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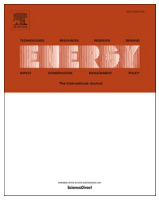

A consumer-satisfaction model to foster consumer participation in digital sustainable energy systems

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ABSTRACT

Active consumers lie at the heart of the energy transition towards digital sustainable energy systems. With digital technologies becoming more prevalent in smart homes and factories, there exists an array of opportunities for energy consumers to play an active role in the energy system and gain economic as well as ecological benefits, e.g., by generating renewable electricity themselves. Once consumers seize these opportunities, it affects the characteristics of consumed or sold energy, which we refer to as energy features (e.g., electricity price or regionality). To foster active consumer participation, understanding consumers' preferences regarding energy features is imperative. We survey 401 private and 40 industrial consumers in Germany and analyze consumer satisfaction building on the Kano Model. Our results reveal which energy features are most important to foster consumer satisfaction and which are less important. Thus, they provide valuable insights on how to successfully foster active consumer participation in digital sustainable energy systems.

List of abbreviations (in order of appearance)

(M)	Must-be feature
(O)	One-dimensional feature
(A)	Attractive feature
(I)	Indifferent feature
(R)	Reverse feature
(Q)	Questionable feature

1. Introduction

The impacts of climate change are global in scope and unprecedented in scale [1]. Without drastic action today, ecosystems and human life are at risk [2–4]. We are in dire need to scale up the adoption of renewable energies to comply with our ambitious climate goals, reduce energy costs, and decrease dependencies on fossil fuels [5,6]. Against this background, it will be imperative for consumers to participate in and actively contribute to the energy transition [7]. For example, consumers may take an active role in digital sustainable energy systems by installing renewable energies on their own premises (e.g., photovoltaic systems) and selling (excess) electricity or by increasing the system-wide utilization of renewable energies by aligning their individual electricity consumption with the temporal and weather-dependent availability of renewable energies.

Consumer participation is a prerequisite for successfully managing the energy transition [7]. Emerging digital technologies are a key enabler for a more sustainable, affordable, and resilient energy supply and provide all means for consumer participation in integrated energy systems [8–10]. For example, these systems allow real-time, autonomous, secure, and local peer-to-peer electricity trading between decentralized renewable electricity generators and consumers [11], or to intelligently manage grid utilization on the basis of interactive communication, control, and monitoring of different energy assets [12]. With digital technologies becoming more prevalent for consumers (e.g., in smart homes or smart factories), there exists an array of opportunities to take an active role in the energy system as described above. However, those opportunities for consumers typically affect the characteristics of consumed or sold energy, which we refer to as energy features (e.g., electricity price, sustainability of electricity supply, or regionality of electricity generation). To achieve a rapid and consumer-driven energy transition, it is particularly important to take

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consumer preferences for energy features and resulting consumer satisfaction into account [13]. Consumer preferences represent essential determinants of whether consumers will actively involve in digital sustainable energy systems. Therefore, consumer satisfaction regarding energy features is key. Consumers' willingness to invest in an electrical storage substantially depends on their preferences regarding those features. To that end, our study aims at linking the features of energy supply and generation induced by novel technology-enabled opportunities for consumer participation with consumer preferences. In doing so, we deliberately focus on private and industrial consumers. Private consumers (i.e., households) and industrial consumers represent two particularly relevant consumer segments, as they typically account for large shares of energy consumption, e.g., more than half of total energy consumption in Europe [14]. Thus, private and industrial consumers feature high potentials to contribute to achieving our ambitious climate targets.

Numerous studies have explored digital business models for consumer participation to actively co-create digital sustainable energy systems [15,16]. So far, however, few studies have focused on the associated effects on consumer satisfaction, representing an important determinant of consumers' willingness to seize such opportunities [17,18]. This study sets out to bridge this gap between technology-enabled opportunities for consumer participation and consumer satisfaction. In particular, we infer novel energy features and examine the importance that private and industrial consumers attach to those features. Further, we investigate, how energy features affect consumer satisfaction. In doing so, the Kano Model builds the theoretical foundation of our study. The Kano Model is widely applied in both, Marketing and IS research, and is usually employed to understand and categorize consumer needs regarding features of products or services in the digital realm [19–21].

Our research question reads: *How does the fulfillment of energy features affect the satisfaction of private and industrial energy consumers?*

To answer this question, we conducted a representative online survey to elicit private and industrial consumers' preferences. We collected data from 401 private and 40 industrial consumers. Our study yields three key findings: First, consumers consistently perceive energy features to be important. Second, for both private and industrial consumers, energy price and excludability from energy consumption are performance features – they increase consumer satisfaction when fulfilled but decrease satisfaction if not. Third, energy autarky and profit potentials are excitement features for private and industrial consumers – they increase consumer satisfaction when fulfilled, but do not cause dissatisfaction. Additionally, having greater agency regarding the energy transition and contributing to reduced energy system costs are excitement features for industrial consumers. Overall, with our research, we gain important insights regarding consumer satisfaction in the context of digital sustainable energy systems, which we believe is an important step towards enabling consumers to play an active role in the energy transition towards more sustainability at large scale and all levels of society.

This study is structured as follows: We outline the theoretical background of this study in Section 2. Then, Section 3 introduces the applied research method. We present our results in Section 4, followed by a discussion of implications, and limitations of our study in Section 5. Finally, we summarize our findings and conclude in Section 6.

2. Theoretical background

First, we need to understand emerging opportunities for consumer participation in digital sustainable energy systems. Second, we elaborate on how those opportunities translate into energy features perceived by consumers. Third, we focus on linking energy features with consumer satisfaction.

2.1. Opportunities for consumer participation in digital sustainable energy systems

Due to the urgent need for fast decarbonization, the traditional paradigms of energy systems are subject to fundamental change. Specifically, high shares of renewable electricity generation are associated with a high number of decentralized renewable energy sources instead of a small number of large fossil generators [22]. Further, the intermittent and stochastic nature of renewable electricity generation requires a high degree of temporal flexibility, which may be provided by flexible energy demand or storage systems [23,24]. To successfully master the transition towards more sustainability, consumers need to take on an increasingly active role in energy systems to leverage the decentralized scale-up of renewable energies and flexibility potentials on the demand side [7].

Various studies have highlighted that digital innovations and technologies provide novel solutions to effectively master associated challenges and unlock opportunities for consumers to participate in the energy transition [25,26]. Especially digital technologies unlock new possibilities that may be utilized by private or industrial consumers offering monetary profits and may contribute to a more sustainable energy supply [7]. Such technology-enabled opportunities for consumer participation in digital sustainable energy systems finally allow consumers' role to shift from merely a passive role towards an active role, e.g., by generating and trading electricity or by dynamically aligning own electricity consumption with the availability of (renewable) electricity supply [7]. Digital technologies and their characteristics such as fast distribution of information, connectivity, or autonomy substantially enable those opportunities. For example, digital software solutions for home-management applications allow private energy consumers to adapt their consumption (e.g., electric vehicle charging) to the availability of renewable energies and to corresponding price signals [27]. Such software solutions enable consumers to decrease associated costs and increase agency as they provide the means for consumers to monitor and actively control their energy consumption. However, to unfold the full potential of consumer participation towards renewable decentralized energy systems, large-scale adoption is key. Therefore, further research on digital energy management is necessary to identify and address adequate incentives that would motivate consumers to actively participate in sustainable energy systems. High consumer satisfaction is a key incentive for co-creating sustainable digital energy systems in the medium to long term.

2.2. Consumer preferences for multi-dimensional energy features

The technology-enabled opportunities for consumer participation (cf. Section 2.1) have a substantial impact on energy-related features that can be perceived by consumers. Energy features encompass a wide range of economic, ecological, and social factors. As energy features may affect the common dimensions of energy security, energy equity and environmental sustainability associated with energy supply [28], we consider energy features to affect consumers in a multi-dimensional may [29]. For instance, the implementation of an intelligent electrical storage system may enable homeowners to decrease energy-related costs, increase utilization of renewable energy sources, and reduce their reliance on fossil fuels and imported energy. Hence, the implementation of the new opportunity to get an intelligent electrical storage system comes with different features of energy supply and affects the consumer economically and ecologically. Another example are microgrids which are units that are distinct from the rest of the system and can function regardless of whether they are connected to the larger main grid or not [30]. Microgrids have the advantage of high resiliency and reliability to improve electrical grids. Hence, microgrid users can profit from improved capabilities to manage distributed renewable energy resources [30] which may affect them economically and socially.

