of cluster analysis: levels of attractiveness			
Sharers	3.3	3.3	2.8
Rich innovators	3.1	3.3	3.2
Conservative environmentalists	3.4	3.4	3.1
Social innovators	2.3	3.1	2.9
Young educated $_{(non\ EV)}$	2.9	2.9	2.9
Holistic sceptics $_{(non\ EV)}$	3.9	3.3	3.2

Note: Columns 2, 3, and 4 in the above table show characteristics of Electricity Bank, Electricity Club, and Green Electricity Club respectively. Row 1 provides details of each value proposition. Row 2 shows the list of attributes of each value proposition. Row 3 identifies the main focus of each proposition. Row 4 indicates the average score of the attractiveness of individuals in each cluster identified during cluster analyses in section 4. The level of attractiveness is measured on a 5-point Likert scale ranging from 1 = very unattractive to 5 = very attractive while 3 = neutral. n/a = not available.

Table 3
Description of psychographic variables.

Variables	Description	Source
Innovativeness	An individual's tendency to adopt a new product or service more quickly than others	Goldsmith and Hofacker (1991)
Environmental friendliness	Environmental consciousness or behaviour: use, purchase, or behaviour that are perceived as having a positive impact on ecology	Harland et al. (1999); Roberts and Bacon (1997)
Sharing and social media use	Individual's perceived usefulness of social media and sharing attitude	Jarvenpaa and Staples (2000); Kim et al. (2015); Kwon and Wen (2010); Lin and Lu (2011)

two distinct factors during the extraction. Six items load on innovativeness with all factor loadings greater than the recommended threshold value of 0.4 and no cross-loadings (Osborne and Costello, 2009). Similarly, three factors load on sharing, four on environmental friendliness, and two on social media use. These four factors were further used in cluster analyses to build customer groups.

In the next step, clusters were identified based on the factors. Two separate hierarchical cluster analyses were conducted to group EV and non-EV respondents because different experiences and preferences of both groups towards energy consumption were assumed. The analyses were based on the input of customers' psychographic and socio-demographic variables such as age, income, and education. The cluster analyses revealed four EV user groups and two non-EV user groups. These clusters were named 'sharers', 'rich innovators', 'conservative environmentalists', 'social innovators', 'holistic-sceptics', and 'young educated' in accordance to their attitudes and preferences. These clusters with respect to their psychographic characteristics are shown in Fig. 3 below.

The cluster characteristics are presented in Table 5. The first cluster is referred to as Sharers ($n_1 = 4$). This cluster has a surprisingly high experience of using EVs (mean = 4.3 years) compared to other clusters. In addition, they score highest on sharing propensity while relatively low on social media use. This cluster is also well educated and has a high income. The second cluster is referred to as Rich innovators ($n_2 = 14$). Their innovativeness score and monthly income are highest (€ 5000 and above) among all clusters. However, they have a low sharing propensity. The third cluster is referred to as Conservative environmentalists ($n_3 = 8$) because they only care about the environment but have a negative attitude towards innovativeness, sharing and social media use. Individuals in this group belong to the highest age group (55 years and above). The fourth cluster is referred to as Social innovators ($n_4 = 7$). Their social media use score is highest among all groups. They are also very innovative. However, they have the lowest sharing propensity. Also, their monthly income and education are lowest among all groups. The fifth cluster is referred to as Holistic sceptics ($n_5 = 12$). They are non-EV users who score relatively high on sharing and environmental friendliness. The sixth

cluster is referred to as Young educated ($n_6 = 9$). They are non-EV users and belong to the lowest age group. They have low salaries compared to others but are highly educated. They are indifferent individuals who are neutral towards innovativeness, sharing, and social media use. All clusters care about the environment, which might also be a country-of-origin effect.

In the next step, it was explored how differently configured value propositions influence the attractiveness of the V2G technology (see Fig. 4). As described above, each value proposition had a different customer value focus. Every cluster was compared with their scores on attractiveness for each value proposition design. By adding the attractiveness score for each customer cluster per value proposition, the results show that overall, the performance-based value proposition was most attractive (i.e. the Electricity Club) among EV users (see Table 2). Verbatim statements in the comments suggested that added functionality of being flexible and the collection of credits were perceived very positive. This means that by adding flexibility and a membership function to the value proposition, V2G had a performance focus and could be regarded as a high-end disruptive innovation. The affordability focused value proposition (i.e. the Electricity Bank) followed closely as second-best preferred value proposition among EV users. The Conservative environmentalists, as well as the Sharers, ranked this value proposition equally high as the performance-focused value proposition. They specifically praised the reduced costs for charging in their comments. The Rich innovators and Social innovators preferred the performance-based value proposition over the other two. The non-EV users, on the other hand, show different preferences. The Holistic sceptics were very attracted to the affordability focused value proposition. This shows that inexperienced or potential users can be attracted to a new technology by offering a utilitarian solution (Rintamäki et al., 2007). But the Young educated non-users earning very low wages were neutral to all propositions. Their early stage of career development is the possible reason for their unconcerned behaviour towards V2G and EV technology. The least attractive value proposition for the V2G technology to all EV and non-EV users was the combined value proposition (i.e. the Green Electricity Club). It offered a mix of cost savings and additional functionality such as getting in contact with members to relocate their cars, and hedonic benefits like social comparison and being part of a club. In verbatim comments, respondents of the study stated that the combined value proposition was too complex and unclear.