The features of a good such as energy affect consumer satisfaction and, consequently, the adoption of corresponding technology [31]. Therefore, it is crucial to comprehend which energy features can affect consumer satisfaction and, hence, active consumer participation [25,32]. It is relevant to query consumers' preferences for energy features in energy systems. Because unlike consumers satisfaction consumers preferences can be obtained through surveys. Consumer satisfaction is

described as the aggregation of the perceived performance of the features of a product or service and cannot be queried by a survey [46], [33]. Therefore, consumers' preferences regarding energy features can serve to classify consumer satisfaction. While recent research has focused on either emerging energy opportunities or consumer behavior individually, our study will contribute to building a deeper understanding of the intersection between these two areas, specifically in relation to consumer satisfaction. By exploring this connection, our research will serve as a basis for further investigation.

2.3. Concept of consumer satisfaction measured with the Kano Model

The Consumer satisfaction can be described as the aggregation of the perceived performance of the features of a product or service. While traditional satisfaction analyses argue that feature performance positively affects consumer satisfaction proportionally [34]. Kano et al. [19] proposed a revised model with different types of features – each affecting satisfaction in its own way. As of today, the Kano Model is a well-known framework for assessing consumer satisfaction. It is widely applied in both, Marketing and IS research [20,21,35–37]. As Fig. 1 illustrates, the Kano Model uses five different feature types [19,35,36,38]:

- Must-be (M) features are taken for granted by consumers. If they are not fulfilled, consumers will be extremely unsatisfied. If the feature is fulfilled, however, a further increase in fulfilment does not lead to higher satisfaction. These features are no competitive factor. Not fulfilling them, however, usually leads to consumers neglecting the product overall [33].
- One-dimensional (O) features are the classic linear relationship between feature fulfilment and consumer satisfaction. A low fulfilment leads to consumer dissatisfaction, a high fulfilment to satisfaction. These features are usually explicitly demanded by consumers.
- Attractive (A) features are so called "delighters". Consumers do not expect them. Therefore, a low fulfilment does not lead to dissatisfaction. If the feature is fulfilled, however, the consumer is surprised and excited, resulting in a high satisfaction. These features are usually not demanded explicitly.
- Indifferent (I) features do not yield satisfaction nor dissatisfaction, regardless of the level of fulfilment, because consumers do not care about the feature.
- Reverse (R) features are the inverse of one-dimensional features. Fulfilment leads to consumer dissatisfaction and vice versa.

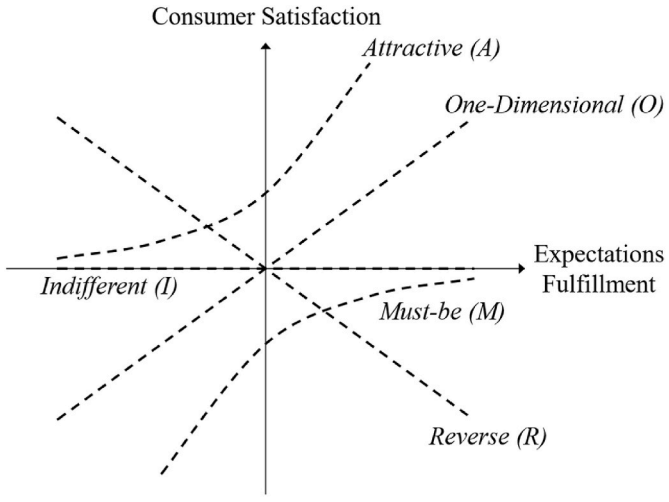

Fig. 1. Illustration of the five different categories in the Kano Model for consumer satisfaction [19].

The Kano Model not only classifies features, but also accounts for the effect that features decay over time as they get incorporated into consumers' expectations. New features usually start as attractive features, as consumers do not expect them. Over time, they may become O and eventually M features. The Kano categories, therefore, indicate the maturity level of a certain feature [19]. In trade-off situations, the Kano categories can also help to determine which feature promises the greatest influence on consumer satisfaction. Therefore, the Kano Model allows us to link consumer preferences for energy features to consumer satisfaction and to finally draw conclusions regarding the perceived attractiveness of features, allowing consumers to play an active role in digital sustainable energy systems.

3. Method

3.1. Consecutive research approach

To answer our research question, we follow a consecutive research approach as illustrated in Fig. 2. In the first step, we followed a systematic literature review approach [39] to gain a holistic understanding of energy opportunities for consumer participation in sustainable energy systems based on existing research. We searched the databases Scopus and Google Scholar to identify relevant articles. We used the following Boolean search string.

(energy OR power*) AND (consum* OR residen* OR household) AND (partici* OR willing* OR active) AND (sustainab* OR renewab*) AND (digit* OR techno*) AND (demand OR supply OR market OR system), which was applied to the title, abstract, and keyword sections of listed articles in the databases. Our search resulted in a reference list of 2088 articles. To narrow the scope of our search, we applied the following inclusion criteria: (1) We limited our results to articles that were published and classified as articles, conference papers, reviews, and book chapters. (2) We excluded all articles that were not published in English. (3) We excluded all articles unrelated to energy opportunities to foster active consumer participation. In addition to applying exclusion and inclusion criteria, we examined the reference list and selected papers regarding their relevance to our research question. After reviewing the reference list, we gained a profound understanding of technology-enabled opportunities for consumer participation in energy systems, which serves as basis to deduce associated energy features.

In the second step, we synthesized the results of the literature review to identify multi-dimensional energy features. Our work started with an identification of energy features in the articles from the literature review. It involved examining the results of the articles as well as comparing their findings to identify energy features. Next, the content was discussed in a workshop with a group of 15 research experts, which had a high level of expertise in the field of energy-related research, to provide validation and justification for the identified energy features. The workshop focused on assessing the completeness and plausibility of the features as well as on refining and supplementing them. As part of the expert workshop, we acquired further recommendations for relevant scientific articles. The information and knowledge we obtained from the expert workshop enriched our understanding of the energy features. After combining the systematic literature review and the additional articles as proposed by energy research experts, our refined reference list contained 48 articles.

In the third step, we conceptualized a survey design using the Kano methodology based on the identified energy features to measure energy features' impact on consumer satisfaction [33]. We include the self-stated importance measurement in the survey catalog to validate the relevance of the chosen energy features to the consumer. In Section 4.1, we present the energy features that were derived, and in Sections 4.2 and 4.3 we discuss the results of the survey.

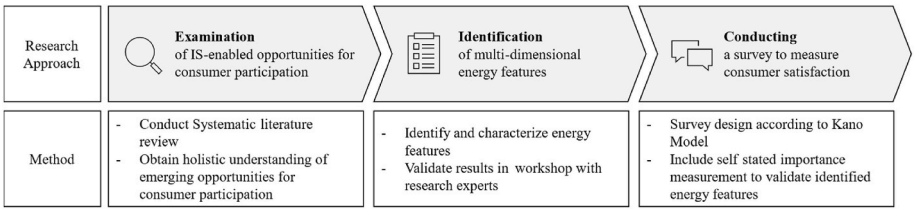

Fig. 2. Illustration of the consecutive research approach and applied methods.

3.2. Data collection

A representative German online survey was conducted in 2022 to collect data and analyze corresponding consumer satisfaction considering the features of opportunities for consumer participation. Our decision to investigate Germany as a country was motivated by the goal of promoting consumer participation and helping to achieve the targets set for the German energy market by 2030. Gross electricity consumption from renewable energy sources is to be increased to 80 % [40].