Concluding the above, the results suggest that configuring the V2G technology with different value propositions influence the customer value. In other words, by changing or adding customer

Table 4
Factor loadings and standardized factors.

Factors and Items	Factor Loadings			
	Innovative-ness	Sharing Propensity	Environ-mental Friendliness	Social Media Use
I am first to buy new products among my friends	0.908			
I know the names of new products before others know	0.832			
Compared with friends, I have new products	0.807			
If I hear about a new product in the market, I am interested in buying	0.807			
I am the last one among friends to know the name of the latest products [a]	0.645			
Even if I have not heard, I will buy the new product	0.491			
I make extensive use of new sharing concepts		0.783		
I think the growing number of sharing concepts is an important development		0.745		
I would not mind participating in a car-sharing concept		0.719		
Waste separation gives me a good feeling			0.764	
If I drive a car, I will do my best to drive economically/efficiently			0.728	
I always check that all lights are off while leaving home			0.692	
I think it's important that my energy provider delivers green energy [b]			0.398	
I use social media to follow others' lives				0.856
I like to keep people informed of highlights via social media				0.745

[a] Item was reverse coded for analysis.
[b] Item retained with caution as loading is approximately 0.4.

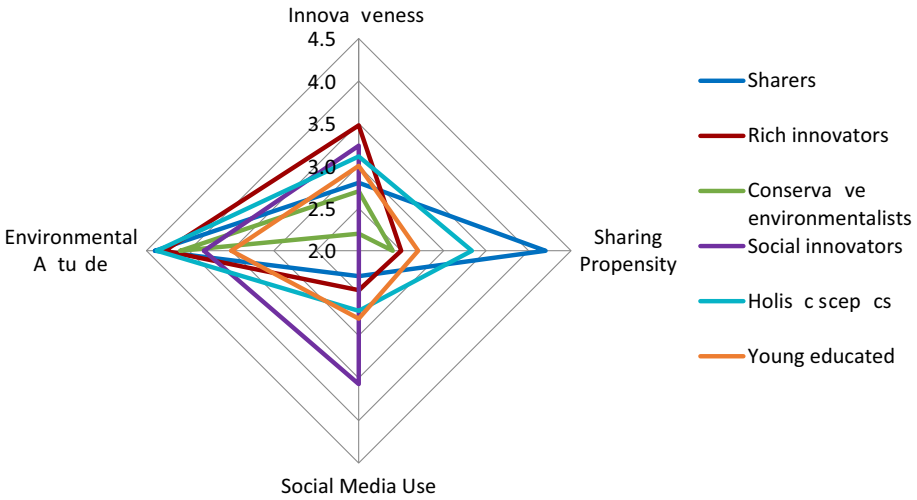

Fig. 3. Customer clusters based on customer psychographics.

Table 5
Cluster comparison.

Cluster	Sample size (n)	Charging Experience (in years)	Age	Education	Income	Innovativeness	Sharing propensity	Social Media Use	Environmental Attitude
Sharers	4	4.3	2.3	3.5	3.5	2.8	4.2	2.3	4.4
Rich innovators	14	1.6	2.9	3.4	3.8	3.5	2.5	2.5	4.3
Conservative environmentalists	8	1.6	3.3	3.3	2.3	2.2	2.4	1.3	4.1
Social innovators	7	1.6	2.9	2.4	1.6	3.2	2.0	3.6	3.8
Holistic sceptics$_{(non\ EV)}$	12	0.0	2.7	3.5	2.9	3.1	3.3	2.7	4.4
Young educated$_{(non\ EV)}$	9	0.0	1.1	3.9	1.9	3.0	2.7	2.8	3.5
Mean scores		1.5	2.5	3.3	2.7	3.0	2.9	2.5	4.1

Note: Age, education, and monthly income are categorical variables with four categories as indicated in Table 1, where 1 represents the lowest and 4 represents the highest age, income, and education group. EV charging experience in years is a continuous variable. The psychographic constructs are observed on a 5-point scale as discussed in section 3.2. All the variables are averaged for each cluster.

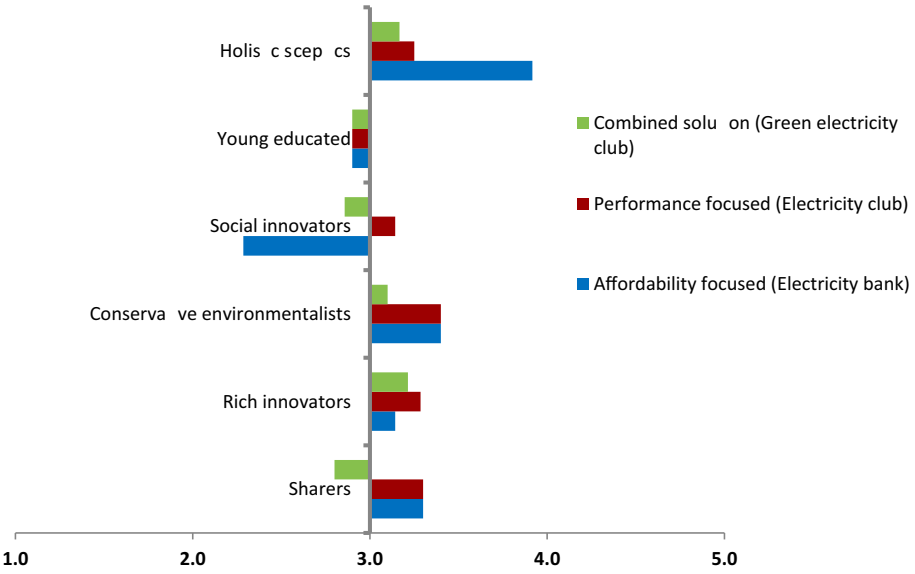

Fig. 4. Visual representation of attractiveness of value proposition configurations by customer segments (horizontal axis reflects the degree of attractiveness, 3 = neutral).

values, the technology's trajectory was changed significantly. Although exploratory, the results suggest that VPD rendered the technology as either low-end disruptive innovation or a high-end disruptive innovation. Stressing economic values created a more utilitarian bundle which positioned the technology more attractive for the low-end market and new market (for instance, non-EV users). Emphasizing social and emotional attributes created a more hedonic bundle which appealed to the high-end market. However, in either case, the functional value was a necessity. The results also indicate that the combination of utilitarian and hedonic values is regarded as less attractive by all types of vehicle users.

5. Discussion

This study explored value proposition design for disruptive innovation that can benefit society, i.e. how the design of a value proposition can influence the trajectory of a sustainable technology in order to disrupt the market. The findings indicate, first, that a value propositions can increase the attractiveness of a technology, and second, depending on the emphasized customer values, a technology can be positioned as high-end, low-end or new market disruptive innovation, i.e. cater to a specific market (see Fig. 5). Third, a mixed bag of attributes was found – i.e. a jack of all trades – to decrease attractiveness; confirming findings of Anderson et al. (2006) that a combined, too complex value proposition is less appealing and unclear to the potential user. The explanatory framework in Fig. 5 below illustrates the effect of VPD on disruptive technologies. VPD can help to elevate a disruptive technology to become attractive for the high-end market by stressing hedonic elements (see Arrow 1, Hedonic VPD). Equally, VPD can configure a value proposition in a way that it is appealing for the low-end or new market by stressing utilitarian elements (see Arrow 2, Utilitarian VPD). A combination of hedonic and utilitarian elements will likely not shift the trajectory, continue its trajectory and therefore not disrupt any market (see Point 3). This result shows, in accordance with business model designs themes (cf. Brettel et al., 2012; Hu, 2014; Zott and Amit, 2007, 2008), that efficiency-centered and novelty-centered value propositions are two important design themes to target a specific market (low-end, high-end, and new customer).