We recruited 542 participants using Dynata as a professional research panel. Recruitment was restricted to participants located in Germany. The sample for this study includes 492 private consumers and 50 industrial consumers (i.e., corporate representatives who participated in the survey on behalf of industrial companies). Private consumers answered the survey questions according to their individual perspectives. The sub-sample of private consumers is nationally representative of Germany in terms of age, gender, and region [41]. To ensure that our panel data is nationally representative, we utilized the quotas provided by the Statistical Office of Germany to establish percentage ratios for the survey participants. Industrial consumers participating in the survey are employed or self-employed in energy-intensive industries, with operational energy management being part of their jobs. Industrial consumers were specifically asked to answer the survey questions from the perspective of the industrial company they work in.

As online materials might not engage every participant, we implemented several attention checks to the survey [42,43]. After excluding inattentive participants, our final sample comprised 401 private consumers participants (50.12 % female, 50.12 % male, .25 % diverse, aged between 18 and 70) and 40 industrial consumers (27.5 % female, 72.5 % male, 0 % diverse, aged between 19 and 66). We pre-registered the study [44,45] using the platform AsPredicted. This pre-registration aligns with ongoing developments in IS research, questioning the mere reliance on statistical significance [46,47].

Fig. 3 illustrates the survey procedure. First, participants received a brief introduction to the subject of the survey and were informed of the fundamental concepts. Second, participants were confronted with sociodemographic questions. Third, we asked participants to indicate the importance they attach to energy features (cf. Section 2.2). Fourth, participants answered a Kano questionnaire to elicit their preferences regarding energy features (cf. Section 2.2). Finally, we provided participants with a debriefing regarding the survey.

3.3. Measures of satisfaction assessment

Besides questions addressing the sociodemographic characteristics of survey participants, we measured the self-stated importance participants attach to different energy features as well as a Kano questionnaire to link energy features with consumer satisfaction. In doing so, we employed a five-point Likert scale.

For the Kano questionnaire, we followed the methodology outlined by 33 (1996): For each feature, we used a set of two Kano questions, each with a five-point Likert scale (cf. Appendix A and B). The first measures the reaction of the consumer if a feature is present (functional form), the second one measures the reaction if the feature is not present (dysfunctional form) (Table 1) [48].

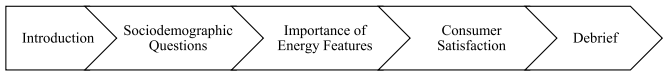

Fig. 3. Schematic illustration of the consecutive steps of the survey procedure (cf. Appendix A and B).

Table 1
Example of the Kano questionnaire according to Matzler et al. [33].

Energy Feature	Kano Questions for Private Consumers		Kano Questions for Industrial Consumers	
	Functional	Dysfunctional	Functional	Dysfunctional
Consumer price	If your electricity is cheap, how do you feel?	When your electricity is expensive, how do you feel?	If your company's electricity is cheap, how do you feel?	If your company's electricity is expensive, how do you feel?
…	…	…	…	…

The evaluation of the Kano questions consisted of three steps. First, the survey respondents' individual answers to the functional and dysfunctional questions were mapped to a Kano category using a Kano evaluation table. This process categorized each energy feature based on the preferences of each survey respondent. Second, the Kano category with the highest frequency across all respondents determined the final classification of the energy feature as Must-be, One-dimensional, Attractive, or Indifferent. The Kano category with the highest frequency across all respondents is used to classify the energy feature (Must-be, One-dimensional, Attractive, or Indifferent). If the assignment of one of the Kano categories is ambiguous, we use the evaluation rule proposed in literature M > O > A > I [33]. Third, we calculated consumer satisfaction coefficients [33]. These coefficients indicate how strongly a certain feature influences satisfaction or dissatisfaction and yield an average impact through a normalizing factor. The Coefficient of Satisfaction (Dissatisfaction) ranges from 0 to 1 (−1); the closer the coefficient to its maximum, the higher the influence on satisfaction (dissatisfaction). The Coefficient of Satisfaction is determined by adding the counts of respondents who view the energy feature as either One-dimensional (O) or Attractive (A) and dividing by the total number of respondents who provided relevant classifications (O, A, M, I). This coefficient reflects the proportion of respondents for whom the feature positively impacts satisfaction. The Coefficient of Dissatisfaction is calculated by adding the count of respondents who see the feature as Must-be (M) or One-dimensional (O) and then dividing by the total relevant responses. The result reflects that these features, if absent, lead to dissatisfaction.

$$\text{Coefficient of Satisfaction} = \frac{A+O}{A+O+M+I} \tag{1}$$

$$\text{Coefficient of Dissatisfaction} = -\frac{O+M}{A+O+M+I} \tag{2}$$

4. Results

This section presents the results of the relevant energy features and the results of the online survey. First, we summarize the conducted literature review to identify the relevant energy features that were

analyzed. Second, we present participants' self-stated importance regarding these energy features (Section 4.1). Third, we outline the results of the consumer satisfaction assessment based on the Kano Model (Section 4.2).

4.1. Identified multi-dimensional energy features

To foster active consumer participation in energy systems, we infer multi-dimensional energy features and examine the importance that private and industrial consumers attach to those features. In Table 2, we explain 14 energy features that we have identified in the second step of our consecutive research approach (cf. Section 3.1).

4.2. Importance of energy features

To weed out unimportant energy features identified when following the consecutive research approach presented in Fig. 2, participants assessed each energy feature's importance. Results show that most features are indeed important to private and industrial consumers (cf. Figs. 4 and 5).

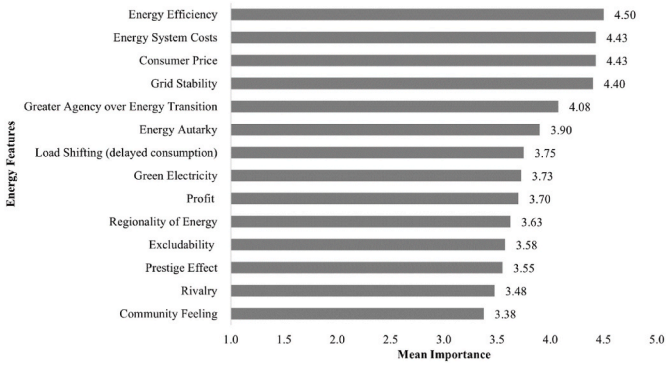

Fig. 4. Mean energy feature importance: private consumers (measurement according to a five-point Likert scale: 5 = very important, 4 = important, 3 = neutral, 2 = less important, 1 = not important).

Table 2
Energy features based on literature review.

Energy**Feature**	**Description**	**Exemplary Sources**
Consumer price for energy	The consumer price for energy is the amount that individual consumers are required to pay for one unit of energy. Opportunities for consumer participation can significantly impact the price that consumers pay for energy, and, as a result, can be a crucial factor in for instance, determining the economic value of investments in this regard.	[49–59]
Energy system costs	Energy system costs refer to the total expenses associated with energy supply, which impact all market participants. In contrast to the Consumer Price for Energy, which affects only individual consumers, energy system costs have wider-reaching implications. Opportunities for consumer participation can influence Energy System Costs, e.g., by offering low-cost balancing services, which can ultimately decrease the overall system costs required for maintaining grid stability.	[52,58,60–62]
Greater agency over energy transition	Greater agency over the energy transition refers to the impact of consumer actions on the energy transition. Opportunities for consumer participation can influence the degree to which consumers view themselves as an active and influential force in driving and shaping the energy transition as innovators and legitimators.	[53,57,63–66]
Regionality of energy	Regionality of energy corresponds to the utilization of locally generated energy. Opportunities for consumer participation can influence consumers' capacity to manage and control the regionality of electricity generation. For example, the collective installation of a local wind farm by the local residents increases the regionality of the available electrical energy.	[52,66–68]
Energy autarky	Energy autarky refers to the extent to which consumers prefer to meet their energy needs, e.g., through their own electricity generation or regional electricity generation in their community or municipality, rather than relying on external sources.	[54,57,69–71]
Profit from electricity generation	Profit from electricity generation relates to consumers' ability to generate revenues and profits. For instance, households may find it appealing to have a profit opportunity as an additional incentive to invest in a photovoltaic system, aside from fulfilling their own electricity requirements.	[56,66,72]
Community feeling	Community feeling addresses consumers' ability to engage in an energy community, where they can share or trade energy with other consumers. For example, participation in a local peer-to-peer energy trading platform can influence consumers' sense of community and collective identity.	[13,40,46,68,73]
Grid stability	Grid stability relates to the balancing supply and demand in the electricity grid at any given time to ensure grid stability. By actively participating in the energy system, consumers may contribute to grid stability, such as by providing balancing power through an electrical storage system.	[63,65,74,75]
Prestige effect	Prestige effect refers to the perceived change in a consumer's prestige or status in society. In addition to aspects related to energy supply security and costs, consumers' perceptions of ingroup norms and collective efficacy also significantly contribute to explaining goal intentions. Consumers may value the opportunity for social comparison or to compare themselves with their peers, which could be facilitated by incorporating gamification elements.	[52,63,76–80]
Green electricity	The feature green electricity relates to the consumption of electricity generated from renewable energy sources as opposed to fossil energy sources such as coal, ignite, or gas. The impact of consumers' decisions and resulting influence on the environment are often viewed in ethical terms, including responsibility to future generations.	[35,48,49,57,64,65,67,68,74,76,81,82,84]
Energy efficiency	Energy efficiency refers to the ability to reduce energy consumption without compromising corresponding output. Consumers can increase energy efficiency by utilizing devices with higher energy efficiency or by implementing intelligent approaches for energy management.	[65,83–87]
Load shifting (delayed consumption)	Load shifting corresponds to the ability of consumers shift their energy consumption temporarily to reduce demand during peak hours and/or take advantage of the availability of (renewable) energy sources. This feature enables consumers to adjust their energy consumption in response to dynamic price signals.	[11,41,45,46,54,57,64,65,67,68,74,83,87–90,92]
Rivalry	Rivalry relates to the competition of several consumers for a limited amount of available energy. This competition for energy may arise, for example, in an energy community with limited electricity capacities.	[24,82,91]
Excludability	Excludability relates to the possibility to exclude individuals from consuming energy. Opportunities for consumer participation may affect excludability from energy consumption for consumers. For instance, if consumers participate in a peer-to-peer trading platform, a non-independent agent may decide on their ability to participate in trading, thus, affecting their access to energy.	[24,91]

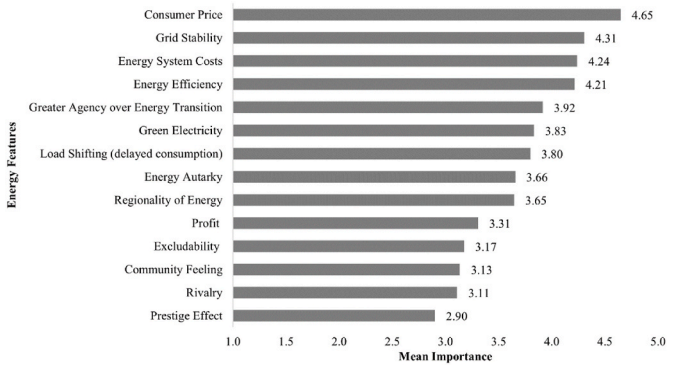

Fig. 5. Mean energy feature importance: industrial consumers (measurement according to a five-point Likert scale: 5 = very important, 4 = important, 3 = neutral, 2 = less important, 1 = not important).

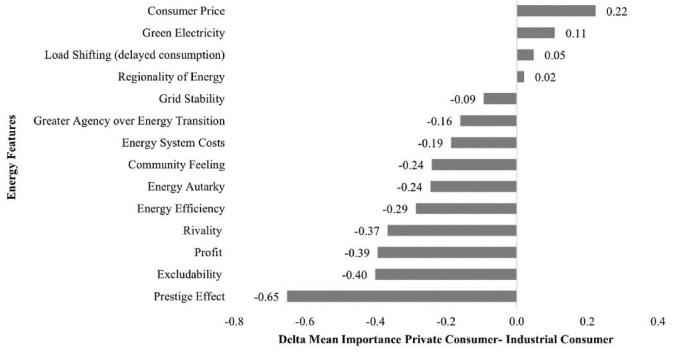

Fig. 6. Mean energy feature importance differences (private vs. industrial consumers).

On average, private consumers attach an importance of 3.71 across all features. For private consumers, energy features that entail economic outcomes such as consumer price, energy system cost, and energy efficiency as well as grid stability are most important (i.e., answers lie on average between 4 = important and 5 = very important). In contrast, prestige effects are least important to private consumers (i.e., answers lie on average between 2 = less important and 3 = neutral). Remaining energy features can be categorized as being of medium to high interest to private consumers.

Industrial consumers attach a mean importance of 3.89 to all features, which is higher compared to private consumers (3.71). For industrial consumers, no feature has an overall mean importance below 2.9 (i.e., all features are rated on average to be at least neutral). Similar to private consumers, industrial consumers rate features such as energy efficiency, energy system costs, consumer price and grid stability as most important (i.e., answers lie on average between 4 = important and 5 = very important).

Fig. 6 illustrates differences in self-stated importance for each feature between private and industrial consumers. Consumer price, green electricity and load shifting (delayed consumption) are more important to private consumers, all other features are more important to industrial consumers.

4.3. Kano categories and consumer satisfaction coefficients of energy features

After assessing the self-stated importance of energy features, the energy features are assigned to Kano categories. This categorization allows for a more fine-grained interpretation of their influence on consumer satisfaction and the maturity of energy features. Tables 3 and 4 summarize to what extent energy features were classified into the different Kano categories according to survey participants' individual responses, energy features' overall categorization into one of the Kano categories, as well as satisfaction and dissatisfaction coefficients for industrial and private consumers (see explanation of the calculations in section 3.3). For each energy feature, the Kano category that exhibits the highest percentage determines its overall categorization into one of the Kano categories [78].

According to Tables 3 and 4, we observe that consumer price is a one-dimensional (O) feature. This indicates that both private and industrial consumers are explicitly demanding cheap energy prices and that they are dissatisfied if the energy feature is not fulfilled. For the reverse (R) features, excludability, consumers explicitly expect the reverse, meaning they expect the inclusion of all consumers. All features that have a higher coefficient of satisfaction than the coefficient of dissatisfaction – tend to be more attractive (A) features. This holds for energy autarky and profit in both groups as well as additionally for energy system cost and greater agency for industrial consumers.

All features have been classified based on survey results, with the inclusion of a (Q) score to indicate any questionable responses. The questionable responses may be due to poorly phrased questions or participant misunderstandings. Among private consumers, no energy feature received a (Q) score higher than 5 percent, and for industrial consumers, no energy feature received a (Q) score higher than 8 percent. The clarity of feature classification has allowed the (Q) category to serve as a quality measurement to filter out poorly answered responses [33].

Table 3
Private consumers: Kano category and consumer satisfaction coefficient overview.

Energy Feature	A	M	R	O	Q	I	Category	Satisfaction	Dissatisfaction
Consumer Price	.18	.07	.01	.60	.01	.12	O	.80	−.69
Excludability	.03	.02	.61	.04	.01	.28	R	.21	−.16
Energy Autarky	.45	.01	.02	.12	.02	.37	A	.60	−.14
Profit	.47	.00	.01	.10	.02	.39	A	.59	−.10
Energy System Costs	.24	.04	.02	.22	.03	.45	I	.48	−.27
Greater Agency	.24	.02	.02	.13	.03	.56	I	.39	−.15
Energy Efficiency	.30	.06	.02	.26	.01	.36	I	.57	−.32
Regionality of Energy	.30	.02	.02	.14	.05	.46	I	.48	−.17
Grid Stability	.32	.02	.01	.13	.01	.51	I	.46	−.16
Green Electricity	.25	.04	.03	.18	.02	.47	I	.45	−.24
Community Feeling	.29	.01	.04	.07	.02	.57	I	.38	−.08
Load Shifting	.22	.02	.04	.13	.02	.56	I	.38	−.16
Prestige Effect	.18	.01	.04	.05	.02	.69	I	.25	−.07
Rivalry	.06	.01	.35	.05	.01	.52	I	.16	−.10

Table 4
Industrial consumers: Kano category and consumer satisfaction coefficient overview.