This more fine-grained understanding of VPD establishes the link between a technology's performance attributes, the value proposition, and disruptive potential which previously has been elusive (cf. Lim and Anderson, 2016); demonstrating that a technology in combination with an innovative business model can disrupt the market as well as illustrating how VPD can be an integral part in shaping the trajectory of disruptive innovations (Govindarajan and Kopalle, 2006; Yu and Hang, 2010). The different value propositions of V2G reflect value propositions as multifaceted bundles of customer values (Kristensen and Remmen, 2019). Future

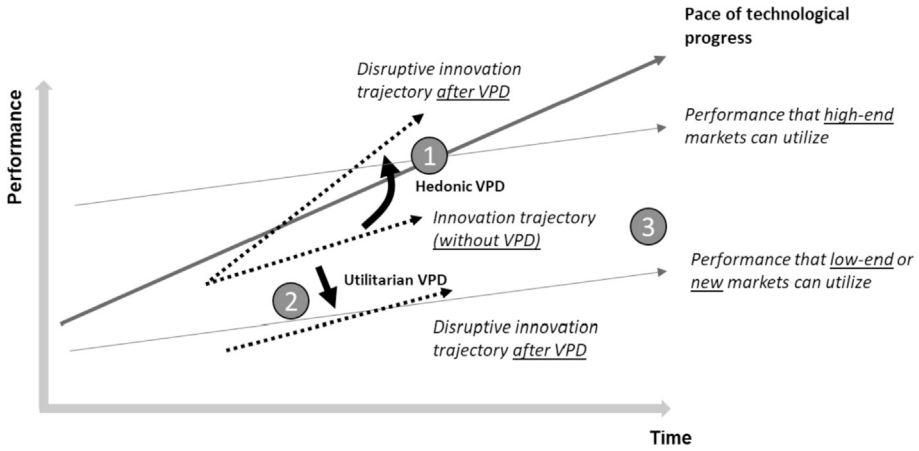

Fig. 5. Explanatory framework for value proposition design.

research may want to go beyond utilizing customer values for VPD and study VPD from a design perspective or user-driven innovation approach, for instance exploring how the change of 'meaning' can drive disruptive innovation or whether the perspective of the customer journey can further stimulate disruption (Geissdoerfer et al., 2016; Verganti, 2009). At the same time, the focal importance of the value proposition was shown, integrating the customer perspective in business model innovation for technologies, specifically for sustainable technologies (Baldassarre et al., 2017; Boons and Lüdeke-Freund, 2013; Foss and Saebi, 2017; Spieth et al., 2014). Yet, at the moment it is unclear how VPD influences the value network. While some modifications might have little impact on the value network, others might require considerable change. Moreover, future studies should take a dynamic perspective on VPD, specifically in relation to new product development (NPD). This could reveal that an ex-ante VPD process and iteration between VPD and NPD could reduce development costs of technologies, which is specifically desirable for technologies that create well-being for the society as it may accelerate the diffusion.

Next to the academic contribution, this paper has also clear managerial implications. The suggested VPD framework can help managers to design better value propositions for technologies to disrupt a market. Although exploratory, the results suggest that involving lead users in the process would support companies in the development of sustainable value propositions. These value proposition solutions can help managers in overcoming the drawback of directing their efforts solely on technological improvements. Moreover, the framework can help anticipate the performance for respective target markets. Moreover, it is suggested to utilize Figs. 1 and 5 as analysis tool and guiding framework. This can enable a more structured and efficient approach to design the value proposition in the business model innovation process.

6. Conclusions

This study conceptualized VPD as the link between a technology and disruptive innovation and explored how it affects the technological progress and disruptive potential of an innovation that benefits society but struggles to enter the mainstream market. The study shows that the success of a disruptive innovation – high-end, low-end, or new market-focused - not only relies on the technology but also on the design of the value proposition comprised of different value bundles. At the case of V2G technology, the value of VPD was demonstrated. The results confirm that value proposition design can increase the attractiveness of an inferior technology. A value proposition based on performance and hedonism appeals more to high-end customers whereas a value proposition based on utilitarian value appeals more to low-end or even new customers. The *all benefits value proposition* is less appealing however and could result in a negative attitude towards the technology.

In short, VPD helps to fulfil the core objective of a business model, i.e. translate technological input to commercial success (Chesbrough, 2006) - all the more for sustainable technologies. Still, the existing work on marketing innovation, design-driven innovation, and sustainable business model innovation does not explicitly explain this link in terms of technologies which are sustainable and have the potential to disrupt the existing market. Next to the academic contribution of conceptualizing VPD, a framework was proposed, which may stimulate disruptive innovations that create well-being for society.

While the chosen research design helped us to explore VPD the method bears limitations. First, given the small sample size, the results can only give indications as to which VPD approach is more successful. Although the results are in line with extant theory, future research needs to confirm these findings. Second, the use of a non-probability sampling technique has its limitations as it suffers from selection bias and inability to generalize findings to population. Third, the assessment of the nature of the attributes was only validated in the panel group. Thus, it is not certain whether respondents in the survey perceived the value propositions as the panel did. In the future, a conjoint analysis could provide more fine-grained results.

Declaration of competing interest

The authors have no conflict of interest.

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