Energy Feature	A	M	R	O	Q	I	Category	Satisfaction	Dissatisfaction
Consumer Price	.28	.12	.00	.42	.02	.15	O	.72	−.56
Excludability	.10	.05	.52	.02	.05	.25	R	.29	−.18
Energy Autarky	.48	.02	.05	.12	.05	.28	A	.67	−.17
Profit	.40	.05	.02	.10	.08	.35	A	.56	−.17
Energy System Costs	.35	.05	.05	.02	.05	.30	A	.61	−.28
Greater Agency	.35	.02	.02	.25	.05	.30	A	.65	−.30
Energy Efficiency	.25	.10	.02	.22	.05	.35	I	.51	−.35
Regionality of Energy	.35	.00	.08	.15	.02	.40	I	.56	−.17
Grid Stability	.15	.02	.02	.22	.08	.50	I	.42	−.28
Green Electricity	.28	.05	.10	.12	.05	.40	I	.47	−.21
Community Feeling	.2	.00	.05	.08	.08	.55	I	.37	−.09
Load Shifting	.15	.10	.02	.15	.05	.52	I	.32	−.27
Prestige Effect	.35	.05	.02	.08	.05	.45	I	.46	−.14
Rivalry	.25	.00	.30	.05	.05	.35	I	.46	−.08

5. Discussion

The high mean importance consumers attach to energy features illustrates that consumers are aware that energy use gained novel and important features due to the new possibilities of digital technologies. In consequence of this high awareness, we observe that consumers' perception of energy as a commodity has changed and their willingness to play an active role in energy systems has increased.

For private consumers, a high importance of grid stability and greater agency over energy transition could be due to the news coverage of the 2022 global energy crisis and the war in Ukraine. Consequently, consumers in Germany may fear power outages and strive to actively contribute to resilient and sustainable energy systems that decrease dependence on fossil fuel imports. This is in line with our finding that green electricity and regionality of energy are important energy features for consumers, as both directly contribute to achieving ambitious climate targets and help to navigate through crises. Consumers attach less importance to energy features that require greater active engagement, such as load shifting (delayed consumption), energy autarky, and profit. Consumers need to actively adjust their energy consumption behavior to benefit from load shifting, which they may not yet see as attractive and beneficial. Education programs could bridge this gap by showcasing how load shifting supports green energy and regional sustainability. Highlighting the benefits of load shifting, such as cost savings and improved energy reliability, could increase consumer interest and engagement.

Perception of electricity in form of rivalry and excludability as well as social factors such as community feeling, and prestige are less important to consumers. For the former two features, this could be due to the rather abstract nature of those energy features and the fact that, today, consumers still perceive energy to be something they are not competing for with other consumers and they cannot be excluded from. prestige may carry a negative connotation, which may lead consumers to understate this seemingly uncomfortable energy feature.

In times of all-time highs of energy costs, such as during the 2022 global energy crisis, industrial consumers focus on energy features affecting profitability, e.g., energy efficiency, energy system cost, and consumer price. The 2022 global energy crisis affects industrial consumers, thereby, increasing the importance of grid stability. While energy features that merely influence social aspects such as community feeling are less important, features with higher active engagement such as greater agency over energy transition, energy autarky, load shifting (delayed consumption), and profit are more important to consumers. However, they are less important than features where profitability can be positively affected even with little active commitment. This is interesting, as even though decarbonization of the industry is a very important topic in society, sustainable energy features such as green electricity and regionality of energy are less important to industrial consumers as compared to energy features affecting profitability. Still, this appears to be logical, as profitability is the prerequisite for industrial consumers to keep operational activities running.

The quality of the energy service provided by end-use equipment is critical aspect of consumer participation. We aim to provide a comprehensive overview of consumer participation potential by focusing on these energy features, without delving into the specifics of individual product quality requirements. The Kano Model allows to prioritize energy features concerning their impact on consumer satisfaction. Table 5 summarizes all analyzed energy features and their categorization according to the Kano Model. Industrial consumers distinguish between price, as a one-dimensional feature, and energy system cost, as an attractive feature. This distinction suggests a potential for increased involvement in grid activities from industrial consumers. The one-dimensional and reverse features consumer price and excludability can be described as performance features. Therefore, entities providing consumers with (digital) concepts for active participation in energy systems should focus on fulfilling those features, before addressing others (cf. Section 5.2). To achieve high consumer satisfaction, consumers explicitly expect these features to be fulfilled. To incite active consumer participation in digital sustainable energy systems, it is imperative for consumer satisfaction to ensure affordable (low) prices and that no consumer is/can be excluded from energy consumption. In both consumer groups (private and industrial) energy autarky and profit are attractive features. These features seem to be interesting, exciting, and new to consumers and if they are fulfilled, they can improve consumers' satisfaction. This result underlines the high awareness of consumers of the challenges and opportunities of today's and future energy systems. In other words, consumers are excited by the idea of increasing independence through electricity generation and to profit from selling excess electricity. To reach a high satisfaction, providers of (digital) solutions for consumer participation should not only focus on one-dimensional and reverse features, but also on improving attractive features. It is important to notice that there is a difference in Kano categorization of features for private and industrial consumers. energy system cost and greater agency over energy transition are attractive features for industrial, but indifferent features for private consumers. This difference is likely to be caused by differences in energy demand profiles, energy-related know-how, and financial resources. For example, private consumers have most likely fewer financial resources and knowledge to improve energy management than industrial consumers (where adequate information and communication technology is already in place, e.g., to adapt electricity consumption patterns).

Indifferent features neither increase nor decrease consumer satisfaction. For private consumers, this relates to the features energy system costs, greater agency, energy efficiency, regionality of energy, grid stability, green electricity, community feeling, load shifting, prestige effect, and rivalry. Indifferent features can be interpreted as features that consumers are not interested in or that they are not sufficiently informed about with such novel energy features only being available to a small

Table 5
Energy features and their corresponding Kano categories.

Energy Feature	Kano Category	
	Private Consumer	Industrial Consumer
Consumer Price	O	O
Excludability	R	R
Energy Autarky	A	A
Profit	A	A
Energy System Costs	I	A
Greater Agency	I	A
Energy Efficiency	I	I
Regionality of Energy	I	I
Grid Stability	I	I
Green Electricity	I	I
Community Feeling	I	I
Load Shifting	I	I
Prestige Effect	I	I
Rivalry	I	I

portion of consumers and society. The latter explanation would comply with existing literature that points to the importance of such features for private and/or industrial consumers, which we could not confirm based on the results of our empirical study.

In our survey, no energy feature is at the core of consumers' expectations in the sense of a must-be feature. Features like consumer price would arguably fall in this category. However, recent events (energy crises) might have led consumers to reconsider the status quo and to not take a stable grid and cheap energy for granted.

5.1. Implications for research

The results of this study yield three key implications for research: First, this study contributes novel and highly relevant insights to the research field of digital sustainable energy systems. This study sheds light on the relationship between consumer satisfaction and energy features influenced by IS-enabled opportunities for an active consumer participation. This opens numerous pathways for further research projects. For example, we believe our study could provide important insights regarding the design of digital sustainable energy systems to foster active consumer participation.

Second, this study builds a starting point for future research that extends our understanding of consumer satisfaction and helps to discover additional energy features relevant to consumers. This study outlines existing opportunities for consumer participation as well as underlying energy features and establishes a systematic categorization of these features according to consumer satisfaction. Further research may extend the obtained insights regarding private and industrial consumer satisfaction in the context of renewable energy systems based on the first insights provided by this study.

Third, this study classifies features into different categories and identifies for which energy features consumers are indifferent. Our finding suggests that consumers tend to be indifferent regarding the fulfillment of some energy features. To gain additional insights into motivations of consumers to participate in digital sustainable energy systems, it is important to understand whether consumers are indifferent regarding those energy features, or merely lack a profound understanding. Against that background, future energy management research may contribute to inform and educate energy consumers regarding the wide-ranging opportunities and benefits of active participation.

5.2. Implication for practice

On the one hand, our results highlight which energy features affect consumer satisfaction and to what extent. This provides highly relevant insights for, e.g., startups or industry incumbents, to better align solutions for active consumer participation in digital sustainable energy systems. Insights into consumer satisfaction allow for a deep understanding of consumer perspectives that are not exhaustively studied yet. On the other hand, our results reveal important insights for (energy) policy-makers. Policy-makers should take consumer preferences into account when designing or adjusting regulatory frameworks and market rules that affect consumers and their ability to actively contribute to the energy transition (e.g., minimum trading volumes or bidding languages that allow to express consumer preferences). Such new regulatory rules and corresponding policy frameworks might yield better overall public acceptance.

5.3. Limitations

This study has several limitations. One limitation concerns the study design which is based on the Kano Model [19,92]. It is important to keep in mind that Kano is not a quantitative, but a qualitative approach and that implications should be drawn in such way. Still, relying on the Kano Model and methodology represents a widely applied approach to elicit consumer preferences in IS research. Another limitation concerns the survey-based measurements of satisfaction, e.g., the self-stated importance. Corresponding results can only be interpreted under some limitations as we cannot fully exclude the possibility that survey participants had difficulties indicating how important different features are to them due to a lack of understanding or familiarity. To cope with this challenge, we included extensive explanations in the online survey regarding all the concepts we relied on and provided survey participants with a comprehensive introduction before letting them start with the survey. Additionally, we face an imbalance between a big sample of private consumers and a small sample of industrial consumers. Therefore, we ensured representative participants according to age, gender, and place of residence to prevent statistical misinterpretations. Finally, while our study focused on analyzing general energy features and their impact on consumer satisfaction, it is important to acknowledge that the quality of the energy service provided by end-use equipment plays a critical role in the successful participation of consumers in digital sustainable energy systems. The performance, reliability, and compatibility of end-use equipment can significantly influence consumer satisfaction and, consequently, the effectiveness of consumer participation. Therefore, the quality and readiness of end-use equipment should be considered a potential prerequisite for active consumer participation. This presents a valuable avenue for future research, where a detailed investigation into the interplay between equipment quality and consumer satisfaction and participation could yield further insights and enhance the understanding of how to best facilitate the energy transition.

6. Conclusion

This study aims at gaining new insights regarding consumer satisfaction to ultimately foster consumer participation in digital sustainable energy systems. In doing so, we build on the Kano Model as a theoretical foundation and analyzed consumer satisfaction based on an online survey with 401 private and 40 industrial consumers in Germany. We found that consumers value novel energy features and that they are genuinely excited and interested in playing an active role in energy systems. Further, our results highlight, which energy features are most important to get consumers excited, and which not. These insights, we believe, bring us one important step closer to gain a deeper understanding of how to incite consumers to positively contribute to the energy transition, e.g., by installing a photovoltaic system and selling excess electricity or installing an electrical storage system to increase utilization of renewable energies. As digital technologies are an enabler for an active consumer participation in energy systems, this study highlights the relevance of sustainable digital energy systems research in advancing the energy transition and contributing to a more sustainable digital future.

CRediT authorship contribution statement

Theresa Magdalena Sophie Heinrich: Conceptualization, Data curation, Formal analysis, Investigation, Project administration, Software, Visualization, Writing – original draft. **Felix Wagon:** Conceptualization, Methodology, Project administration, Supervision, Validation, Visualization, Writing – review & editing. **Martin Weibelzahl:** Conceptualization, Formal analysis, Funding acquisition, Project administration, Supervision, Validation, Writing – review & editing.

Declaration of competing interest

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

Appendix A. Questionnaire for Private Consumers

Contextual and sociodemographic questions

German	English
Wann sind Sie geboren? Nennen Sie bitte das Jahr Ihrer Geburt.	When were you born? Please state the year of your birth.
Welchem Geschlecht fühlen Sie sich zugehörig?	To which gender do you feel you belong?
Welchen höchsten Bildungsabschluss haben Sie?	What is your highest level of education?
Wie hoch ist Ihr persönliches durchschnittliches monatliches Nettoeinkommen?	What is your personal average monthly net income?
Wie lautet Ihr aktueller Beschäftgungsstatus?	What is your current employment status?
Wie ist Ihre derzeitige Wohnsituation?	What is your current housing situation?
Wie lautet Ihre deutsche Postleitzahl?	What is your German zip code?

Importance of energy features (five-point Likert scale)

German	English
Wenn Sie heute über Energie/Strom nachdenken, wie wichtig sind für Sie die folgenden Aspekte?	When you think about energy/electricity today, how important are the following to you?
Verbraucherpreis	Consumer price for energy
Systemweite Energiekosten (Kosten, die für alle anfallen)	Energy system costs (costs incureed by all)
Unterstützung der Energiewende (Wirkung des eigenen Handelns auf die Energiewende)	Greater agency over energy transition (effects of one's own actions on the energy transition)
Regionalität der Energieerzeugung	Regionality of energy
Energie-Autarkie (Deckung des Energiebedarfs mit eigener Energieerzeugung)	Energy autarky (covering the energy demand with own energy production)
Einnahmen durch Stromproduktion (Möglichkeit durch eigene Stromproduktion Geld zu verdienen)	Profit from energy generation (possibility to earn money through own electricity production)
Gemeinschaftsgefühl (Verbundenheit mit externen Energiekonsumenten)	Community feeling (solidarity with external energy consumers)
Netzstabilität (Gleichgewicht zwischen Angebot und Nachfrage im Stromnetz)	Grid stability (balance between supply and demand in the power grid)
Prestigeeffekt/Sozialer Status/Soziales Ansehen	Prestige effect/Social status
Erneuerbare Energien (nachhaltige Energieversorgung)	Green electricity (sustainable energy supply)
Energieeffizienz	Energy efficiency
Energieflexibilität (Anpassung des Energieverbrauches an die wetterabhängige Verfügbarkeit von erneuerbaren Energien)	Load shifting (delayed consumption)
Rivalität um Strom (Konkurrenz mehrerer Verbraucher um Strom)	Rivalry (competition of several consumers for electricity)
Ausschlussfähigkeit des Stroms (Möglichkeit einzelne Verbraucher auszuschließen)	Excludability (possibility to exclude individual consumers)
Kontrollfrage: Bitte klicken Sie "überhaupt nicht wichtig" an	Control question: Please tick "not important at all"
Denken sie, dass die Energiewende wichtig ist?	Do you think that the energy transition is important?

Kano questions (five-point Likert scale)

Feature	German		English	
	Functional	Dysfunctional	Functional	Dysfunctional
Consumer Price	Wenn Ihr Strom günstig ist, wie fühlen Sie sich dann?	Wenn Ihr Strom teuer ist, wie fühlen Sie sich dann?	If your electricity is cheap, how do you feel?	When your electricity is expensive, how do you feel?
Energy System Costs	Wenn Sie zur Senkung der systemweiten Energiekosten beitragen können, wie fühlen Sie sich dann?	Wenn Sie nicht zur Senkung der systemweiten Energiekosten beitragen können, wie fühlen Sie sich dann?	If you can contribute to the reduction of system-wide energy costs, how do you feel?	If you can't help reduce system-wide energy costs, how do you feel?
Greater Agency over Energy Transition	Wenn Sie durch innovative Geschäftsmodelle zur Energiewende beitragen können, wie fühlen Sie sich dann?	Wenn Sie nicht durch innovative Geschäftsmodelle zur Energiewende beitragen können, wie fühlen Sie sich dann?	If you can contribute to the energy transition through innovative business models, how do you feel?	If you can't contribute to the energy transition through innovative business models, how do you feel?
Regionality of Energy	Wenn Sie lokal erzeugten Strom aus erneuerbaren Energie verbrauchen, wie fühlen Sie sich dann?	Wenn Sie nicht lokal erzeugten Strom aus erneuerbare Energie verbrauchen, wie fühlen Sie sich dann?	If you consume locally generated electricity from renewable energy, how does that make you feel?	If you are not consuming locally generated electricity from renewable energy, how do you feel?
Energy Autarky	Wenn Sie Ihren Energiebedarf mit Ihrer eigenen Energieproduktion decken können, wie fühlen Sie sich dann?	Wenn Sie Ihren Energiebedarf nicht durch eigene Energieproduktion decken können, wie fühlen Sie sich dann?	If you can meet your energy needs with your own energy production, how do you feel?	If you can't meet your energy needs through your own energy production, how do you feel?

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Kano questions (five-point Likert scale)				
Feature	German		English	
	Functional	Dysfunctional	Functional	Dysfunctional
Profit	Wenn Sie durch Ihre eigene Stromproduktion Geld verdienen können, wie fühlen Sie sich dann?	Wenn Sie nicht durch Ihre eigene Stromproduktion Geld verdienen können, wie fühlen Sie sich dann?	If you can earn money from your own electricity production, how do you feel?	If you can't make money from your own electricity production, how do you feel?
Community Feeling	Wenn Sie sich an einer Energiegemeinschaft beteiligen könnten, um erneuerbare Energie zu teilen und lokal zu handeln, wie fühlen Sie sich dann?	Wenn Sie nicht an einer Energiegemeinschaft teilnehmen könnten, um erneuerbare Energie zu teilen und lokal zu handeln, wie fühlen Sie sich dann?	If you could participate in an energy community to share renewable energy and act locally, how does that make you feel?	If you could not participate in an energy community to share renewable energy and act locally, how do you feel?
Grid Stability	Wenn Sie zur Stabilisierung des Stromnetzes beitragen, wie fühlen Sie sich dann?	Wenn Sie nicht zur Stabilisierung des Stromnetzes beitragen, wie fühlen Sie sich dann?	If you are helping to stabilize the power grid, how does that make you feel?	If you are not helping to stabilize the power grid, how do you feel?
Prestige Effect	Wenn Sie von anderen für Ihre Energiemaßnahmen bewundert werden, wie fühlen Sie sich dann?	Wenn Sie von anderen nicht für Ihre Energiemaßnahmen bewundert werden, wie fühlen Sie sich dann?	If you are admired by others for your energy actions, how does that make you feel?	If you are not admired by others for your energy actions, how do you feel?
Green Electricity	Wenn Sie erneuerbare Energie verbrauchen, wie fühlen Sie sich dann?	Wenn Sie fossile oder nukleare Energie verbrauchen, wie fühlen Sie sich dann?	When you consume renewable energy, how does that make you feel?	If you use fossil or nuclear energy, how do you feel?
Energy Efficiency	Wenn sich die Energieeffizienz Ihrer Geräte verbessert, wie fühlen Sie sich dann?	Wenn sich die Energieeffizienz Ihrer Geräte nicht verbessert, wie fühlen Sie sich dann?	When the energy efficiency of your appliances improves, how does that make you feel?	If the energy efficiency of your appliances is not improving, how do you feel?
Load Shifting (delayed consumption)	Wenn Sie die Zeitplanung Ihres Energieverbrauchs ändern können, um bei geringer Verfügbarkeit weniger zu verbrauchen, wie fühlen Sie sich dann?	Wenn Sie die Zeitplanung Ihres Energieverbrauchs nicht ändern können, um bei geringer Verfügbarkeit weniger zu verbrauchen, wie fühlen Sie sich dann?	When you can change the timing of your energy consumption to use less when your availability is low, how do you feel?	If you can't change the timing of your energy consumption to use less when availability is low, how do you feel?
Rivalry	Wenn Ihr Stromverbrauch den gleichzeitigen Verbrauch anderer verhindert, wie fühlen Sie sich dann?	Wenn Ihr Stromverbrauch den gleichzeitigen Verbrauch anderer nicht beeinflusst, wie fühlen Sie sich dann?	If your electricity consumption prevents others from consuming at the same time, how do you feel?	If your electricity consumption does not affect the simultaneous consumption of others, how do you feel?
Excludability	Wenn Sie vom Stromverbrauch ausgeschlossen werden können, wie fühlen Sie sich dann?	Wenn Sie nicht vom Stromverbrauch ausgeschlossen werden können, wie fühlen Sie sich dann?	If you can be excluded from electricity consumption, how do you feel?	If you cannot be excluded from electricity consumption, how do you feel?

Additional questions related to perceived rivalry and excludability (five-point Likert scale)	
German	English
Ich habe das Gefühl, dass mein Stromverbrauch durch den gleichzeitigen Stromverbrauch anderer verringert oder verhindert wird.	I feel that my electricity consumption is reduced or prevented by the simultaneous electricity consumption of others.
Ich nehme andere Stromverbraucher in meinem Stromnetz als Konkurrenten wahr.	I perceive other electricity consumers in my power grid as competitors.
Ich habe das Gefühl, dass Strom unbegrenzt verfügbar ist.	I feel that electricity is available indefinitely.
Ich habe das Gefühl, dass ich davon ausgeschlossen werden kann, Strom zu verbrauchen.	I feel that I can be excluded from using electricity.
Ich nehme die Stromversorgung in Deutschland als gegeben wahr.	I perceive the electricity supply in Germany as a given.
Ich habe das Gefühl, dass der Stromverbrauch nur auf zahlende Kunden beschränkt ist.	I have the feeling that electricity consumption is limited to paying customers.

Appendix B. Questionnaire for Industrial Consumers

German	English
Wann sind Sie geboren? Nennen Sie bitte das Jahr Ihrer Geburt.	When were you born? Please state the year of your birth.
Welchem Geschlecht fühlen Sie sich zugehörig?	Which gender do you belong to?
Welchen höchsten Bildungsabschluss haben Sie?	What is your highest level of education?
Wie hoch ist Ihr persönliches durchschnittliches monatliches Nettoeinkommen?	What is your personal average monthly net income?
Wie lautet Ihr aktueller Beschäftigungsstatus?	What is your current employment status?
Wie sind die Eigentumsverhältnisse der Hauptproduktionsstandortes ihres Unternehmens?	What is the ownership structure at your company's main production site?
Wie lautet die Postleitzahl des Hauptproduktionsstandortes ihres Unternehmens in Deutschland?	What is the zip code of your company's main production site in Germany?
In welcher Industrie sind Sie tätig?	In which industry are you active?
Gehört das betriebliche Energiemanagement zu Ihren Aufgaben?	Is operational energy management part of your responsibilities?
In welcher Position sind Sie im Unternehmen tätig?	What is your position in the company?

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German	English
In der Folgenden Umfrage bitten wir Sie, alle Fragen aus der Sicht ihres Unternehmens zu beantworten. Bitte achten Sie darauf die Fragen nicht aus ihrer persönlichen Sichtweise zu beantworten.	In the following survey, we ask you to answer all questions from the perspective of your company. Please make sure not to answer the questions from your personal perspective.
Aus welcher Perspektive beantworten Sie alle folgenden Fragen dieser Umfrage?Aus welcher Perspektive beantworten Sie alle folgenden Fragen dieser Umfrage?	From which perspective do you answer all the following questions in this survey?

Importance of energy features (five-point Likert scale)

German	English
Wenn Sie aus der Sicht Ihres Unternehmens heute über die folgenden Aspekte im Zusammenhang mit Energie/Strom nachdenken, wie wichtig sind diese für Sie?	From your company's perspective, when you think about the following aspects related to energy/electricity today, how important are they to you?
Verbraucherpreis	Consumer price for energy
Systemweite Energiekosten (Kosten, die für alle anfallen)	Energy system costs (costs incureed by all)
Unterstützung der Energiewende (Wirkung des eigenen Handelns auf die Energiewende)	Greater agency over energy transition (effects of one's own actions on the energy transition)
Regionalität der Energieerzeugung	Regionality of energy
Energie-Autarkie (Deckung des Energiebedarfs mit eigener Energieerzeugung)	Energy autarky (covering the energy demand with own energy production)
Einnahmen durch Stromproduktion (Möglichkeit durch eigene Stromproduktion Geld zu verdienen)	Profit from energy generation (possibility to earn money through own electricity production)
Gemeinschaftsgefühl (Verbundenheit mit externen Energiekonsumenten)	Community feeling (solidarity with external energy consumers)
Netzstabilität (Gleichgewicht zwischen Angebot und Nachfrage im Stromnetz)	Grid stability (balance between supply and demand in the power grid)
Prestigeeffekt/Sozialer Status/Soziales Ansehen	Prestige effect/Social status
Erneuerbare Energien (nachhaltige Energieversorgung)	Green electricity (sustainable energy supply)
Energieeffizienz	Energy efficiency
Energieflexibilität (Anpassung des Energieverbrauches an die wetterabhängige Verfügbarkeit von erneuerbaren Energien)	Load shifting (delayed consumption)
Rivalität um Strom (Konkurrenz mehrerer Verbraucher um Strom)	Rivalry (competition of several consumers for electricity)
Ausschlussfähigkeit des Stroms (Möglichkeit einzelne Verbraucher auszuschließen)	Excludability (possibility to exclude individual consumers)
Kontrollfrage: Bitte klicken Sie "überhaupt nicht wichtig" an	Control question: Please tick "not important at all"
Ist die Energiewende ein Thema was ihrem Unternehmen wichtig ist?	From your company's perspective, when you think about the following aspects related to energy/electricity today, how important are they to you?

Kano questions (five-point Likert scale)

Feature	German		English	
	Functional	Dysfunctional	Functional	Dysfunctional
Consumer Price	Wenn der Strom ihres Unternehmens günstig ist, wie fühlen Sie sich dann?	Wenn der Strom ihres Unternehmens teuer ist, wie fühlen Sie sich dann?	If your company's electricity is cheap, how do you feel?	If your company's electricity is expensive, how do you feel?
Energy System Costs	Wenn ihr Unternehmen zur Senkung der systemweiten Energiekosten beitragen kann, wie fühlen Sie sich dann?	Wenn ihr Unternehmen nicht zur Senkung der systemweiten Energiekosten beitragen kann, wie fühlen Sie sich dann?	If your company can help reduce system-wide energy costs, how do you feel?	If your company can't help reduce system-wide energy costs, how do you feel?
Greater Agency over Energy Transition	Wenn ihr Unternehmen durch innovative Geschäftsmodelle zur Energiewende beitragen könnte, wie fühlen Sie sich dann?	Wenn ihr Unternehmen nicht durch innovative Geschäftsmodelle zur Energiewende beitragen könnte, wie fühlen Sie sich dann?	If your company could contribute to the energy transition through innovative business models, how do you feel?	If your company couldn't contribute to the energy transition through innovative business models, how do you feel?
Regionality of Energy	Wenn ihr Unternehmen lokal erzeugten Strom aus erneuerbaren Energie verbraucht, wie fühlen Sie sich dann?	Wenn ihr Unternehmen nicht lokal erzeugten Strom aus erneuerbare Energie verbraucht, wie fühlen Sie sich dann?	If your company consumes locally generated electricity from renewable energy, how do you feel?	If your company does not consume locally generated electricity from renewable energy, how do you feel?
Energy Autarky	Wenn ihr Unternehmen den Energiebedarf mit eigenen Energieproduktion decken kann, wie fühlen Sie sich dann?	Wenn ihr Unternehmen den Energiebedarf nicht durch eigene Energieproduktion decken kann, wie fühlen Sie sich dann?	If your company can meet its energy needs with its own energy production, how do you feel?	If your company cannot meet its energy needs through its own energy production, how do you feel?
Profit	Wenn ihr Unternehmen durch die eigene Stromproduktion Geld verdienen könnte, wie fühlen Sie sich dann?	Wenn ihr Unternehmen nicht durch die eigene Stromproduktion Geld verdienen könnte, wie fühlen Sie sich dann?	If your company could earn money by producing its own electricity, how do you feel?	If your company could not make money through your own electricity production, how do you feel?
Community Feeling	Wenn ihr Unternehmen sich an einer Energiegemeinschaft beteiligen könnte, um erneuerbare Energie zu teilen und lokal zu handeln, wie fühlen Sie sich dann?	Wenn ihr Unternehmen nicht an einer Energiegemeinschaft teilnehmen könnten, um erneuerbare Energie zu teilen und lokal zu handeln, wie fühlen Sie sich dann?	If your company could participate in an energy community to share renewable energy and act locally, how do you feel?	If your company could not participate in an energy community to share renewable energy and act locally, how do you feel?
Grid Stability	Wenn ihr Unternehmen zur Stabilisierung des Stromnetzes beiträgt, wie fühlen Sie sich dann?	Wenn ihr Unternehmen nicht zur Stabilisierung des Stromnetzes beiträgt, wie fühlen Sie sich dann?	If your company helps stabilize the power grid, how do you feel?	If your company is not helping to stabilize the power grid, how do you feel?
Prestige Effect	Wenn ihr Unternehmen von anderen für Ihre Energiemaßnahmen bewundert wird, wie fühlen Sie sich dann?	Wenn ihr Unternehmen von anderen nicht für Ihre Energiemaßnahmen bewundert werden, wie fühlen Sie sich dann?	If your company is admired by others for your energy actions, how do you feel?	If your company is not admired by others for your energy actions, how do you feel?
Green Electricity	Wenn ihr Unternehmen erneuerbare Energie verbraucht, wie fühlen Sie sich dann?	Wenn ihr Unternehmen fossile oder nukleare Energie verbraucht, wie fühlen Sie sich dann?	If your company uses renewable energy, how do you feel?	If your company uses fossil or nuclear energy, how do you feel?

(*continued on next page*)

(*continued*)

Kano questions (five-point Likert scale)				
Feature	German		English	
	Functional	Dysfunctional	Functional	Dysfunctional
Energy Efficiency	Wenn sich die Energieeffizienz der Geräte und Maschinen in Ihrem Unternehmen verbessert, wie fühlen Sie sich dann?	Wenn sich die Energieeffizienz der Geräte und Maschinen in ihrem Unternehmen nicht verbessert, wie fühlen Sie sich dann?	When the energy efficiency of your company's equipment and machinery improves, how do you feel?	If the energy efficiency of your company's equipment and machinery is not improving, how do you feel?
Load Shifting (delayed consumption)	Wenn Sie die Zeitplanung des Energieverbrauchs ihres Unternehmens ändern können, um bei geringer Verfügbarkeit weniger zu verbrauchen, wie fühlen Sie sich dann?	Wenn Sie die Zeitplanung des Energieverbrauchs ihres Unternehmens nicht ändern können, um bei geringer Verfügbarkeit weniger zu verbrauchen, wie fühlen Sie sich dann?	If you can change the timing of your company's energy consumption to use less when availability is low, how do you feel?	If you can't change the timing of your company's energy consumption to use less when availability is low, how do you feel?
Rivalry	Wenn der Stromverbrauch ihres Unternehmens den gleichzeitigen Energieverbrauch anderer verhindert, wie fühlen Sie sich dann?	Wenn der Stromverbrauch ihres Unternehmens den gleichzeitigen Verbrauch anderer nicht beeinflusst, wie fühlen Sie sich dann?	If your company's power consumption prevents others from consuming power at the same time, how do you feel?	If your company's power consumption does not affect the concurrent consumption of others, how do you feel?
Excludability	Wenn ihr Unternehmen vom Stromverbrauch ausgeschlossen werden kann, wie fühlen Sie sich dann?	Wenn ihr Unternehmen nicht vom Stromverbrauch ausgeschlossen werden kann, wie fühlen Sie sich dann?	If your company can be excluded from power consumption, how do you feel?	If your company cannot be excluded from electricity consumption, how do you feel?

Additional questions related to perceived rivalry and excludability (five-point Likert scale)	
German	English
Ich habe das Gefühl, dass der Stromverbrauch meines Unternehmens durch den gleichzeitigen Stromverbrauch anderer verringert oder verhindert wird.	I feel that my company's electricity consumption is reduced or prevented by the simultaneous electricity consumption of others.
Ich nehme andere Stromverbraucher im Stromnetz meines Unternehmens als Konkurrenten wahr.	I perceive other electricity consumers in my company's power grid as competitors.
Ich habe das Gefühl, dass Strom unbegrenzt verfügbar ist.	I feel that electricity is available in unlimited supply.
Ich habe das Gefühl, dass mein Unternehmen davon ausgeschlossen werden kann, Strom zu verbrauchen.	I feel that my company can be excluded from using electricity.
Ich nehme die Stromversorgung der Industrie in Deutschland als gegeben wahr.	I perceive that electricity is available to industry in Germany.
Ich habe das Gefühl, dass der Stromverbrauch nur auf zahlende Kunden beschränkt ist.	I have the feeling that electricity consumption is limited to paying customers.

Data availability

Data will be made available on request.

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